

Full Length Research Paper

# Farmer perceptions on the use of non-conventional animal protein sources for scavenging chickens in semi-arid environments

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For sustainable intensification of village production systems, it is important to understand the views of farmers who keep the chickens on the utilization of available protein sources. The objective of the study was to assess farmer perceptions on the use of non-conventional animal protein (NCAP) sources for scavenging chickens. Resource-poor households of Msinga local municipality in uMzinyathi district, KwaZulu-Natal province (n = 239) were interviewed using a semi-structured questionnaire. Logistic regression was used to analyse the data. Females were the prominent heads of households, followed by males, and then youths. Feed shortages were among the major challenges that limited chicken production. Provision of chicken housing and religion highly influenced ( $P < 0.05$ ) a household's likelihood of experiencing feed shortages. Farmers who did not provide overnight housing to their chickens were likely to not provide any supplementary feeding. Christian farmers were predisposed to chicken feed shortages compared to traditional-religious farmers. More than half of the farmers (56.6%) were aware that NCAP sources have a huge potential to be used as protein sources for chickens. Farmers commonly used termites as a protein supplement. Other common NCAP sources were earthworms and locusts. The potential of using NCAP sources were high on farmers with large village chicken flocks and female-headed households.

**Key words:** Scavenging chickens, resource-poor farmers, termites, earthworms, flock size, non-conventional animal protein (NCAP), scavengeable feed resource base (SFRB).

## INTRODUCTION

Increasing productivity of village chickens has a huge potential to increase protein consumption among resource-poor households, particularly for children (Mwalusanya et al., 2001). Village chickens are usually

raised with little or no investment in housing, feeding and health care (McAinsh et al., 2004). To increase meat and egg productivity, it is crucial to establish the scavenging behaviour of village chickens. Scavenging is an

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instinctive behaviour and skill that can be acquired from hens by their chicks. These skills are not well developed in most imported and synthetic chicken genotypes since they were selected under intensive indoor production systems. The scavenging feed resource base (SFRB) is highly variable and mainly composed of snails, flying insects, worms in the soil, grass seeds, berries and foliage (Sonaiya, 2004). Quality and quantity of the SFRB is inconsistent (Goromela et al., 2006) and depends on season, dominant crops grown, location and life cycle of insects, among other factors. Plants and grasses are the abundant feed resources that village chickens scavenge on. These green materials are rich in energy. Protein content of the SFRB is, therefore, likely to be below the requirements of the chickens (Goromela et al., 2006). There is, therefore, a growing interest in developing methods on the propagation, harvesting, processing methods, storage and optimum inclusion levels of preferred non-conventional animal protein (NCAP) sources for scavenging chickens. Non-conventional animal protein sources include earthworms, locusts, termites, fly maggots, caterpillars, cockroaches and snails.

The increased interest in understanding the contribution of NCAP sources for village chickens is also motivated by the desire to produce organic chicken meat and eggs (Mtleni et al., 2013). These products can fetch premium prices and enhance household income and rural livelihoods. The supply of such products in the markets is, however, erratic, low and unreliable. The contribution of NCAP sources to the diets of scavenging chickens should, therefore, be estimated. Before determining the nutritive value of these feed resources, it is essential to understand farmer perceptions on the potential of using NCAP sources so as to integrate their views in developing sustainable strategies to meet nutrient requirements for village chickens. The objective of the current study was, therefore to assess farmer perceptions on the use of NCAP sources for scavenging chickens.

## MATERIALS AND METHODS

### Study site

The study was conducted in Msinga local municipality in UMzinyathi district, KwaZulu-Natal province, South Africa. Msinga local municipality is located at 28°40'00"S and 30°34'00"E with an average altitude of 672 m above sea level. It is semi-arid, hilly and rocky with annual average rainfall of 400 to 900 mm (Zindove and Chimonyo, 2015). Most residents in Msinga rely on subsistence production of crops and livestock for consumption and sale. Village chickens are among important livestock that are imperative to the livelihood of households. The municipality is characterized by irrigable land and irrigation infrastructure that is situated near the Tugela river where there is wide alluvial plain. Alongside the Tugela river, informal agricultural endeavours are practiced in areas adjoining the irrigation scheme. Common agricultural produce from the irrigation scheme are tomatoes, butternuts, spinach, sweet potatoes, potatoes and onions. These products contribute considerably to the livelihoods and household economy.

Agricultural activities in the rain-fed gardens include intercropping of maize and beans, cowpeas and pumpkin.

### Sampling of households

Two villages were randomly selected from the municipality. Sampling of the households was based on chicken ownership and willingness to participate in the study. All farmers who owned chickens were randomly selected to participate in the study. Each farmer had an equal probability of being selected for the study. A pre-tested semi-structured questionnaire was administered to 239 households by eight trained enumerators. Enumerators were obtained from the local villages to ensure that farmers are comfortable to co-operate during the study.

### Data collection

Discussions with key informants were held. The key informants were prominent livestock farmers in the municipality, officials from active non-governmental non-profit organisations, local traditional and political leadership, school headmasters and agricultural extension workers. A semi-structured questionnaire was also used to collect data. The questionnaire was granted ethical approval (HSS/0584/013M) by the University of KwaZulu-Natal. The questions were translated into the vernacular Zulu language to improve quality of data captured. The questionnaire captured data on household demographic and socio-economic status, uses and ownership patterns of chickens, challenges to chicken production, feeding practices and uses of NCAP sources. Data were also collected through direct observations of socio-economic status of farmers, housing structures and chicken genotypes used. Transect walks were also made in the communities to explore resource endowments in the area.

### Statistical analyses

All the data were analyzed using SAS (2003). Household socio-economic status, uses of chickens, challenges to chicken production and the use of NCAP sources were analysed using PROC FREQ of SAS (2003). The PROC GLM procedure was used to analyse the effects of gender of head of the household on livestock herd size and chicken flock composition. Pair-wise comparisons of the least square means were performed using the PDIF procedure. An ordinal logistic regression (PROC LOGISTIC) was used to predict the odds of a household to experience chicken feed shortages and farmer perceptions on the potential of using NCAP as a feed resource for chickens. The variables fitted in the logit model included age of the farmer, gender, marital status, religion, household size, production system, housing and flock size. The model used was:

$$\ln [P/1-P] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_i X_i + \epsilon$$

Where: P is the probability of household experiencing chicken feed shortages; [P/1-P] is the odds of the household to experiencing chicken feed shortages;  $\beta_0$  is the intercept;  $\beta_1 \dots \beta_i$  are the regression coefficients of predictors;  $X_1 \dots X_i$  are the predictor variables;  $\epsilon$  is the random residual error.

When computed for each predictor ( $\beta_1 \dots \beta_i$ ), the odds ratio for feed shortages was interpreted as the proportion of households that experienced chicken feed shortage versus those households that experienced no shortages. For farmer perception on the use of NCAP, odds ratio were interpreted as the probability of the farmer being aware of the potential of using NCAP as a feed resource versus those who were not aware of NCAP as potential feed

**Table 1.** Socio-economic status of heads of households of Msinga local municipality.

Status	Adult females (n = 148)	Adult males (n = 50)	Youth (n = 41)
Farmers who were christians (%)	47.9	52.9	64.2
Farmers who were single (%)	73.1	40.0	65
Major source of income (%)			
Old age grant	41.9	47.0	0
Child support grant	35.8	19.6	50.8
Casual work	15.4	15.7	44.1
Formal work	6.9	17.7	5.1
Chicken raised under extensive system (%)	97.3	90.2	94.9
Household size (mean $\pm$ S.E)	6.1 $\pm$ 0.27 <sup>b</sup>	7.7 $\pm$ 0.46 <sup>a</sup>	6.0 $\pm$ 0.73 <sup>b</sup>

Values with different superscript along the rows differ (P<0.05).

resources.

## RESULTS

### Household demographics and socio-economic status

The demographics and socio-economic status of farmers are given in Table 1. Adult males and females mostly relied on old age grants of South Africa rand of R14 400 per annum as their major source of income. Child supports grant of R 3 600 per annum and casual work were the main sources of income to youth. The common livestock species kept in Msinga local municipality are shown in Table 2. There was a large variation in flock size, with an average of  $21.6 \pm 12.82$  ranging from 1 to 69 chickens per household. Surprisingly, chicks were fewer than hens. The cock: hen ratio was 1:3.5. Chicks were excluded because they were not sexually matured.

### Chicken ownership patterns, gender participation and uses

Adult females (69.2%) were dominant household members who owned chickens followed by males (24.5%) and youth (6.3%). The management of chickens was mainly performed by females (69.3%), youth (21.4%) and lastly males (9.3%). Duties included feeding, housing, health management and sales. Chickens were largely used for meat, income and rituals in that order in female households (Table 3). Male-headed households mostly used chicken for meat, income and status. Youths used chickens mainly for meat, income and followed by manure.

### Challenges to chicken production

Female-headed households were challenged by feed shortages, high disease prevalence and theft in that order

(Table 4). The most prevalent diseases were reported as Newcastle disease, fowl pox, infectious bursal disease, ulcerative pododermatitis and diarrhoea. No definite diagnoses, were, however, conducted. High disease prevalence, predation and feed shortages were the major challenges faced by male-headed households. Farmers reported snakes, mongooses, dogs, hawks and wild cats as common predators. Youth-headed households were prone primarily to feed shortages, ecto-parasite infestation and predation in that order. Dominant ecto-parasites observed included scaly leg mites, chicken mites, Tampan fowl ticks and avian lice.

### Low availability and poor quality of housing

The majority of the households (77.5%) did not provide separate overnight housing for their chickens. Chickens that were not provided with housing mostly rested on tree branches. The housing materials commonly used were wood, mud and corrugated iron sheets, followed by combination of timber planks and nets and, to a lesser extent, bricks.

### Predation

Snakes were the most important predator to growers and adults chickens followed by chicks and lastly eggs (Figure 1). Mongooses were also important to growers and adults chickens and lastly eggs. Dogs were a major problem to eggs and relatively less harmful to chicks and adult and growing chickens. Hawks were problematic to chicks, whilst growers and adult chickens and eggs were less affected. Wild cats were important predator to growers and adult chickens followed by chicks and to little extent, eggs.

### Feeds and feeding practices

Thirty percent of the farmers practiced supplementary

**Table 2.** Least square means ( $\pm$  S.E) for livestock herd and chicken flock composition in Msinga local municipality.

<b>Livestock herd size</b>	<b>Adult females (n= 148)</b>	<b>Adult males (n=50)</b>	<b>Youth (n=41)</b>
Scavenging chickens	22.8 $\pm$ 1.03 <sup>a</sup>	24.9 $\pm$ 1.75 <sup>a</sup>	14.5 $\pm$ 1.95 <sup>b</sup>
Cattle	2.6 $\pm$ 0.49 <sup>b</sup>	5.9 $\pm$ 0.84 <sup>a</sup>	3.5 $\pm$ 0.94 <sup>ab</sup>
Sheep	0.1 $\pm$ 0.21 <sup>b</sup>	2.0 $\pm$ 0.40 <sup>a</sup>	0.1 $\pm$ 0.45 <sup>b</sup>
Goats	10.3 $\pm$ 1.16 <sup>b</sup>	18.6 $\pm$ 2.00 <sup>a</sup>	7.4 $\pm$ 2.02 <sup>b</sup>
Ducks	0.1 $\pm$ 0.06 <sup>b</sup>	0.4 $\pm$ 0.10 <sup>a</sup>	0
Pigs	0.1 $\pm$ 0.06 <sup>a</sup>	0.2 $\pm$ 0.11 <sup>a</sup>	0.3 $\pm$ 0.12 <sup>a</sup>
<b>Chicken flock composition</b>			
Chicks	6.8 $\pm$ 0.68 <sup>c</sup>	10.0 $\pm$ 1.16 <sup>a</sup>	3.1 $\pm$ 1.29 <sup>b</sup>
Hens	12.0 $\pm$ 0.65 <sup>a</sup>	11.0 $\pm$ 1.12 <sup>ab</sup>	8.1 $\pm$ 1.24 <sup>b</sup>
Cocks	4.0 $\pm$ 0.22 <sup>a</sup>	3.9 $\pm$ 0.37 <sup>a</sup>	3.3 $\pm$ 0.41 <sup>a</sup>

Values with different superscript along the row differ ( $P < 0.05$ ).

**Table 3.** The most important reasons (%) of uses of chickens in Msinga local municipality.

<b>Uses</b>	<b>Adult females (n = 148)</b>	<b>Adult males (n = 50)</b>	<b>Youth (n = 41)</b>
Meat	71.6	70.6	61.0
Eggs	2.0	2.0	2.4
Income	15.5	9.8	20.1
Rituals	7.5	2.0	6.3
Manure	3.4	7.7	10.2
Status	0.0	7.9	0.0

feeding to their chickens. The predominant feeds used to supplement chickens were unground rotten maize, kitchen waste, bought-in feeds, sorghum and rice. Non-preferential feeding was mostly practiced (88.8%). Birds were commonly supplemented once a day (76.3%) before they scavenge. At least 98.8% of the chicken keepers provided water to their birds.

### Feed shortages

Chicken housing and household religion highly influenced ( $P < 0.05$ ) the household's likelihood to experience feed shortages (Table 5). Farmers with overnight housing for their chickens were less likely to experience feed shortages. Christian farmers were predisposed to chicken feed shortages compared to traditional-religious farmers.

### Potential of using non-conventional animal protein sources to village chickens

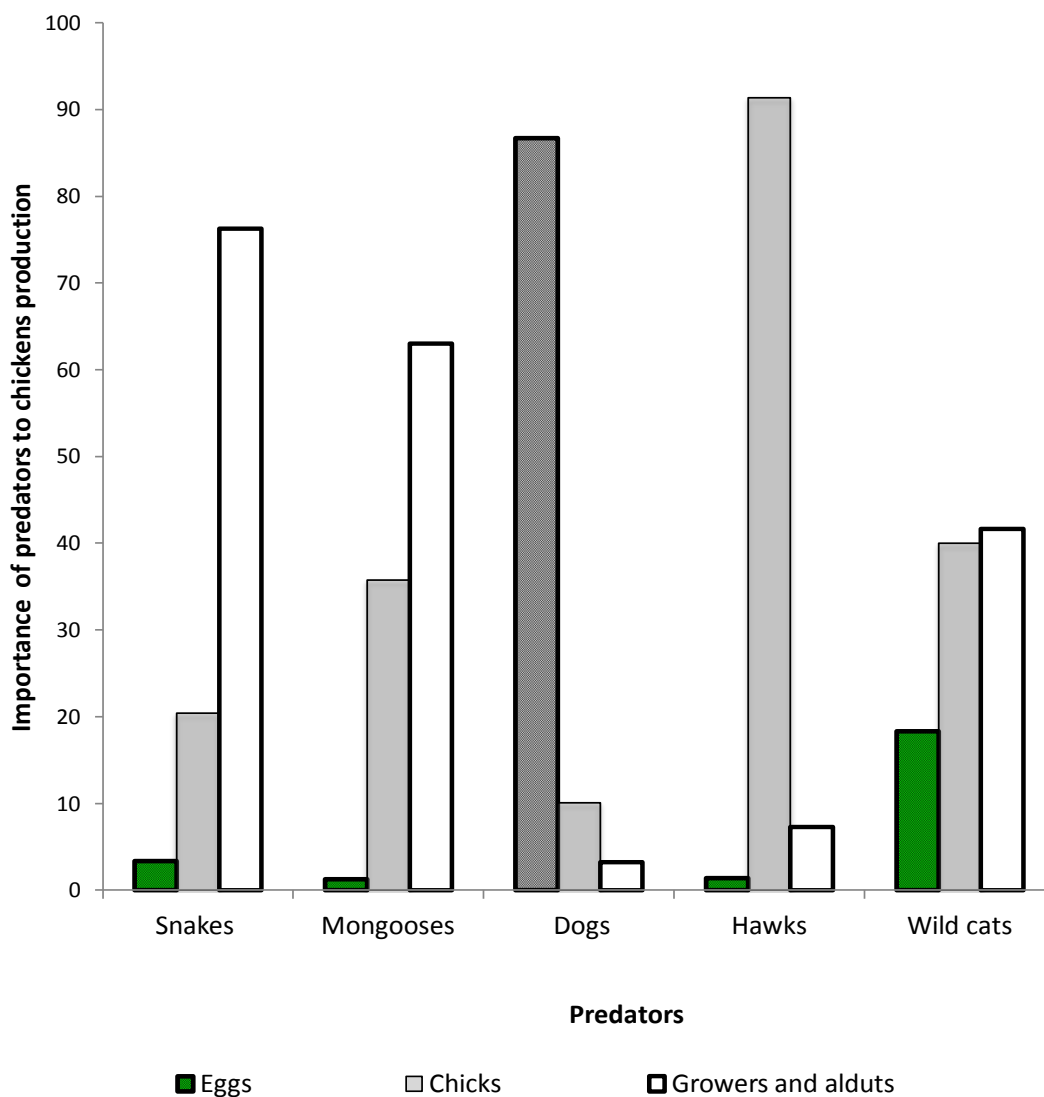
Most farmers did not provide NCAP sources (94.6%) to their chickens. However, more than half of the farmers (56.6%) were aware that these NCAP sources have a potential of being used as chicken feed. One in four

farmers (25.4%) cited lack of knowledge on the methods of collection and bulking them to feed a large flock of chickens. Few farmers (5.4%) supplemented chickens using termites. The members of the termite colony mostly used to feed chickens were soldiers and workers. These termites were predominantly found in tree stems, deteriorated wooden door frames and mounds. Farmers also trapped termites by opening a hole in the mound and incorporate clay pot with green materials then sealed with cover. Women were the main responsible household members to feed chickens with these animal protein sources.

The NCAP feedstuffs were relatively less available during the hot dry season, for example, 21.9% of farmers reported that earthworms are more available during the hot dry season whilst 78.1% observed less availability (Table 6). The NCAP sources were dominant in the rainy season. Earthworms, termites and locusts in that order were identified as NCAP sources with the highest potential for feeding village chickens. Farmers claimed that chickens preferred these NCAP sources because they are easy to obtain or hunt and are more available. Farmers also reported that NCAP are common animal protein feedstuffs consumed by scavenging chickens. However, they are low in proportion especially during dry season. They were mostly found in river banks, crop

**Table 4.** The most important challenges (%) to chicken production in Msinga local municipality.

Challenges	Adult females (n = 148)	Adult males (n = 50)	Youth (n = 41)
High diseases prevalence	20.0	30.7	7.6
Ecto-parasite infestation	7.3	9.5	22.5
Intestinal parasites infestation	2.5	2.7	5.3
Theft	15.3	4.8	7.3
Predation	9.8	21.6	9.8
Poor market	0.8	7.8	3.3
Poor availability housing	8.8	5.8	2.0
Feed shortages	35.5	17.3	42.2



**Figure 1.** Percentage of the most important predators to chickens.

fields, kraals, wetlands and in deteriorated materials. The odds ratio estimates of farmers being aware of NCAP as potential feed resources to chickens were high on

chicken flock size, gender of head of the household and household size (Table 7). Farmers with large chicken flock sizes were likely to be aware of NCAP as potential

**Table 5.** Odds ratios for chicken feed shortages.

Predictor	Odds ratio	Lower CI	Upper CI	Significance
Age (youth ≤35 versus adults >35 years)	2.4	0.62	4.78	ns
Gender (female versus male)	1.7	0.38	7.86	ns
Marital status (single versus married)	2.2	0.61	8.36	ns
Religion (tradition versus christian)	4.5	1.12	24.02	*
Household size (large >6 versus small ≤6 members)	1.4	0.36	5.39	ns
Production system (extensive versus semi-extensive)	3.9	0.58	26.14	ns
Chicken housing (no versus yes)	5.6	1.31	23.63	*
Chicken flock size (large >22 versus small ≤22)	1.6	0.42	6.30	ns

The higher the odds ratio the stronger the predictor of chicken feed shortages. CI: confidence interval. ns not significant ( $P>0.05$ ), \*  $P<0.05$ .

**Table 6.** Seasonal availability (%) of non-conventional animal protein (NCAP) sources in the study area.

Non-conventional animal protein sources	Hot dry	Rainy
Earthworms	21.9	99.6
Fly maggots	10.4	99.2
Termites	32.9	99.2
Locusts	18.3	96.7
Snails	3.3	98.8
Caterpillar	5.8	98.8
Cockroaches	21.3	95.8

Values indicate highest availability of NCAP, relative to low availability in the same season.

feed to chickens.

## DISCUSSION

Females are liable for any homestead related activities (Halima et al., 2007; Tarwireyi and Fanadzo, 2013). Most females in rural areas are over-burdened with a wide range of activities, tasks and responsibilities, in agriculture, animal husbandry and in the household (Guèye, 2003). The finding that households major source of income was through receiving old age pension and government grant agrees with Nyoni and Masika (2012). Extensive production system is the common management of scavenging chickens in Africa (Halima et al., 2007; Mtileni et al., 2013; Muchadeyi et al., 2004). Village chickens have a potential to alleviate protein shortages in rural households because they are ubiquitous as they are kept by almost every household (Mtileni et al., 2013). The mean flock size of 21.6 was higher than 17 and 10.9 of reported earlier (Nyoni and Masika, 2012; Mtileni et al., 2013). Production practices, flora and fauna in the locality, disease outbreaks, predation and feed shortages were the major reasons for losses from flocks (Kuit et al., 1986) could explain these flock size differences.

The observed hen to cock ratio obtained is similar to observations by Yakubu (2010) in Nigeria. Cocks are usually slaughtered to keep reasonable ratios of cock to hen, meanwhile providing meat. High proportion of hens in flock indicates that they are reared to produce eggs and chicks. Low proportion of chicks in the flock is a result of high disease prevalence, feed shortages, predation which hampers the growth and production of chicks (Gondwe and Wollny, 2007). Chicks are the weaker group in flock, non-preferential feeding could, therefore, explain the low number of chicks in the flock (Dessie and Ogle, 2001).

The high ranking of chickens for human consumption agrees with Mwale and Masika (2009) who reported that the purpose of keeping chicken was mainly for meat in Centane district, Eastern Cape. Village chickens can be slaughtered easily and can be consumed in one meal without need for refrigeration. Msinga local municipality is one of the most undernourished rural areas of KwaZulu-Natal, which could explain why farmers consider using chicken for meat consumption rather than selling. The observation that the ownership and management of chickens were predominantly by females agrees with Halima et al. (2007). Village chicken production could be a sustainable resource for rural women empowerment. Higher proportion of adult males than youths in owning

**Table 7.** Farmer perceptions on the potential of using NCAP sources as feed for scavenging chickens.

Predictor	Odds ratio	Lower CI	Upper CI	Significance
Age (youth ≤35 versus adults >35 years)	0.6	0.30	1.36	ns
Gender (female versus male)	2.8	0.78	9.94	ns
Marital status (single versus married)	1.7	0.46	6.35	ns
Religion (tradition versus christian)	1.1	0.31	3.66	ns
Household size (large >6 versus small ≤6 members)	2.4	0.65	8.98	ns
Production system (extensive versus semi-extensive)	0.2	0.03	1.77	ns
Chicken housing (no versus yes)	1.2	0.25	5.46	ns
Chicken flock size (large >22 versus small ≤22)	4.5	1.06	20.43	*

The higher the odds ratio, the stronger the probability of farmer being aware of the potential of using NCAP as feed resources. CI: confidence interval. ns: not significant, \* P<0.05.

chickens agrees with Muchadeyi et al. (2004) who reported that men owned 36% of the chickens and boys and girls owned 6 and 6%, respectively.

The finding that households were largely challenged by diseases agrees with previous reports (Aboe et al., 2006; Okeno et al., 2012). Extension officers of the municipality highlighted that Newcastle disease was the commonest disease that can kill the almost entire flock (Naidoo, 2003). Government extension officers, in conjunction with local non-government organizations and farmers, need to collaborate when attempting to purge prevalence of Newcastle disease. When the management or combating of Newcastle disease has been done, it would promote investment in chickens (Aboe et al., 2006). Chicken theft necessitates appropriate chicken housing with security features. Chicken feed shortages to rural households could be because harvested maize has many needs in the household. For example, females mostly threshed maize to make maize meal and porridge. Female, male and youth-headed households have different household resources and priorities, these differences are considered to affect the interest of household scale of operation, management strategies and knowledge of poultry (Aklilu et al., 2008).

The finding that most chickens were not provided with overnight housing suggests that farmers do not invest much into their chickens. The interviewed farmers and prominent livestock farmers in the municipality argued that providing overnight housing invites predators, such as snakes. Political leaders, school head masters and farmers also added a plausible explanation that females were responsible for chickens whilst chicken house construction is generally done by males which could also explain minority of households who provide overnight housing. The main reason for providing housing is to protect birds from predation and theft (Gondwe and Wollny, 2007). The major predators were snakes, mongooses, dogs, hawks and wild cats. Harmfulness of hawks to chicks indicates that chicks need to be restricted from scavenging by enclosing them to their house. Dogs prefer eggs more than chickens, probably

because they are not fed on balanced diets. Active non-governmental non-profit organisations revealed that high incidence of snakes killing chickens are related with the current study area that is rocky and therefore, provides a good habitat for snakes which are often found underneath the rocks.

The materials used for houses and nests could increase infestation for external parasites such as fowl ticks, mites and fleas which spend most of their lives hiding in cracks and crevices in building (McAinsh et al., 2004). Housing also delays birds to come out and keep them away from the fields during this time of the year (Muchadeyi et al., 2004). Farmers who provided housing at night resorted to cheap and locally available materials such as wood, mud and metal sheets, combination of plank timber and nets and using bricks, as also reported earlier (Mtileni et al., 2013). Farmers should be encouraged and trained to construct appropriate houses for chickens to reduce predation, parasites infestation and improve productivity.

One major constraint to the increase in chicken productivity is feed availability and quality. Unground rotten maize grain was the main supplementary feed given to chicken as also observed in other parts of South Africa (Naidoo, 2003; Mwale and Masika, 2009; Nyoni and Masika 2012). Maize is available in large quantities during harvesting and threshing periods (Mtileni et al., 2013). Although maize grain is rich in energy, aflatoxins and mycotoxins are usually a huge challenge. Supplementing with maize grain could only sort out energy requirements issues but not protein. Therefore, scavenging chickens have to use their ability to hunt for protein-rich feed resources, such as earthworms around the surroundings to meet protein needs. As a result, they are vulnerable to theft and predation. Furthermore, they interact with other neighbouring flock which makes them vulnerable to disease (Kitalyi, 1998). Water supply to birds is useful by reducing hunting responsibility for water in niches where they are susceptible to predation, theft and disease. Supplying of water to birds is likely to promote scavenging for feed resources, thus improve

feed intake and growth.

African traditional religious farmers stored remainders of sorghum to feed chickens after making traditional beer for ritual ceremonies. This could explain why they had less likelihood of facing chicken feed shortages. Sorghum is, however, deficient in protein content. Negligible feeding input to chickens raised under extensive production system could be related to farmers not affording feed that is sold in the market. Youths largely relied on child support grants and casual occupations for income generation. Unstable occupation and meagre income could be the reason young farmers face feed shortages for chickens. Youths have limited access to resources such as credits, agricultural inputs, technologies (Kitalyi, 1998).

Unfamiliarity of farmers with the use of NCAP to chickens calls for training of farmers about importance of NCAP sources to chickens for sustainable feeding system and improvement of chicken productivity. Training should include possible propagating and harvesting techniques using locally available resources to produce these protein sources. Existence of termites during the dry season has been reported by farmers. Termites are known to thrive under dry conditions and recycle to contribute to ecosystem by feeding on dead plants such as wood, leaf litter and animal dung (Okeno et al., 2012). Feeding termites to chicken would be, therefore, a way of converting unusable materials to food for rural people.

Farmers indicated that NCAP sources are available even during the hot dry season could those who are residing in village situated near Tugela river where there is wide alluvial plain. Along the river, there are swampy areas where NCAP sources such earthworms and flies mostly found. Seasonal availability of NCAP sources necessitates innovative methods that need to be implemented to produce these novel sources at all times to supply birds with protein sources throughout the year. The method of producing these protein sources should be inexpensive and complement the living standards of smallholder farmers by using locally available materials. For example, possible methods of producing and harvesting earthworms are through enclosing them into fresh sludge. Cattle dung provides sources of NCAP sources such as earthworms and cut worms and is used as a media of production (Goromela et al., 2007). Combination of fermented blood mixture, rumen contents and cattle dung can be used to produce maggot larvae (Smith, 1990).

Earthworms, termites and locusts are potential protein sources to birds. They are a natural food source for poultry and are highly palatable to chickens. They are used for human consumption in other countries (Paoletti et al., 2000). Using them as feed to chickens can increase productivity of chickens while maintaining low input cost of production. These protein-rich feed resources have a beneficial effect when included into the poultry diet (Tiroesele and Moreki, 2012). Interviewed

farmers, prominent livestock owners and local traditional indicated that unlike fly maggots and snails, these protein sources are not disgusting, meaning that they could consume a chicken being supplemented with earthworms, termites, locusts. The farmers and key informants highlighted that they are prepared and willing to adopt technologies that can increase the availability and supply of earthworms, locusts and termites as feed for chickens. Earthworms are easy to produce, since some of the farmers are aware of the concept of vermicomposting which utilises crop residues, detritus material such as kitchen wastes. There is need to determine the digestibility, nitrogen retention, absorption and utilization of these protein sources in village chickens. Although locusts are commonly consumed by chickens, the farmers and active non-government non-profit organizations felt that propagation and production of locusts seems difficult. Consumer unacceptance of feed derived from maggots and snails could limit their use. The unacceptability of maggots and snails is based of cultural beliefs and negative perceptions about them.

Presence of NCAP sources has been reported in crop contents of birds (Goromela et al., 2007). There are variety of reservoirs of NCAP such as river banks, crop fields, cattle dung, and wetlands. Farmers with large chicken flock sizes are likely to have more attention on chicken husbandry, thereby aware of the potential of NCAP as potential protein feed source for chickens. Woman involvement on chicken management and production explains why they are likely to understand the potential of NCAP as feed to chickens. Nutritional value of NCAP supplements need to be determined. Nutritional status of scavenging chicken is also a prerequisite in different locations, seasons, and farming systems. This will help to determine how much of NCAP sources need to be supplemented.

## Conclusions

Challenges to chicken production varied with gender of the head of household. Feed shortages were among the major challenges to chicken production. Chicken housing and religion highly influenced the household's probability to experience feed shortages. Farmers who supplemented chickens with NCAP were few and were mostly women. Farmers were aware that these NCAP sources have a potential of being used as chicken feed. Odds ratio estimates showed that farmers with large chicken flock sizes were likely to be aware of NCAP as potential feed to chickens. Availability of these animal protein sources is seasonal. NCAP were the main sources of proteins that chickens scavenge on.

## Conflict of interest

No conflicts of interest exist between the authors and the



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