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ORIGINAL ARTICLE

Local chicken production system in Malawi: Household flock structure, dynamics, management and health

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Abstract Household flocks of scavenging chickens were monitored from August 2002 to August 2003 in 27 villages in Lilongwe, Malawi. The objective was to evaluate the local chicken production system by investigating flock structure, utilization, management and constraints. Farmers and researchers jointly obtained data on household flocks. Mean flock size was 12.9, with a range of 1–61 chickens. The flock dynamics of chickens over 8 weeks old constituted 91% migrating out of flocks and 9% into the flocks. Primary functions based on flock dynamics were, in order of importance, household consumption, participation in socio-cultural ceremonies, selling, exchanging breeding stock and gifts. Of the flock exits, 43.9% were due to losses from diseases, predation and theft. Most flocks (85%) were housed in human dwelling units. Scavenging was the main source of feed. The majority (77.6%) of farmers supplemented their chickens erratically with energy-rich feeds, mostly maize bran. Most supplementation took place during the cold-dry season. Village chicken production offers diverse functional outputs but faces animal health (diseases, parasites, predation) and management (feeding) constraints, which require an integrated intervention approach at community and household level.

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Keywords Flock dynamics · Local chickens · On-farm monitoring · Scavenging

Abbreviations

CRD	chronic respiratory disease
EPA	Extension Planning Area
LADD	Lilongwe Agricultural Development Division
NCD	Newcastle disease
SFRB	scavenging feed resource base

Introduction

Local chicken production is common in rural smallholder households. These chickens are produced extensively (free-range) on a scavenging feed resource base (SFRB). This means that local chickens, unlike intensively raised chickens, live and produce in a broad spectrum of socio-economic and physical production environments. This environment includes feeding, breeding and health management, which also interact with variants of human culture, marketing and other utilities. A production system can generally be defined when all the factors of the production environment and interaction between local chickens and human beings are described. Currently this production system for village chickens is generally described as low-input low-output (Safalaoh, 1997). Despite being low-output, products from these village poultry are diverse and are utilized by the majority of people in both rural and urban areas with few restrictions or taboos (Tadelle *et al*., 2003a).

Noting their importance, studies to describe local chicken production systems in Malawi were initiated in the late 1990s (Safalaoh, 1997; Ahlers, 1999), as in other countries in Africa (Minga *et al*., 2000; Dessie and Ogle, 2001; Missohou *et al*., 2002). Such initiatives were important for contributing to better understanding of the production system for rural chickens (Kondombo *et al*., 2003). Understanding the production, management and breeding systems, and the associated factors for local chicken production, is essential to develop holistic improvement strategies (Branckaert and Guèye, 1999). Knowledge of the production system will, thus, form a basis for improving local chickens production (Dessie and Ogle, 2001; Mwalusanya *et al*., 2001). Studies are still limited in this area of rural poultry production systems (Kondombo *et al*., 2003; Tadelle *et al*., 2003b). Often, such studies have been based on short surveys. The current study investigated the production system for local chickens in smallholder farmers in rural areas through flock monitoring. The objectives were: (i) to evaluate household flock structure and its characteristics; (ii) to monitor flock dynamics and determine primary output based on the dynamics; (iii) to evaluate flock management in terms of feeding, housing and health; and (iv) to identify constraints and potentials.

Materials and methods

The study area

The study was carried out in 27 villages of Mkwinda and Mitundu Extension Planning Areas (EPA) of Lilongwe Agricultural Development Division (LADD). These villages surround Bunda College of Agriculture (BCA), a constituent College of the University of Malawi, and are located within the coordinates 14.10° S, 33.47° E. Altitude is approximately 1200 m above see level (Garmin GPSMAP 76CS, Garmin Ltd, www.garmin.com). Over the past 4 years, rainfall for Lilongwe averaged 932 mm per annum (National Statistical Office, 2003). Two seasons are distinct: a wet warm season (November to April) and a dry season (May to October). In this study, seasons were defined as cold-dry (May to August), hot-dry (September to November) and hot-wet (December to April) to take account of ambient temperature changes. Most of the smallholder farmers belong to the *Chewa* tribe and practise subsistence agriculture in a crop–livestock integrated system. About 82% of these farmers own local chickens, which are more equitably distributed among rural households than other livestock (Gondwe and Wollny, 2002). Farmers were communally vaccinating their chickens against Newcastle disease (NCD) using La Sota live vaccine (1000 doses cloned; Lohmann Animal Health GmbH) at 3-monthly intervals, between May and December. Through a community participatory approach, farmers organized into village chicken groups and shared the cost of the vaccine.

Data collection

Data were derived from a monitoring study of chicken production among smallholder farmers in the study area from August 2002 to August 2003. A monthly mean of 134 households (flocks), a minimum of 91 farmers (October 2002) and a maximum of 176 flocks (June 2003) participated in the study. Both researchers and farmers recorded data. Chickens over 8 weeks old were individually identified through wing or leg tags.

Data for household flock size and structure included monthly recording of number of mature breeding cocks and hens and non-breeding stock that included chicks and growers. Types of feed offered as supplement to chickens and periods of supplementing were recorded. Quantities of feed offered could not be measured because farmers provided feed erratically.

Flock dynamics included weekly monitoring of migration of growing and adult chickens over 8 weeks old into and out of household flocks. For each individual migrant, reasons for such migration, live weight at migration and age (based on hatch dates and previous weighing for migrants out), sex and phenotype were recorded. Farmers retained wing and leg tags for birds that were either consumed or were found predated or dead. Migration of chicks less than 8 weeks of age was

Table 1 Average household flock size and flock structure by age-group during the 12-month period

Parameter	n^a	Mean	Median	SD	Range
Flock size	1427	12.90	12.00	8.37	1.00–61.00
Hens	1613	5.17	4.00	3.57	0.00–37.00
Cocks	1713	0.81	0.00	1.17	0.00–9.00
Chicks and growers	1451	7.11	6.00	6.23	0.00–52.00
Flock sex ratio (female:male)	784	4.70	4.00	3.06	1.00–30.00

$^a n$ = number of month-flock observations
SD = standard deviation

not included owing to difficulties encountered by farmers and researchers in following such losses accurately.

Monitoring of flock health included occurrence of diseases and parasites, deaths, predation and other losses of growing and adult chickens. Researchers visited households once weekly. Farmers and research assistants were trained to identify and diagnose important diseases. This training took place regularly (at least once in every 4 months) as part of feedback seminars to farmers based on previous observations. The training was participatory and included discussion of local knowledge of farmers on various diseases and parasites. Local names of important diseases known by farmers were documented. English equivalent names and appropriate veterinary drugs were included in the document. As an intervention, sick birds were treated using veterinary drugs bought from pharmacies and veterinary clinics. These drugs included Piperazine (CAPS, Zimbabwe), Amprolium (Netherlands), Triple Sulfa (Antec healthcare Africa Ltd, South Africa) and tick grease (Cooper Ltd, Zimbabwe). Identification and diagnosis of diseases and parasites was, therefore, primarily based on the farmer's local knowledge, facilitated by training (Guèye, 1998).

After one year, 1714 month-flock observations had been recorded; 43% during the cold-dry season, 37.86% in the hot-wet season, and 19.14% in the hot-dry season.

Data manipulation and analyses

Qualitative data were subjected to frequency distribution analysis using the Frequency procedure of SAS (SAS, 1999). Cross-tabulations were generated to determine the association between factors. Chi-square test was used to determine the strength of the association. Where possible, other explanatory effects on possibility of events were determined using a logistic regression model through the Proc Logistic procedure of SAS (SAS, 1999).

Where quantitative data were used, appropriate analyses were applied. These included Proc Means, Proc GLM and correlation procedures of SAS (SAS, 1999).

Results

Household flock status and structure

On a monthly average, a flock size of 12.9 (median of 12.0) was observed during the study period in rural areas (Table 1). This flock size comprised mostly chicks and growing chickens, followed by breeding hens, and breeding cocks were fewest. For those flocks with cocks and hens, the sex ratio was 4.70 (median of 4.00) hens per cock. For all parameters, distributions showed a wide range (minimum–maximum values). This distribution was skewed for sex ratio, hence it was necessary to include median values.

Household flock dynamics and use pattern for chickens

During the study period, growing and adult chickens constituted 9.45% of migration into the flock and 90.55% out of the flock ($n = 815$ migrants). Primary factors in flock dynamics are summarized in Table 2. Migration into flocks represented intake. Of this intake, the majority of chickens were brought into flocks for breeding. A few farmers bought chickens to raise them, while some chickens were presented as gifts.

Migration out of the flock (flock exit), which represented flock offtake, was the most important component of flock dynamics. When calculated as a proportion of flock size, this monthly flock exit constituted 38.74% (median 40.00; SD 2.39, $n = 524$ observations with

Table 2 Factors that contributed to the dynamics of growing and adult chickens in village flocks by type of migration (frequencies expressed in percent (%) of birds (n) observed migrating)

	Migration[a]		
Factor	Into the flock $n = 75$	Out of the flock $n = 732$	Overall $n = 807$
Household consumption	1.33 (0.12)	28.42 (25.77)	25.90
Sales or direct barter	9.33 (0.87)	9.43 (8.55)	9.42
Gifts	5.33 (0.50)	0.68 (0.62)	1.12
Acquiring breed stock	84.00 (7.81)	3.83 (3.47)	11.28
Ceremonies	–	13.80 (12.52)	12.52
Diseases	–	30.05 (27.26)	27.26
Predation and other losses	–	13.80 (12.52)	12.52

[a]Numbers in brackets are percentage of overall migration. Others are percentage migration within type of migration (column); n = number of chickens recorded migrating during the monitoring period

full flock structure) of household flock sizes excluding chicks. This offtake was 16.89% (median 16.67; SD 2.47, $n = 370$) when based on flock size including chicks. Of these exits, 56.16% was offtake for household and community functions while 43.85% was due to losses. Household use included slaughtering chickens for household consumption, followed by contributing chickens to socio-cultural and communal functions. Other functions included selling of live chickens for cash or direct barter, providing or exchanging breeding stock with other farmers and, least, giving out chickens as gifts. Communal ceremonies, diseases, predation and theft also contributed to offtake. Diseases caused higher losses than predation and theft.

More male chickens than females ($p < 0.05$) were slaughtered during socio-cultural ceremonies (Fig. 1). Only male chickens were presented as gifts. Females

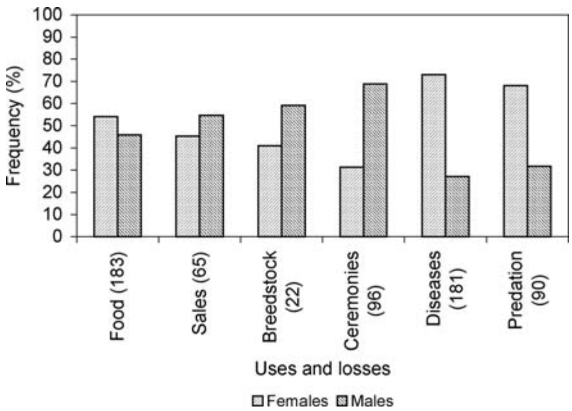

Fig. 1 Distribution of chickens migrating out of flocks by type of offtake by sex (each category is considered separately). Number in brackets = number of birds with identified sex within the off-take category

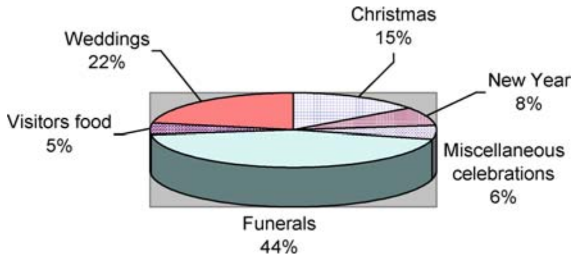

Fig. 2 Social and cultural activities associated with chickens migrating out of flocks due to communal and household ceremonial functions; $n = 101$ chickens migrating out for ceremonial purposes

dominated ($p < 0.05$) those lost due to disease and predation.

Sales of birds were by cash (67.57% of birds sold), by barter for kitchenware, clothes and mats (23.18%), and as wages for hired labour working on crop gardens. When compared between seasons, sales for cash took place in all seasons but were at their peak during the hot-dry season. Farmers were providing or exchanging chickens for breeding purposes mostly during the hot-dry season.

There were many socio-cultural ceremonies in which chickens were utilized (Fig. 2). Funeral and wedding ceremonies were important communal events in which households participated and contributed a chicken for slaughter.

Age and live weights at migration

Age structure and mean live weights for chickens at migration (Table 3) showed that chickens migrated into flocks, for example for breeding, while in the growing stage (<20 weeks). Male chicken migrants into flocks

Table 3 Mean age and live weights for chickens at migration into or out of flocks

	Age (weeks) at migration			Weight (g) at migration		
Purpose of migration	*n*	Mean	SD	*n*	Mean	SD
Migration into flock						
Breedstock acquisition	55	18.7	6.0	62	913.8	379.5
Migration out of flock						
Household consumption	127	26.5	13.0	207	1249.6	416.9
Sales	50	23.8	9.5	69	1152.6	485.4
Gifts	–	–	–	5	1320.0	406.3
Breedstock sharing	17	20.4	7.3	27	1088.2	383.0
Ceremonies	75	28.9	13.0	101	1307.5	395.2
Diseases	150	24.9	16.7	216	834.8	533.6
Predation	74	22.4	14.9	98	920.6	523.6

n = number of birds observed migrating for the stated purpose with age or weight record

were significantly ($p < 0.05$) heavier (1199.0 g; SD 510.8 g) than females (810.1 g; SD 335.14 g). Birds migrating out of flocks showed a consistent age range of 20–28 weeks at migration. Birds provided for breeding had the least age, while those provided for ceremonial functions were older ($p < 0.05$). Their live weights were not significantly different ($p > 0.05$). Chickens migrating due to disease, parasites and predation had significantly ($p < 0.05$) lower live weights than birds utilized by households. Male chickens migrating out were significantly ($p < 0.05$) heavier (1223.7 g; SD 548.8 g) than females (996.9 g; SD 448.5 g).

Farm-gate prices of birds

Farmers sold their chickens at an average price of MK 170.32 (SD MK 58.66) per live chicken or MK 142.79 (SD MK 42.59) per kg live weight (US$ 1 = MK 85.00). However, farmers bought young (9.0 weeks old) chickens, weighing 765 g, at an average price of MK 79.29 (SD MK40.87) per live chicken or MK 98.17 (SD MK 26.76) per kg. Direct sales and sales through barter took place at the farmer's household.

Housing for local chickens

Three types of housing were used for night shelters for local chickens. These were human dwelling units (84.5% of flocks), household kitchens (8.05% of flocks) built separate from main house, and traditional poultry houses (locally called *khola*) (7.41% of flocks).

Feeding management

The scavenging (free-range) system was the sole system for raising local chickens. A significant ($p < 0.001$, χ^2-test) majority of farmers (77.6%) provided feed supplement of unknown quantities (Table 4). In order of proportions of supplements, feedstuffs included maize bran (*madeya*), brewers' waste (a by-product

Table 4 Frequency distribution (% flocks) of supplement feeding to local chickens by feed type and season

Season/Supplement feed	Cold-dry $n = 737$	Hot-dry $n = 328$	Hot-wet $n = 649$	Overall $n = 1714$	χ^2 statistic[a]
Maize	0.41	8.23	1.69	2.39	***
Maize bran (*Madeya*)	82.09	48.78	48.38	62.95	***
Maize grits (*Misele*)	0.27	7.32	0.92	1.87	***
Brewers wastes (*Masese*)	9.91	–	13.87	9.51	NS
Madeya and *Masese*	2.04	–	–	0.88	–
None	5.29	35.67	35.13	22.40	***
χ^2 statistic[b]	***	***	***	***	

[a]Test for a supplement feed between seasons (Fig. 3); [b]test for supplement feeds within season; significant levels (χ^2-test): ***$p < 0.001$; NS, not significant ($p > 0.05$)
n = number of flocks observed during the study period

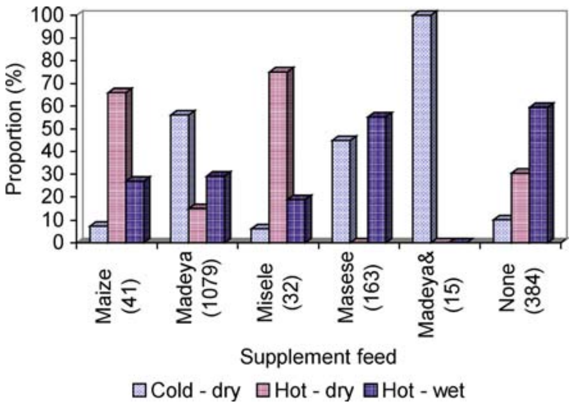

Fig. 3 Frequency distribution of supplement feed used by season. Madeya& = Madeya and Misele; Number in brackets = number of flocks fed that supplement feed

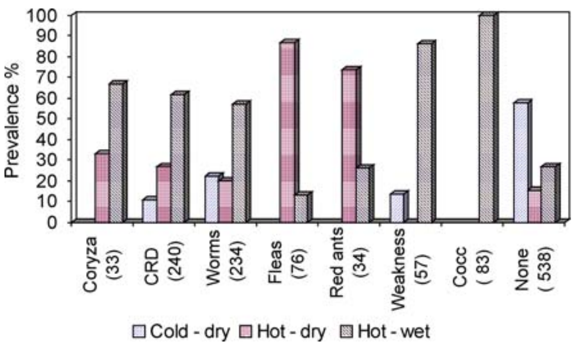

Fig. 4 Household flock infection cases compared between seasons. CRD = chronic respiratory disease; Cocc = coccidiosis. Number in brackets = number of month-flock observations. Respective local names: Coryza = *Chikwirikwiti*; coccidiosis = *Kamwazi*; CRD = *Chifuwa*; helminths = *Nyongolosi*; fleas = *Utitiri/Nthata*; red ants = *Linthumbu*; weakness = *Kuwumbwa*

from local beer brewing locally called *masese*), maize grits *(misele)*, and whole maize grain. Most ingredients except brewers' waste were fed in all seasons (Fig. 3). Maize and maize grits were offered to chickens mostly during the hot-dry season, followed by the hot-wet season and least during the cold-dry season. *Masese* was supplemented in the cold-dry and hot-wet seasons only. *Madeya* was supplemented most (56%) in the cold-dry season and least (15%) in the hot-dry season.

Flock health

Cases of occurrence of disease and parasitic infections in household flocks were used to evaluate flock health status. These infections and their seasonal distribution are shown in Fig. 4. In the cold-dry season, flocks were infected with chronic respiratory disease (CRD), internal parasites (helminths) and unspecified ailments characterized by general weakness. In the hot-dry season, infectious coryza and red ants were also observed. Coccidiosis was reported specifically during the hot-wet season. Overall, CRD and helminths were common infections prevalent in all seasons. External parasite infestation (notably fleas) ranked third in terms of prevalence, while coccidiosis and weakness ranked fourth. Multiple infections were also observed on some flocks. For example, combinations of CRD and internal parasites (3%) and CRD and coccidiosis (2%) were observed.

Table 5 Causative factors for loss of growing and adult chickens in household flocks (n = 320 growing and adult chickens lost from flocks)

Cause	Frequency (%) of total losses
Helminths	25.24
CRD	7.35
Infectious coryza	3.19
NCD	21.41
Ectoparasites	2.56
Egg peritonitis	0.96
Other diseases	2.56
Predation	20.13
Accidents	7.03
Lost	4.79
Theft	4.47
Food poisoning	0.32

Thirty-two percent (32%) of flock observations were non-infected. Of these, more were in the cold-dry season, followed by the hot-dry season and then the hot-wet season (Fig. 5). Monthly trends of flocks infected by diseases and parasites showed that during the hot-dry season 70–90% of cases for the hot-dry season were in October and November. During the hot-wet season, over 90% of flocks were infected in January and February. A transition period from the end of the hot-dry season to the beginning of the hot-wet season (October to February) showed high rates of flock infection.

The impact of prevailing infections was evaluated by monitoring offtake from flocks of growing and adult chickens according to losses and their causes (Table 5). All diseases and parasites that infected local chickens, except coccidiosis (according to farmers' perception and observed recovery of birds infected with coccidiosis), contributed to mortality. Internal parasites (helminths) were the most important cause of mortality. The occurrence of NCD was due to the fact that farmers delayed vaccinating their chickens.

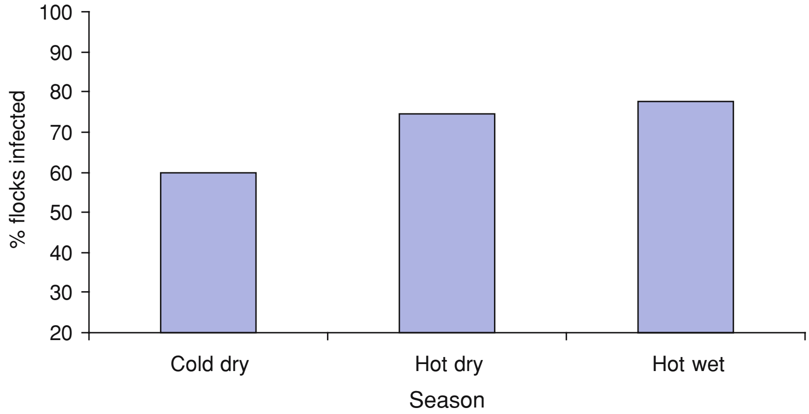

Fig. 5 Seasonal proportions of aggregate cases of disease and parasite infections of household flocks

As well as diseases and parasites, predation contributed to losses. Predators reported were wild cats (*Felis* sp.), locally called *Vumbwe*, *Msangala* and *Likongw*e; hawks (*Accipiter* sp.); African kites (*Chelictinia* sp.), called *Kamtema*; and domestic dogs (*Canis familiaris*). Predation was more common in the hot-wet season, followed by the cold-dry season, and usually occurred during daytime when chickens were scavenging. Accidents included chickens being hit by cars and bicycles, burns from fires, houses falling on chickens, chickens being hit by falling trees and domestic furniture falling on chickens.

Discussion

Flock characteristics

Household flock sizes and structure observed in the study fall within the ranges reported in Malawi (Ahlers, 1999) and other countries in Africa (Dessie and Ogle, 2001; Mwalusanya *et al*., 2001; Ekue *et al*., 2002; Tadelle *et al*., 2003b) and Asia (Aini, 1990). For example, Missohou and colleagues (2002) reported that the number of cocks per household flock was 0.9 in Southern Senegal, which agrees with the results of this study. In Zimbabwe, Maphosa and colleagues (2004) reported flock sizes of 23 chickens in a communal area and 35 chickens in a small-scale commercial area, which were higher than flock sizes observed in this study.

Flock dynamics

Flock dynamics results showed that there was more exit of growing and adult chickens from flocks than entry into flocks. The main purpose of chickens migrating into flocks was for breeding. This finding agrees with earlier observations from surveys of local chicken production in this area and in Northern Malawi that farmers acquire or exchange breeding stock with their friends and relatives (Gondwe *et al*., 1999). Both male and female chickens were involved in migration for breeding purposes. Exchange of breeding stock took place among households within and between neighbouring villages. The number of chickens and households involved in breeding stock exchange was small, however. This implies that hens in a flock produced most replacement stock. This practice may lead to inbreeding.

Flock exit demonstrated the primary functions of local chickens. These functions were dominated by use as a source of animal protein for households, followed by participation in community socio-cultural ceremonies, especially funeral and wedding ceremonies. Selling of chickens ranked third, followed by providing breeding stock to friends and relatives. The findings agree with those of many authors in different countries in Africa and elsewhere. The order of importance of various functions differs among authors, however. For example, Dessie and Ogle (2001) reported equal importance of use of chickens for sacrifice, sale and consumption, as perceived by farmers in the Central Highlands of Ethiopia. Ekue and colleagues (2002) reported that the main functions of local chickens among farmers in Cameroon were for income and as a source of food. Missohou and colleagues (2002) reported that farmers used chickens mainly for household consumption and only a few sold their chickens for income in Southern Senegal. Despite differences in order of importance of the roles played by local chickens in rural communities, multifunctional use of local chickens is

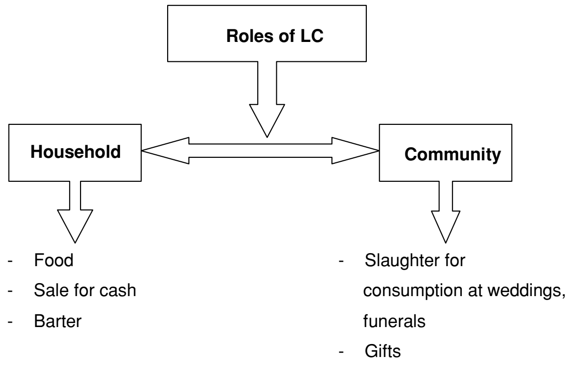

Fig. 6 Functions of local chickens at household and community level based on flock exit

obvious. These roles could be structured to be at individual household and at community levels (Fig. 6). Uses of local chickens for traditional medicine and sacrifices reported by Tadelle and colleagues (2003a) were not observed in this study.

Some functions of chickens were associated with season primarily because of seasonal occurrence of certain socio-cultural events, e.g. slaughter of chickens for Christmas and New Year. Wedding ceremonies usually took place during the dry seasons.

The proportion of migrants out of flocks due to disease, parasites and predation was significant. The low live weights of chickens that died due to diseases are probable indications of poor body condition. Lower live weights for chickens predated indicate that younger and weaker ones are at high risk.

The limited migration of chickens into flocks in relation to migration out of flocks indicates that flocks are sustained by offspring to replace aging and lost breeding stock. Tadelle and colleagues (2003a) reported that reproduction is one of the primary functions of chickens. Reproduction is a function without direct utility and could not be depicted directly in monitoring studies like this one. The age of chickens when utilized or lost showed that the majority were in the growing phase. This shows that farmers utilized chickens that were hatched from the flocks and did not replace breeding stock, especially hens. Gondwe and colleagues (1999) reported that farmers kept their breeding stock for up to 3 years. Hens are maintained as an asset to reproduce and sustain the flock.

Housing system

The housing systems for local chickens were similar to those in Tanzania (Mwalusanya *et al.*, 2001), Senegal (Missohou *et al.*, 2002) and Ethiopia (Dessie and Ogle, 2001). Housing systems in Burkina Faso (Kondombo *et al.*, 2003) and Morocco (Benabdeljelil and Arfaoui, 2001) included night roosting in trees, which was not observed in the study area. Keeping local chickens in *kholas* at night was more common in northern parts of Malawi (Ahlers, 1999) than in this study area. Security of chickens from theft was the main reason for keeping them in the house. Types of housing differ between regions and countries, agreeing with observations by Kitalyi (1998).

Feeding system

The observation that the majority of farmers provided supplements for their local chicken flocks agrees with what Sonaiya and colleagues (2002) observed in Nigeria. The use of by-products from food processing to supplement scavenging chickens was reported in Northern Malawi (Ahlers, 1999) and in other countries in Africa (Kitalyi, 1998; Roberts, 1999; Dessie and Ogle, 2001; Kondombo *et al.*, 2003). This study further identified specific ingredients used, their relative importance and their seasonal distribution in supplementing local chickens. Maize bran was the common supplement. Household leftover food was not regarded as feed supplement but as part of the scavenging feed resource households provided to chickens as waste thrown into refuse heaps, from which chickens could scratch and eat. Farmers who also brewed local beer supplemented *Masese*.

Feed supplementation was more common during the cold-dry season ($p < 0.001$, χ^2-test). The odds ratios of supplementing local chickens also show seasonal influences. This seasonal trend reflects availability of ingredients, noting that all supplements were waste by-products from maize whose household stock reserves vary by season, being more abundant during cold-dry season following crop harvest. Dessie and Ogle (2001), Pedersen (2002) and Kondombo and colleagues (2003) reported similar seasonal influence on supplementing feed to chickens in Ethiopia, Zimbabwe and Burkina Faso. In Malawi, most rural households run out of food reserves from harvested crops during the hot-dry season (September to November) (FEWSNET, 2002; Oygard *et al.*, 2003). Subsequently there are fewer by-products available, resulting in farmers reducing supplementation. During the hot-wet season, most households depended on relief food (FEWSNET, 2003;

Oygard *et al*., 2003), from which *madeya* is used to supplement chickens.

Chickens housed in traditional *kholas* were more likely to be supplemented (odds ratio 4.22) than chickens housed in human dwelling units and kitchens. Coincidentally, those farmers with separate chicken houses had food reserves available even during the hot-wet season. The likelihood of supplementing local chickens increased with increase in number of hens ($p < 0.001$, χ^2 Wald test). Numbers of cocks and chicks as covariate factors were not significant ($p > 0.05$). This observation suggests that farmers consider flock sizes based on hens and, therefore, do not put preference on supplementing feeds to chicks and cocks. In their monitoring study, Maphosa and colleagues (2004) also observed that there is no preferential treatment for chicks during supplemental feeding. Those findings are in contrast with those of Kitalyi (1998) and Kondombo and colleagues (2003), who observed that supplementation was mainly provided to chicks.

Flock health

NCD vaccination was effective and enabled chickens to survive through the cold-dry and hot-dry seasons, which are NCD infection periods. This corroborates the importance of NCD in rural poultry production as reported by many authors (Ahlers, 1999; Branckaert and Guèye, 1999; Dessie and Ogle, 2001; Mwalusanya *et al*., 2001; Kondombo *et al*., 2003; Kusina *et al*., 2001). However, despite successful NCD prevention, the prevalence of other diseases and parasites, and subsequent mortality, showed the presence of health problems in addition to those due to NCD. Pedersen (2002) reported similar health problems in NCD-vaccinated flocks in Zimbabwe. Maphosa and colleagues (2004) reported high chick mortality (60%) in NCD-free flocks in Nharira and Lancashire areas of Zimbabwe. Predation was also reported to be an important cause of losses from chicken flocks by Mwalusanya and colleagues (2001), Pedersen (2002) and Kusina and colleagues (2001). In their study in Tanzania, Magwisha and colleagues (2003) found that all growing and adult chickens observed were infected with helminths. These helminth infections usually contribute to reduced productivity, reproduction and immunity against other infections such as NCD (Horning *et al*., 2003).

Seasonal patterns of disease, parasites, and to some extent, predation observed in the study may be due to an association between seasonal factors and the infectious agents. Overall, infection was highest in the hot-dry season. Hüttner and colleagues (2001) observed high adult chicken mortality between September and December in Northern Malawi. Kusina and colleagues (2001) also reported that in Zimbabwe diseases and parasites were severe during the hot-dry season. Internal parasites are associated with wet and humid conditions (Magwisha *et al*., 2003). High temperatures during the hot-dry season and feed shortages, especially during the rainy season, may contribute to reduced immunity and susceptibility to diseases. Just as with NCD, knowledge of the seasonal pattern and importance of infections is helpful in designing strategic measures of intervention. This information could be used, for example, to develop a management calendar recommending appropriate control or preventive measures when risk is highest.

Health problems cause losses in flocks and reduce their productivity (Magwisha *et al*., 2003), and hence require intervention. While NCD vaccination using *La Sota* was effective, treatment against other diseases using modern medicines faced challenges of drug misadministration, availability and knowledge of correct treatment by farmers. Most infections were contagious; thus a single infection spread to other birds in a flock and to other flocks. Because of this intra-flock and inter-flock infection, flock health management is difficult in local chickens (Aini, 1990) and cannot be dealt with on an individual flock basis but requires a community approach. Such a community approach would facilitate communal purchase of drugs cost-effectively and, following communal treatment, would minimize disease incidence and recurrence. No use of traditional remedies for control of diseases and parasites was observed in the study area. This may be due to loss of indigenous knowledge. Vaccines were available for coryza and gumboro, but, unlike NCD vaccine, were expensive.

The possibility of breeding for disease resistance should be explored, especially for internal parasites, which were the most important single cause of loss of birds. Gauly and colleagues (2001, 2002) reported high repeatability values ($r = 0.55$–0.87) and medium heritability values (0.10–0.19) for mean log faecal egg counts for *Ascaridia galli*, thus showing a potentially high genetic variance that can be utilized to select for helminth resistance in chickens.

The flock size and structure and most practices observed in managing local chickens are traditionally oriented. These traditional practices seem likely to remain in place for the near future. Based on the analysed production system of local chickens, single technical interventions, such as NCD vaccination, are apparently not sufficient to improve the efficiency of the system. An integrated intervention approach requiring minimal external inputs should be directed at both household and community level.

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References

Ahlers, C., 1999. *Erkrankungen und Produktionsverluste in der traditionellen Hühnerhaltung in Nord-Malawi*, (PhD thesis, Free University of Berlin, Germany)

Aini, I., 1990. Indigenous chicken production in South-East Asia. *World's Poultry Science Journal*, **46**, 51–57

Benabdeljelil, K. and Arfaoui, T., 2001. Characterisation of Beldi chicken and turkeys in rural poultry flocks of Morocco. Current state and future outlook. *Animal Genetic Resource Information*, **31**, 87–95

Branckaert, R.D.S. and Guèye, E.F., 1999. FAO's programme for support to family poultry production. In: F. Dolberg and P.H. Petersen (eds), *Poultry as a Tool in Poverty Eradication and Promotion of Gender Equality*, Proceedings of a Workshop, Tune Landboskole, 1999, (Danish Agricultural and Rural Development Advisers Forum). (http://www.husdyr.kvl.dk/htm/php/tune99/24-Branckaert.htm)

Dessie, T. and Ogle, B., 2001. Village poultry production systems in the Central Highlands of Ethiopia. *Tropical Animal Health and Production*, **33**, 521–537

Ekue, F.N., Pone, K.D., Mafeni, M.J., Nfi, A.N. and Njoya, J., 2002. Survey of the traditional poultry production system in the Bamenda area, Cameroon. In: *Characteristics and Parameters of Family Poultry Production in Africa*, (FAO/IAEA Co-ordinated Research Programme on Assessment of the effectiveness of vaccination strategies against Newcastle disease and Gumboro disease using immunoassay-based technologies for increasing farmyard poultry production in Africa; IAEA, Vienna). (http://www.iaea.or.at/programmes/nafa/d3/public/2-survey-ekue.pdf)

FEWSNET, 2002. *Monthly Food Security Report, Mid-August to Mid-September, 2002*, (USAID Famine Early Warning Systems Network, Lilongwe, Malawi)

FEWSNET, 2003. *Monthly Food Security Report, Mid-March to Mid-April, 2003*, (USAID Famine Early Warning Systems Network, Lilongwe, Malawi)

Gauly, M., Bauer, C., Martens, C. and Erhardt, G., 2001. Effect and repeatability of *Ascaridia galli* egg output in cockerels following a single low dose infection. *Veterinary Parasitology*, **96**, 301–307

Gauly, M., Bauer, C., Preisinger, R. and Erhardt, G., 2002. Genetic differences of *Ascaridia galli* egg output in laying hens following a single dose infection. *Veterinary Parasitology*, **103**, 99–107

Gondwe, T.N.P. and Wollny, C.B.A., 2002. Traditional breeding systems in smallholder rural poultry in Malawi. In: Session 25, Developing Sustainable Breeding Strategies in Medium to Low input Systems, *7th World Congress on Genetics Applied to Livestock Production*, August 19–23, Montpellier, France

Gondwe, T.N.P., Ambali, A.J.D., Chilera, F.C., Lwesya, H. and Wollny, C., 1999. Rural poultry biodiversity in Lilongwe and Mzuzu Agricultural Development Divisions (ADD), Malawi. *Malawi Journal of Science and Technology*, **5**, 17–25

Guèye, H.F., 1998. Village egg and fowl meat production in Africa. *World's Poultry Science Journal*, **54**, 73–86

Horning, G., Rasmussen, S., Permin, A. and Bisgaard, M., 2003. Investigation on the influence of helminth parasites on vaccination of chickens against Newcastle disease virus under village conditions. *Tropical Animal Health and Production*, **35**, 415–424

Hüttner, K., Leidl, K., Pfeiffer, D.U., Kasambala, D. and Jere, F.B.D., 2001. The effect of a community-based animal health service programme on livestock mortality, off-take and selected husbandry applications. A field study in Northern Malawi. *Livestock Production Science*, **72**, 263–278

Kitalyi, A.J., 1998. *Village chicken production in rural Africa, household food security and gender issues*, (Animal Production and Health Paper No. 142; Food and Agricultural Organization of the United Nations, Rome)

Kondombo, S.R., Nianogo, A.J., Kwakkel, R.P., Udo, H.M.Y. and Slingerland, M., 2003. Comparative analysis of village chicken production in two farming systems in Burkina Faso. *Tropical Animal Health and Production*, **35**, 563–574

Kusina, J., Kusina, N.T. and Mhlanga, J., 2001. A survey on village chicken losses: causes and solutions as perceived by farmers. In: R.G. Alders and P.B. Spradbrow (eds), *SADC Planning Workshop on Newcastle Disease Control in Village Chickens*, Maputo, Mozambique, 6–9 March, 2000, Workshop proceedings, 148–155

Magwisha, H.B., Kassuku, A.A., Kyvsgaard, N.C. and Permin, A., 2003. A comparison of the prevalence and burdens of helminth infection in growers and adult free-range chickens. *Tropical Animal Health and Production*, **34**, 205–214

Maphosa, T., Kusina, J., Kusina, N.T., Makuza, S. and Sibanda, S., 2004. A monitoring study comparing production of village chickens between communal (Nharira) and small-scale commercial (Lancashire) farming areas in Zimbabwe. *Livestock Research for Rural Development*, **16**(7). (http://www.cipav.org.co/lrrd/lrrd16/7/maph16048.htm)

Minga, U.M., Yongolo, M.G.S., Mtambo, M.M.A., Mutayoba, S.K., Lawrence, P., Mwalusanya, N.A., Katule, A. and Mlozi, M.R.S., 2000. The potential for rural poultry production and health in Africa. In: G. Pederson, A. Permin and U.M. Minga (eds), *Possibilities for Smallholder Poultry Projects in Eastern and Southern Africa*, Network for

Smallholder Poultry Project, (The Royal Veterinary and Agricultural University, Copenhagen, Denmark), 83–94

Missohou, A., Dieye, P.N. and Talaki, E., 2002. Rural poultry production and productivity in Southern Senegal. *Livestock Research for Rural Development*, **14**, 2002. (http://www.cipav.org.co/lrrd/lrrd14/2/miss142.htm)

Mwalusanya, N.A., Katule, A.M., Mutayoba, S.K., Mtambo, M.M.A., Olsen, J.E. and Minga, U.M., 2001. Productivity of local chickens under village management conditions. *Tropical Animal Health and Production*, **34**, 405–416

National Statistical Office, 2003. *Malawi in Figures 2003*, (National Statistical Office, Malawi). (www.nso.malawi.net)

Olukosi, O.A. and Sonaiya, E.B., 2003. Determination of the quantity of scavengeable feed for family poultry on free range. *Livestock Research for Rural Development*, **15**(5). (http://www.cipav.org.co/lrrd/lrrd15/5/0luk155.htm)

Oygard, R., Garcia, R., Guttormsen, A.G., Kachule, R., Mwanaumo, A., Mwanawina, I., Sjaastad, E. and Wik, M., 2003. *The maze of maize: improving input and output market access for poor smallholders in Southern African Region, the experience of Zambia and Malawi*, (Report No. 26, Agricultural University of Norway, AS-NLH)

Pedersen, C.V., 2002. *Production of semi-scavenging chickens in Zimbabwe*, (PhD thesis, Royal Veterinary and Agricultural University, Copenhagen, Denmark)

Roberts, J.A. 1999. Utilisation of poultry feed resources by smallholders in the villages of developing countries. In: F. Dolberg and P.H. Petersen (eds), *Poultry as a Tool in Poverty Eradication and Promotion of Gender Equality*, Proceedings of a Workshop, Tune Landboskole, 1999, (Danish Agricultural and Rural Development Advisers Forum). (http://www.husdyr.kvl.dk/htm/php/tune99/28-Roberts.htm)

Safalaoh, A.C.L., 1997. Characteristics of indigenous chickens of Malawi. *Animal Genetic Resource Information*, **22**, 61–69

SAS, 1999. *SAS/STAT Users Guide*, Version 8.1, (SAS Institute, Cary, NC, USA).

Sonaiya, E.B., Dazogbo, J.S. and Olukosi, O.A., 2002. Further assessment of scavenging feed resource base. In: *Characteristics and Parameters of Family Poultry Production in Africa*, (FAO/IAEA Co-ordinated Research Programme on Assessment of the effectiveness of vaccination strategies against Newcastle disease and Gumboro disease using immunoassay-based technologies for increasing farmyard poultry production in Africa; IAEA, Vienna). (http://www.iaea.org/programmes/nafa/d3/public/20-further-sonaiya.pdf)

Tadelle, D., Million, T., Alemu, Y. and Peters, K.J., 2003a. Village chicken production systems in Ethiopia: 2. Use patterns and performance valuation and chicken products and socio-economic functions of chicken. *Livestock Research for Rural Development*, **15**(1). (http://www.cipav.org.co/lrrd/lrrd15/1/tadeb151.htm)

Tadelle, D., Million, T., Alemu, Y. and Peters, K.J., 2003b. Village chicken production systems in Ethiopia: 1. Flock characteristics and performance. *Livestock Research for Rural Development*, **15**(1). (http://www.cipav.org.co/lrrd/lrrd15/1/tadea151.htm)

Système de production de poulets locaux à Malawi: Structure, dynamique, gestion et santé des volées domestiques

Résumé – Des volées domestiques de poulets détritivores ont été suivies du mois d'août 2002 au mois d'août 2003 dans 3 villages de Lilongwe, au Malawi. L'objectif a été d'évaluer le système de production de poulets locaux en étudiant la structure, l'utilisation, la gestion et les contraintes imposées aux volées. Des fermiers et des chercheurs ont obtenu en commun des données sur les volées domestiques. La taille moyenne des volées était de 12.9, avec une répartition de 1 à 61 poulets. La dynamique des volées de plus de 8 semaines a représenté 91% de migrations hors des volées et 9 dans les volées. Les fonctions primaires basées sur la dynamique des volées ont été, dans l'ordre d'importance, la consommation domestique, la participation à des cérémonies socioculturelles, la vente, l'échange de géniteurs et les dons. Sur les sorties des volées, 43.9% étaient dues à des pertes en raison de maladies, de prédateurs et de vols. La plupart des volées (85%) étaient hébergées dans des unités d'hébergement humaines. Les détritus étaient la principale source d'alimentation. La majorité (77.6%) des fermiers supplémentaient occasionnellement leurs poulets avec des aliments riches en énergie, principalement du son de maïs. La majeure partie du complément alimentaire était donnée durant la saison froide-sèche. La production de poulets de villages offre divers rendements fonctionnels mais est confrontée à un problème de santé des animaux (maladies, parasites, prédation) et à des contraintes de gestion (alimentation) qui nécessitent une approche d'intervention intégrée au niveau communautaire et domestique.

Sistema de producción local de pollos en Malawi: Estructura de la manada doméstica, dinámicas, manejo y salud

Resumen – Se monitorizaron manadas domésticas de pollos carroñeros desde agosto de 2002 a agosto de 2003 en 27 pueblos de Lilongwe, Malawi. El objetivo del estudio fue evaluar el sistema de producción local de pollos, investigando la estructura de la manada, la utilización de ésta, el manejo y las limitaciones. Los granjeros y los investigadores obtuvieron datos conjuntos de las manadas. El tamaño medio de la manada fue de 12.9, con un rango de 1 a 61 pollos. Las dinámicas de la manada de pollos mayores de 8 semanas estaban constituidas por un 91% de pollos que migraban fuera de la manada y un 9% dentro de la manada. Las funciones principales en base a las dinámicas de la manada, eran, en orden de importancia, el consumo casero, la participación en ceremonias socio-culturales, la venta, el intercambio de razas, y los obsequios. De las bajas de la manada, un 43.9% era debido a pérdidas por enfermedades, depredación y robos. La mayoría de las manadas (85%) estaban albergadas en habitáculos humanos. El deambular alimentándose de carroña constituía la principal fuente de alimento. La mayoría de los granjeros (77.6%) suplementaba de manera errática a sus pollos con alimentos ricos en energía, principalmente salvado de maíz. La mayoría de esta suplementación tenía lugar durante la estación fría-seca. La producción de pollos de pueblo ofrece diversos rendimientos funcionales, pero afronta limitaciones en cuanto a la salud del animal (enfermedades, parásitos, depredación), y en cuanto al manejo (alimentario), que requieren de un enfoque de intervención integrado a nivel de comunidad y doméstico.