African Journal of Agricultural Research Vol. 1 (3), pp. 091-100, November 2006
Available online at http://www.academicjournals.org/AJAR
ISSN 1991- 637X © 2006 Academic Journals

Review

Strategies to optimize the use of scavengeable feed resource base by smallholders in traditional poultry production systems in Africa: A review

E.H.Goromela[1]*, R.P. Kwakkel[2], M.W.A. Verstegen[2] and A.M. Katule[3]

1National Livestock Research Institute, P.O. Box 202 Mpwapwa, Tanzania;
[2]Animal Nutrition Group, Wageningen University, P.O Box 338, 6700 AH Wageningen, The Netherlands;
[3]Sokoine University of Agriculture, P.O. Box 3004 Morogoro, Tanzania

Accepted 2 November, 2006

Traditional poultry production accounts for about 80% of the poultry population in Africa. Such poultry species are kept by smallholders, mostly in free-range and in backyard systems for food security, income and socio-cultural purposes. Flock productivity is low compared to high input systems due to sub-optimal management, lack of supplementary feeds, low genetic and diseases. Scavenging system provides most of the scavengeable feed resource base (SFRB) for rural poultry. However, the quantity and quality of SFRB for scavenging poultry varies with season, altitude, climatic conditions, farming activities as well as social, management and village flock biomass. In the present review, diets consumed by scavenging poultry indicates to contain on average low nutrient concentration of protein (100 g kg DM^{-1}), energy (11.2 MJ kg DM^{-1}) and minerals such as Ca (11.7 g kg DM^{-1}) and P (5 g kg DM^{-1}). This low concentration indicates that the amount of nutrients from SFRB alone cannot support optimal growth and egg production of scavenging poultry. Thus such nutrients which can not optimally supplied by SFRB should be provided as supplementary feeds. However, quantitative assessment of SFRB and nutrient concentrations could provide the best strategies to optimize the available SFRB for improving rural poultry productivity.

Key words: Traditional, rural poultry, free-range, backyard, scavenging, scavengeable feed resource, nutrient, composition

INTRODUCTION

In many developing countries, particularly Africa, poultry production in rural and peri-urban areas is based on traditional scavenging systems. It is estimated that about 80% of the Africa's poultry population, is found in traditional production systems (Guèye, 1998; Branckaert et al, 2000). These husbandry systems are characterized by a low input/low output production system and contribute significantly to household food security in developing countries (Branckaert et al, 2000). Traditionally, the scavenging system plays an important role in supplying local populations with additional income and high-quality food in the form of meat and eggs. Moreover, the production system is closely linked to the religious and socio-cultural lives of many farmers in developing countries (Kitalyi, 1998; Branckaert et al, 2000). In traditional poultry production systems, different poultry species are kept and the most important being chickens, guinea fowls, ducks, pigeons, geese and turkeys. Productivity of these poultry species depends on the management systems adopted (Guèye 2003) and increases with the level of improved feeding and management (Sonaiya et al, 1999). In general under the scavenging systems whereby the low input/low output is the dominant husbandry system, several authors have acknowledged low productivity (Smith, 1990; Gunaratne et al, 1993; Guèye, 1998; Kitalyi, 1998; Guèye 2003), compared to high-input systems. The low productivity is caused by a number of factors, the most important being sub-optimal management, lack of supplementary feed, low genetic potential and diseases (Permin and Bisgaard, 1999). However, much of the low performance of poultry

*Corresponding author's E-mail: egoromela@yahoo.com.

Table 1.: Characteristics of major types of husbandry systems practiced in traditional poultry production systems in Africa.

Characteristics	Traditional free range	Backyard or subsistence	Semi-intensive	Small-scale intensive
Flock size	1-10 birds	10-50 birds	50-200 birds	50-500 birds
Key rearers	Majority of rural families	Moderate number of rural families	Few rural families	Urban families
Ownership	Mostly women & children	Mostly women and family	Middlemen	Business men
Type of breeds	Indigenous breeds	Indigenous and few crossbreds	Local/improved	Layers or broilers
Feed resources	Scavenging	Scavenging and supplementation	Commercial/local	Balanced diets
Health status	No vaccination/medication	Vaccination and little medication	Vaccination	Full vaccination
Housing system	No specific housing	Simple and small houses	Medium & improved	Big and improved
Egg production	30-50 eggsyear^{-1}hen^{-1}	50-150 eggsyear^{-1}hen^{-1}	80-160 eggsyear^{-1}hen^{-1}	250-300 eggsyear^{-1}hen^{-1}
Growth rate	5-10g day^{-1}	10-20g day^{-1}	10-20g day^{-1}	50-55g day^{-1}
Mortality rate	High mortality	Moderate mortality	Low mortality	Low mortality
Use of products	Home consumption	Home consumption and sale	Family income	Business income
Profit	Small cash income	Family income	Family income	Business income
Socio-economic	Social and cultural	Social and micro-credit	Credit based assets	little social

Source: Kitalyi (1998); Sonaiya et al (1999); Guèye (2003) and Riise et al (2004).

under scavenging systems has been attributed to poor SFRB (Roberts and Gunaratne, 1992; Tadele and Ogle, 1996). Thus if SFRB is improved in the traditional poultry production systems, productivity of local birds can be increased. However SFRB are dependent on extrinsic factors such as seasonal variables, and levels of predation, health, scavenging behaviour, age, and physiological status of the scavenging birds (Gunaratne, 1999). This paper gives a review of the existing poultry production systems in particular African countries, the role of SFRB as a major nutritional input and the factors influencing its quantity and quality. The paper concludes by suggesting strategies that can be used to optimize the use of SFRB in traditional poultry production systems to maximize flock productivity.

Poultry Production Systems In Developing Countries

Generally four poultry production systems in developing countries can be described (Bessei, 1987, Sonaiya et al, 1999, Branckaert and Guèye, 2000; Guèye, 2000a). These include the free-range system or traditional village system; the backyard or subsistence system; the semi-intensive system and the small-scale intensive system. These poultry management systems are also found in smallholder poultry sector in Africa (Kitalyi, 1998). Some important characteristics of these poultry production systems in Africa are summarized in Table 1. However; according to Guèye (1998), free-range system and the backyard system are the main types of poultry husbandry system practiced in the traditional poultry production in Africa. The free-range system is commonly practiced by majority of the rural families. Flock sizes may vary from an average of 1-10 birds of indigenous poultry per rural household. The birds are owned mostly by women and children for home consumption, small cash income, social and cultural activities. These are left to scavenge around the homesteads during daytime feeding on household leftovers, waste products and environmental materials such as insects, worms, seeds and green forages. In addition, the birds are not regularly provided with water and other inputs such as supplementary feeds, houses, vaccination and medication. As a consequence, many birds die during pre-weaning periods due to starvation, diseases and predators. The level of productivity in terms of number of eggs produced (30-50 eggs hen^{-1} year^{-1}) and growth rate (5-10g day^{-1}) is very low compared to improved free-range or backyard systems. The backyard or semi-scavenging system is practiced by a moderate number of rural families. They keep about 5-50 birds, which mostly are owned by women and family members. In the backyard system, birds are semi-confined either within an enclosure made from local materials, overnight shelters or within a fenced yard (Sonaiya, 1999). Thus in this system, there is a regular provision of water, grains and household wastes, improved night shelters, vaccination and little medication to control diseases and parasites and to some extent exchange of cockerels between the farms. Because of better management mortality is moderate and there is an increased egg production (50-150 eggs hen^{-1} year^{-1}) and growth rate (10-20g day^{-1}). Moreover, profitability is high and products are used for home consumption, family cash income and as a source of micro-credit. The semi-intensive system is a sub-system of the intensive system. In this system, poultry are kept in complete confinement, fed with formulated diets either bought commercially or produced from feed mills (Sonaiya, 1995; Aini, 1999). Sometimes they are fed with home-made rations by mixing various ingredients such as oyster shells, fishmeal, bone meal, blood meal, oil seed cakes, cereal grains, cereal by-products and kitchen

Table 2. Types and physical components of scavengeable feed resources (SFRB) found in the crop and gizzard contents of eviscerated scavenging birds

Types of SFRB	Physical components	References
Household materials		
- Grains	Paddy, rice, broken rice Maize and Wheat	Huque (1999); Mwalusanya et al (2002) Gunaratne et al (1993); Rashid et al (2004)
- Bran/polishings	Rice bran, wheat bran and rice polishings	Huque (1999); Mwalusanya et al (2002) Rashid et al (2004, 2005)
- Kitchen wastes	Cooked rice, cooked pulses, egg shells, dried fish scraps, intestine vegetable trimmings and scales of fish, pieces of bread, coconut residues,	Huque (1999); Mwalusanya et al (2002) Gunaratne et al (1993)
Environmental materials		
- Seeds	Grasses and fruits	Tadelle (1996) & Rashid et al (2004, 2005)
- Green forages	Green leaves of vegetables Grasses, plant materials	Mwalusanya et al (2002); Rashid et al l(2004, 2005), Gunaratne et al (1992); Tadelle (1996)
- Insects and worms	Small snails, earthworms, Cockroaches, ants, flies	Huque (1999); Mwalusanya et al (2002), Rashid et al (2004) Gunaratne et al (1992) Tadelle (1996)
- Sand and grits	Sand and insoluble grits,	Gunaratne et al (1993); Rashid et al (2004)
Miscellaneous materials		
	Feathers, hair, polythene, Piece of glass and brick paper products and button	Rashid et al (2004, 2005)
Unidentified materials		
	Various feed particles	Huque (1999); Rashid et al (2004

wastes (Sonaiya, 1995; Kitalyi, 1998). In this system, flock size varies between 50 and 200 birds (Sonaiya, 1990, Kitalyi, 1998) and a domestic fowl hen produces between 80 and 160 eggs year^{-1} (Sonaiya, 1990; Guèye, 2003). However, genetically improved breeds or dual-purpose breeds have been recommended as they are more efficient both in utilizing high-quality feeds provided by small-scale producers as well as economically than the indigenous breed (Roberts, 1999). The small-scale intensive or “small-scale confined” system is another sub-system of the intensive system. The system is based on specialized breeds of broiler and layer with a flock size ranging between 50 and 500 birds (Sonaiya et al, 1999). This husbandry system is practiced by few rural families particularly those living in peri-urban and urban areas where there are markets for eggs and meat and is owned mainly by business men. Producers use the recommended standard practices such as appropriate housing, feeding, health and disease control programmes. Poultry productivity is as high as that of large-scale commercial poultry with production of 250-300 eggs hen^{-1} year^{-1} and growth rate of 50-55g day^{-1}(Sonaiya et al, 1999). However, according to Guèye (2000a) the choice of any of these production systems depends on the availability of resources and inputs needed for a particular production system. In poultry farming, feed is the most important input accounting for 60-70% of the total production costs (Smith, 1990; Gunaratne, 1999).

SFRB As A Major Nutritional Input In Traditional Poultry Production Systems

SFRB can simply be defined as those feed resources available at farm level that consists of household refuse and all the materials available in the immediate environment that the scavenging birds can use as feed. In Table 2, a range of SFRB and their physical components as given in various literature sources can be distinguished. More broadly, Sonaiya (2004) has defined

Table 3. Physical composition of crop contents of chickens summarised in relation to the season, climatic zone, altitude and type of bird

Factors	Physical components of crop contents (% fresh basis)					References
	Bran	Grains	Green forages	Insects/worms	Kitchen wastes	
Wet season						
Short rains	-	37.5	22.5	17.4	22.6*	Tadelle (1996)
Short rains	11.5	13.5	33.7	17.9	23.4	Mwalusanya et al (2002)
Long rains	-	25.9	31.8	18.9	23.4*	Tadelle (1996)
Long rains	19.3	37.4	22.6	7.6	13.1	Mwalusanya et al (2002)
Dry season						
Dry period	-	29.5	27.7	17.2	25.6*	Tadelle (1996)
No harvesting	-	33.5	15.4	10.8	40.3	Rashid et al (2004)
Harvesting	-	54.5	14.7	12.4	18.4	Rashid et al (2004)
Climatic zone						
Warm wet	13.7	38.8	25.1	5.5	16.9	Mwalusanya et al (2002)
Warm dry	13.1	41.5	20.6	4.7	20.1	Mwalusanya et al (2002)
Cool wet	30.0	20.1	23.6	7.1	19.2	Mwalusanya et al (2002)
Altitude						
High	-	33.2	28.2	17.8	20.8	Tadelle (1996)
Medium	-	32.0	27.9	17.4	22.7*	Tadelle (1996)
Low	-	27.7	25.8	18.2	28.3*	Tadelle (1996)
Bird type						
Layers	19.3	38.2	23.1	5.8	13.6	Mwalusanya et al (2002)
Layers	-	42.2	16.1	11.9	29.8	Rashid et al (2005)
Growers	19.2	38.4	22.6	5.6	14.2	Mwalusanya et al (2002)
Growers	-	46.0	14.2	11.2	28.6	Rashid et al (2005)

*Unidentified feed materials

SFRB as scavengeable feed resources which are the total sum of (1) household materials i.e. food left over, kitchen wastes, gardens, crop grains, orchards, and harvest residues (2) environment materials such as plant leaves and seeds, worms, insects, snails, slugs, stone grits and sand. Under normal conditions the proportion of the SFRB supplied by household materials as determined by the crop contents of scavenging birds usually forms a greater part of the total SFRB consumed per day (Roberts, 1999). In Sri Lanka, Gunaratne et al (1993) found that 72% of the crop contents of the 15 hens slaughtered consisted of household materials and the remaining of the crop contents came from the environment. Similar observations have been reported by Sonaiya (2004) in Nigeria where the household refuse made up 64% of the crop content. This trend can also be seen in Table 3, where several authors (Tadelle, 1996; Mwalusanya et al*,* 2002; Rashid et al*,* 2004) have indicated the greater proportions of SFRB being supplied by household refuse. However, the size of the household materials in scavenging systems always varies depending on factors such as population density (Roberts 1999), food crops grown, their processing methods and decomposition due to climatic conditions (Kitalyi, 1998) and the number of scavenging animals which all may compete with rural poultry (Sonaiya, 2004). As a result, the supply of SFRB in scavenging systems in developing countries is not always constant (Cumming 1992; Tadelle and Ogle, 1996).

Factors Influencing The Quantity And Quality Of SFRB

Season, altitude and climatic conditions

As it can be noted in Table 2, SFRB in the traditional scavenging systems consists of household refuse and environmental feed materials. During the rainy season there is abundant supply of insects, worms and green forage materials while in the dry or harvesting season there is high supply of cereal grains, cereal by-products and low supply of green forage and insects/worms (Table 3). The amount of kitchen wastes as indicated in Table 3 appears to be small in rainy season indicating that in this period there is less food available in most rural households compared with dry period. In Tanzania, Mwalusanya et al (2002) reported that during wet season there is less amounts of grains and kitchen wastes with high amount of insects/worms and green forages. In

Table 4. Chemical composition of crop and gizzard contents of scavenging indigenous chickens and ducks as influenced by season

Season	Chemical composition (g Kg DM^{-1})									References
	DM	CP	EE	CF	ASH	NFE	Ca	P	ME (MJ kg DM^{-1})	
Short rains	541	87	23	103	55	732	7	5	13.1	Tadelle (1996)
Short rains	425	123	68.2	58.8	137	613	6.7	4.8	-	Mwalusanya et al (2002
Long rains	397	102	17	99	108	674	11	9	11.4	Tadelle (1996)
Long rains	437	85.7	54.1	57.7	114	688	6.5	2.4	-	Mwalusanya et al (2002
Rainy	-	79	14.9	90.9	113	581	38.7	4.1	-	Huque (1999)
Dry period	610	76	12	105	81	726	8	7	11.5	Tadelle (1996)
Harvesting	514	109	26.6	81.3	113	674	9.4	3.5	11.2	Rashid et al (2005)
No harvest	443	102	14.9	47.1	137	700	9.7	3.9	11.8	Rashid et al (2005)
Winter	-	87.4	14.3	99	99	571	28.5	4.7	-	Haque et al (1994)
Winter	-	79.9	14.6	94.4	113	574	37.3	4.2	-	Huque (1999)
Summer	-	87.7	15.2	91.2	104	582	36.8	4.1	-	Huque (1999)

Ethiopia, type of altitudes seems to have no difference on the availability of insects and worms but in high and medium altitudes there is a high amount of grains and forages with low amount of kitchen wastes compared with low altitude (Tadelle, 1996). Moreover, observations show that not all materials that are part of the SFRB are available in each environment. This is apparently seen in some countries such as Ethiopia, Indonesia, Sri Lanka and Tanzania, where studies have shown that the amount of the available SFRB varies greatly with season, climate and location (Table 3). In addition, the SFRB could vary also with the type of birds due to their foraging behaviour and stage of growth. The proportion of the grains in the layers' crop contents was lower compared to that in growers' crop contents (Table 3). The higher proportion of green forages, insects/worms and kitchen wastes in the layer crop contents could be due to their selective feeding behaviour which depends upon nutritional requirements of a particular age group of chickens and production stage. Since laying hens have higher requirement of CP and Ca, they are more likely to pick up feedstuffs rich in protein and calcium compared to growers to support egg production (Rashid et al*.,* 2005). According to Sonaiya et al (1999) most of the materials available for scavenging are not concentrated enough in terms of energy because they contain a lot of crude fibre. Thus a bird kept on free-range and backyard systems can certainly not find all the nutrients it needs for optimal production all the year round. These findings are in line with those of other authors (Huque et al 1994; Tadelle, 1996; Huque, 1999; Mwalusanya et al*.,* 2002; Rashid et al*.,* 2005) who observed that in different seasons, SFRB is critically deficient or unbalanced in nutrients. The chemical composition as indicated in Table 4, of crop and gizzard contents of scavenging indigenous chickens and ducks in various countries contains on average low amounts of protein (100 g kg DM^{-1}), energy (11.2 MJ kg DM^{-1}) and minerals such as Ca (11.7 g kg DM^{-1}) and P (5 g kg DM^{-1}). The difference in chemical composition could be due to differences in climate which determine the type and availability of SFRB consumed by scavenging birds. The protein content of SFRB tends to fall considerably during the short rainy season and dry season which could be due to the comparatively lower population of insects and worms (Tadelle and Ogle, 1996; Mwalusanya et al, 2002) which were of minor proportion in the diets of scavenging birds. Insects, snails, maggot larvae and earthworms are the potential feedstuffs which have reasonably high protein content (Smith 1990, Sonaiya et al., 1999). Studies in Ethiopia have indicated that energy supply is deficient in the diet of scavenging birds for most of the periods, throughout the year (Tadele and Ogle 1996) and the supply of energy is even more critically low in the dry periods (Tadelle (1996). The contents of the minerals such as calcium and phosphorus in the crop and gizzard contents of SFRB are also very low in the dry season. This might have been contributed by a minor proportion of succulent green forages in the diet consumed by scavenging birds (Table 3).

Flock biomass and managemental factors

Flock biomass is defined as the total liveweight or the number in the flock times the mean liveweight. Like other feed resources, the availability of SFRB can be determined by the total biomass of scavenging poultry that can be optimally supported by the available feed resources. Roberts (1995) has described this relationship between the availability of SFRB and village flock biomass using a model of the scavenging village chicken production system. The model of Roberts describes the village community in terms of families which discard household refuse and which then becomes available to the village chicken flock as SFRB. The remainder of the SFRB usually comes from the environment. In the absence of disease outbreaks or festival activities which diminish the flock, the biomass of the village flock which is the sum of the flocks of those families in the village which keep chickens, will remain at a level which can be supported by the available SFRB (Roberts, 1995). However, if the village flock biomass exceeds the carrying capacity of the SFRB, then there will be a strong competition pressure among chickens of different sex and ages on the available household refuse and environmental feed. Under this competition, chicks and growers because they are the weakest members of the village flock cannot compete with adult chickens for SFRB. In Nigeria, Sonaiya et al (2002b) found that the quantity of SFRB available for a chick was 0.996 kg $year^{-1}$ whereas a hen had 11.04kg $year^{-1}$ under a communal disposal of SFRB in six villages of south-western Nigeria. This small quantity of SFRB that was available to the chicks demonstrates that there is likelihood that both chicks and growers consume less amount of SFRB with low quality. As can be noted in Table 5, chicks and growers at this stage their requirements in terms of energy, protein and minerals are greater than other members of the poultry flock. This low concentration of energy, protein and minerals in the SFRB is inadequate to support growth for chicks and growers. As the result, chicks and growers grow slowly and the weaker birds may die due to starvation when there is strong competition for SFRB (Roberts, 1999). Thus, growth and survival of chicks and growers can be greatly improved if they are given preferential access to household refuse supplemented with energy, protein and mineral sources by smallholders.

Social and bird behavioural factors

The availability of SFRB provided by household refuse is directly related to the density of housing (Roberts, 1999).

Table 5. Recommended nutrient levels per bird type for commercial and village chickens in comparison with the nutrients supplied by SFRB in various villages of developing countries

Flock class and bird type	ME (MJ kg DM^{-1})	Nutrient levels (g kg DM^{-1})			Reference
		CP	Ca	P	
White egg layers (6-12 weeks)	11.9	160	8	3.5	NRC (1994)
Brown egg layer (6-12 weeks)	11.7	150	8	3.5	NRC (1994)
Broilers (3-6 weeks)	13.4	200	9	3.5	NRC (1994)
White egg layers	12.1	150	32.5	2.5	NRC (1994)
Brown egg layers	12.1	165	36	2.7	NRC (1994)
Nutrient from SFRB of a village	9.6	94	-	-	Roberts (1999)
Nutrient from SFRB in a village	12	88	9	6	Tadelle (1996)
Nutrient from SFRB of a village	10.7	82	33.8	5.7	Ukil (1992)
Nutrient from SFRB in a village	9.5	94	8	9	Gunaratne et al (1993)
Nutrient from SFRB in a village	-	104	6.5	3.6	Mwalusanya et al (2002)

This means that in areas where the density of housing is high there is an abundant supply of house refuse provided that most of the village families do not keep large number of poultry. However, if the village families keep large number of poultry, this would lead into competition pressure for the household refusal and the poultry will have a limited land area for scavenging. The land area available for scavenging and distance a flock can travel to scavenge will depend on many factors such as flock size, feed availability, population density, agricultural activities and predators (Gunaratne, 1999). In some areas, social factors such as rapid urbanisation, development projects and environmental changes are causing restrictions on the availability and accessibility of the SFRB (Roberts, 1999). In Tanzania, the last few decades most post harvesting activities such as threshing; winnowing, pounding and milling were carried out at the homesteads. This situation allowed for more access of scavenging feed resource base to the rural poultry. However due to villagization programme, some farmers are living in the village or towns far away from the crop fields and most of post-harvest activities are carried out there or some processes such as milling of cereal grains are carried out by machines where some of the cereal by-products go to other livestock production systems. In addition, bird behaviour also determines the availability of SFRB. A participatory study in central Tanzania shows that some indigenous chickens have better scavenging ability compared to their counterpart crossbreds (Goromela et al., 1999). Similar findings have been reported by Gunaratne (1999) in behavioural studies in Sri Lanka where crossbred chickens released for scavenging environment tended to restrict their scavenging area close to the household compounds

Strategies to Optimize Available SFRB in Traditional Poultry Production Systems

Determination of SFRB available for scavenging birds

The first attempt to determine quantity of SFRB in the free-range system was done in south-east Asia by Roberts (1992) and Roberts and Gunaratne (1993). This method requires weighing the amount of household refuse from each family per day for a specific period of time and the proportion of the household leftovers determined from the crop content of a bird slaughtered after scavenging. However for precise estimates of SFRB, each family should have access to the household refuse and environmental feed. This approach helps to determine the quantity of SFRB required by each family flock per unit time. The contribution of household refuse and environmental feed to the total SFRB can easily be determined by examining the feed components in the chickens' crops at different times of the day. This estimate however, does not show the proportion of the SFRB available to each individual bird category in the family flock (Sonaiya 2002a). Because of the variations within the family flocks due to age-group and sex; and because of competition for the SFRB in a communal scavenging condition, estimation of the SFRB on the basis of bird category such as cocks, hens, growers and chicks is more appropriate (Sonaiya et al., 2002a). In this case, any differential access to the SFRB by chicks, growers, hens and cocks in the family flock can be easily assessed. Thus Sonaiya et al (2002a) have proposed the concept of using "bird unit" by modifying the formula developed by Roberts (1992) and Roberts and Gunaratne (1993). According to Sonaiya et al (2002a), the advantage of the "bird unit" method is that, it shows the difference in the

Table 6. Chemical composition of crop and /or gizzard contents of scavenging indigenous chickens and ducks in developing countries

	Chemical composition (g kg DM-1									
	DM	**CP**	**EE**	**CF**	**ASH**	**NFE**	**Ca**	**P**	**ME (MJ kg DM^{-1})**	**References**
Chicken crop[1]	432	97.3	60.4	55.2	132	655	7.5	3.7	-	Mwalusanya et al (2002)
Chicken crop[2]	429	111	61.9	61.3	119	647	5.8	3.5	-	Mwalusanya et al (2002)
Chicken crop[3]	431	104	61	58	125	652	6.3	3.6	-	*Mwalusanya* et al *(2002)*
Hen crop	523	88	19	102	-	-	9	6	12	Tadelle and Ogle (1996)
Crop & gizzard	-	96.2	-	-	-	-	-	-	11.7*	Ali (2002)
Crop & gizzard	-	81.8	16.1	94.4	97.8	579	33.8	5.7	10.7	Ukil (1992)
Layer crop	455	117	20.7	60.4	124	683	13.2	4.6	11.6	Rashid et al (2004)
Grower crop	489	98.9	21.1	64	123	693	7.6	3.4	11.5	Rashid et al (2004)
Crop & gizzard	-	113	81.3	97.4	-	-	13.8	5.3	-	Prawirokusumo (1988)
Crop & gizzard	344	94	92	54	160	600	8	9	9.5	Gunaratne *et al* (1993)

* = Gross energy; Chicken crop[1] = Adult female chickens; Chicken crop[2] = Growers (2-4 months) of mixed sex; Chicken crop[3] = Mean of adult female chickens and growers.

quantity of SFRB available for each bird category in a family flock. Using this method, Sonaiya (2002b) found that the quantity of SFRB that was available to a cock was 43.7g day^{-1} while a hen and the chick had access to 34.98 and 2.19g day^{-1}, respectively. This estimate shows that the quantity of SFRB available to a chick was very low and the results suggest that the chicks should be given supplementary feeds over a certain period of time in order to reduce losses that may occur due to starvation. Under scavenging conditions, starvation has been reported as one of the main causes of mortality rates in village chicks and growers in Africa and south-east Asia (Ologhobo, 1992; Roberts and Senaratne, 1992; Wickramaratne et al*.,* 1993). In South-east Asia, chicks and growers which died had lower growth rates than the average chick in their groups had (Wickramaratne et al*.,* 1993). This could be due to the fact that the amounts of nutrients supplied by the SFRB are generally too low for optimal growth of chicks and growers. Thus the low survival rates of chicks and growers reported in Africa and south-east Asia during a pre-weaning period could be greatly improved by providing them with small amounts of supplements.

Determination of nutritional value of SFRB

Determination of nutritional values of SFRB might help to develop appropriate feeding and management strategies for optimal performance of scavenging poultry. The nutritional values of SFRB as shown by the chemical composition of the crop and gizzard contents from scavenging birds in Table 6, demonstrate the presence of some variations. These variations in chemical composition might have a direct relationship with the differences in physical quantities and nutritional quality of SFRB consumed by scavenging birds from various environments (Table 3). The proximate analysis of the crop and gizzard contents of the sacrificed scavenging chickens indicates protein contents of the feed consumed ranged between 82 and 117 g kg DM^{-1} (Table 6). This indicates that the availability of protein was a constraint on poultry production in these countries. According to NRC (1994), the recommended levels of protein in growing chicken ranges from 150-200 g kg DM^{-1} and in mature chicken from 100-160 g kg DM^{-1} for the commercial birds (Table 5). Protein rich materials such as earthworms, snails, insects and young plant shoots can be used to correct the protein imbalance observed in these countries (Table 6). The crude fibre content in the scavenged feed was very high in almost all countries ranging between 54 and 102 g kg DM^{-1}. Fibre fraction is known to contain cellulose, lignin and hemicelluloses that can not be digested efficiently by monogastric endogenous enzymes. The higher fibre content observed in the crop and gizzard feed might have a significant effect on the feed digestibility and nutrient intake in scavenging chickens. Moreover, the energy contents from the SFRB were generally low ranging between 9.5 and 12.0 ME (MJ kg DM^{-1}) than the recommended levels of between 11.7 and 13.4 ME (MJ kg DM^{-1}) for optimum growth of growers and 12.1 ME (MJ kg DM^{-1}) for high egg production in layers (Table 5). The mineral contents such as calcium and phosphorus in the scavengeable feed resources were also low compared to the recommended levels of these minerals for growers and laying hens (Table 5). These results indicate that there is a high chance of an imbalance of calcium: phosphorus ratio in the diets consumed by scavenging birds. The recommended optimal ratio of these two mineral elements in poultry is within the range of 1:1 to 2:1. Nevertheless, in laying hens the proportion of calcium in the diets is much higher since they require a large amount of this element for egg shell formation (McDonald et al, 2002).

CONCLUSION

The present review shows that most of the poultry in developing countries in particular Africa is found in traditional sector. These poultry play an important role in supplying the local people with additional income and high-quality protein food. Under traditional sector, four poultry management systems can be distinguished where free-range and backyard systems are mostly practiced by rural households. Flock productivity is generally low due to sub-optimal management, lack of supplementary feeds, low genetic and diseases. Scavenging is a dominant husbandry system and provides most of the SFRB consumed by scavenging poultry. However, the availability of SFRB varies with seasons, altitude, climatic conditions, farming activities, social, management, and flock biomass and bird behaviour. Moreover it is indicated that SFRB contain on average low amounts of protein (100 g kg DM^{-1}), energy (11.2 MJ kg DM^{-1}) and minerals such as Ca (11.7 g kg DM^{-1}) and P (5 g kg DM^{-1}). The low concentration of these nutrients can only support maintenance, low growth rate and low egg production for scavenging poultry. The low concentration can be corrected by providing scavenging poultry with supplementary feeds rich in these nutrients. However, quantitative assessment of SFRB and its nutritional value could help in developing appropriate supplementation using locally scavengeable feed resources. In order to achieve this, further studies are needed to identify and characterize potential scavengeable resources in different farming systems at different periods of the year.

REFERENCES

Aini I (1999). Village Chicken Production and Health. Sout-East Asian Perspectives. $th Asia-Pacific Health Conference. http://www.avpa.cia.au/confer/ideris.htm.

Ali MS (2002). Study on the effect of feed supplementation to laying hen under the rural condition of Bangladesh. M.Sc. Thesis.The Royal Veterinary and Agricultural University, Denmark.

Bessei. W. (1987). Tendencies of World Poultry Production. Paper presented at 3rd International DLG-Symposium on poultry production in Hot climates. June 19-22, Hameln, Germany.
Branckaert RDS, Gaviria L, Jallade J, Seiders RW (2000). Transfer of technology in poultry .production for developing countries. SD-dimension. FAO http://www.fao.or/sd/cddirect/cdre0054.htm.
Branckaert RDS, Guèye EF (2000). FAO's Programme for support to familypoultryproduction. http://www.husdry.kvl.dk/htm/tune99/24.branckaert.thm.
Cumming RB (1992). The Advantages of Free Choice Feeding for village chickens. Proceedings of the XIX World's Poultry Congress. 3: 627-630 Amsterdam, The Netherlands.
Goromela EH, Komwihangil DM, Mwanga J (1999). Participatory Rural Appraisal studies in central Tanzania: Annual Report Livestock Production research Institute, Mpwapwa Tanzania.
Guèye EF (1998). Village egg and fowl meat in Africa. Regional report. World's Poultry Sci. J. 54: 73-86.
Guèye EF (2000a). Approaches to family poultry Development. Proc. Of the 21st World's Poultry Congress. Montreal Canada.
Guèye EF (2003). Gender issues in family poultry production systems in low income food deficit countries. Am. J. Alternat. Agric. 18: (4) 185-195.
Gunaratne SP, Chandrasir A, Halamatha W, Roberts JA. (1993). Feed resource base for scavenging village chickens in Sri Lanka. Trop. Anim. Health and Prod. 25 (4): 249-257.
Gunaratne SP (1999). Feeding and nutritional of scavenging chickens. In: The Scope and Effects of Family Poultry Research and Development. International Network for Family Poultry Development-INFPD. http://www.fao.org/ag/againfo/subjects/en/infpd/documents/econf_scope/add_paper2.html.
Huque QME (1999) Nutritional status of family poultry in Bangladesh. Livestock Research for Rural Development (11) 3 Kitalyi AJ (1998).
Kitalyi, A.J (1998). Village chicken production systems in rural Africa Household food security and gender issues. FAO Animal Production and Health Paper 142:http://www.fao.org/DOCREP/003/W8989E/W8989E00.htm.
Village chicken production systems in rural Africa Household food security and gender issues. FAO Animal Production and Health Paper 142 http://www.fao.org/DOCREP/003/W8989E/W8989E00.htm.
McDonald P, Edwards RA, Greenhalgh JFD, Morgan CA (2002). Animal Nutrition. 6 Edition. p.119.
Mwalusanya NA, Katule AM, Mutayoba SK, Minga UM, Mtambo MM, Olsen JE (2002). Nutrient status of crop contents of rural scavenging local chickens in Tanzania. Br. J. Poultry Sci. 43: 64-69.
NRC (1994). Nutrient requirements of poultry. Ninth revised edition. Subcommittee on Poultry Nutrition. National Academy Press. Washington DC,USA. pp. 61-79.
Ologhobo AD (1992). The dilemma of animal feeds and indigenous poultry in Nigeria. Proceedings of 19th World's Poultry congress, Amsterdam. 2: 81-86.
Permin A, Bisgaard M (1999). A general review on some important diseases in free range chickens. Poultry as a tool in Poverty Eradication and Promotion of Gender Equality. Proceedings of a Workshop, March 22-26, Tune Landboskole, Denmark. pp. 181-187.
Prawirokusumo S (1988). Problems to improve small scale native chickens management in South East- Asian countries. In: Proceedings of XVIII world's Poultry Congress, Nagoya, Japan. pp.113-117.
Rashid MM, Islam MN, Roy BC, Jakobsen K, Lauridsen C (2005). Nutrient concentrations of crop and gizzard contents of indigenous scavenging chickens under rural conditions of Bangladesh. Livestock Research for Rural Development 17(2) . http://www.cipav.org.co/lrrd/lrrd17/2/rash17016.htm.
Rashid M, Roy BC, Asaduzzaman. (2004). Chemical composition of crop contents of local chickens. Asian Network for Scientific Information (2004). Pak. J. Nutr. 3 (1):26-28.
Riise JC, Permin A, McAinsh CV Frederiksen L (2004). Keeping village poultry. A technical manual on small-scale poultry production. Network for Small holder Poultry Development. Chapter 1.
Roberts JA (1992). The scavenging feed resource base in assessments of the productivity of scavenging village chickens. In: Newcastle disease in village chickens. Edited by B.P.Spradbrow, Canberra-Australia. Proc. Agric. Centre for Int. Res. (39): 29-32.
Roberts JA (1995). Assessing the scavenging feed resource base for smallholder poultry development. In: Sustainable rural poultry production in Africa. Proceedings of an international workshop held on June 13-16, at the international Livestock Research Institute, Addis Ababa, Ethiopia. pp. 40-52.
Roberts JA (1999). Utilization of Poultry Feed Resources by Smallholders in the Villages of Developing Countries. Poultry as a Tool in poverty Eradication and Promotion of Gender Equality - Proceedings of a Workshop. http://www.husdyr.kvl.dk/htm/php/tune99/28-Roberts.htm.
Roberts JA (1999) Utilization of Poultry Feed Resources by Smallholders in the Villages of Developing Countries. Poultry as a Tool in poverty Eradication and Promotion of Gender Equality - Proceedings of a Workshop. http://www.husdyr.kvl.dk/htm/php/tune99/28-Roberts.htm.
Roberts JA, Senaratne R (1992). The successful introduction of hybrid egg laying into a Sri Lanka village. Proceedings of the 19th World's poultry congress. Amsterdam. 1: 818-821.
Roberts JA. Gunaratne SP (1992). The scavenging feed resource base for village chickens in a developing country. Proceedings of the 19th World's poultry congress. Amsterdam. 1: 20-24.
Smith AJ (1990). The Tropical Agriculturalist - Poultry CTA-Macmillan Press London 106: 179-188.
Sonaiya EB (1990).The context and prospects for development of smallholder rural poultry production in Africa. CTA seminar proceedings, Smallholder Rural Poult. Prod.1: 35-60.
Sonaiya EB (1995).Feed resources for smallholder poultry in Nigeria. World Anim. Rev. 82 (1): 25-33.
Sonaiya EB, Branckaert RDS Guèye EF (1999). The scope and effect of family poultry research and development. Research and Development options for family poultry. First-INFPD/FAO Electronic Conference on Family Poultry. http://www.faoext02.fao.org/WAICENT/FAOINFO/AGRICULT/AGA/AGAP/LPS/FAMPO/intropap.html.
Sonaiya EB, Dazogbo JS, Olukosi OA. (2002a). Further assessment of scavenging feed resource base: http://www.iaea.or.at/programmes/nafa/d3/public/20-further-sonaiya.pdf
Sonaiya EB, Olukosi OA, Obi O, Ajuwon KM (2002b). Vaccination and scavengeable feed resource assessment for village poultry: http://www.iaea.org/programmes/nafa/d3/mtc/sonaiya-doc.pdf.
Sonaiya EB (2004) Direct assessment of nutrient resources in free range and scavenging systems. Regional report: In: World's poultry Sci. J. 60:.523-535.
Sonaiya EB, OA. Olukosi, Obi O, Ajuwon KM (2002b). Vaccination and scavengeable feed resource assessment for village poultry. http://www.iaea.org/programmes/nafa/d3/mtc/Sonaiya-doc.pdf .
Sonaiya EB, Dazogbo JS Olukosi OA (2002a). Further assessment of scavenging feed resource base. http://www.iaea.org/programmes/nafa/d3/public/20-further-sonaiya.pdf
Sonaiya EB (2002). Feed resources for smallholder poultry in Nigeria. http://www.fao.org/ag/aga/AGP/WAR/wara11/v4440b/v4440b0a.htm.
Tadele D (1996). Studies on village poultry production systems in the Central Highlands of Ethiopia MSc. Thesis. Swedish University of Agricultural Sciences. Uppsala, Sweden.
Tadele D, Ogle B (1996). Studies on village poultry production in the Central Highlands of Ethiopia: http://www.husdyr.kvl.dk/htm/php/tune96/7tessier.htm.
Ukil MA (1992). Availability of nutrients to scavenging chickens and ducks in Bangladesh. M.Sc. Thesis. Bangladesh Agricultural University, Bangladesh.
Wickaramatne SHG, Gunaratne SP, Chandrasiri ADN (1993). Growth Performance of village chickens under different feeding systems. Trop. Agric. Res. 5: 359-367.