ADAN J. Agric. 2023, 4: 71-83 **DOI:10.36108/adanja/3202.40.0180**

ISSN 2736-0385

Outdoor egg production using local forages in the warm wet tropical climate

[1]Ekwe, O.O. [2]Onwudike, O. C. [1]Nwali, C.C.., [3] Effiong, O.O. and [3]Ozung, P.O.

Department of Animal Science, Faculty of Agriculture and Natural Resources Management, Ebonyi State University, Abakaliki. Nigeria, [2]Rhema University, Aba, Abia State, Nigeria, [3]Department of Animal Science, University of Calabar, Cross River State, Nigeria,

Corresponding Author: *e-mail:ekweo3@gmail.com, Phone No.: 07035054649*

Abstract

This review discusses the findings of existing research surrounding the nutritional impact of leaf meals as incorporated in chicken diets, the importance of forages in sustainable poultry production and the capacity of hens to digest high fibre diets. The potentials of conventional and/or outdoor production systems for developing countries, the effects of outdoor production systems on the welfare of laying hens, and methods used in measuring forage intakes and the feed items obtained by hens from the outdoor area are also discussed. This review highlights those factors ranging from utilization to behaviors of free - range hens and the recommendations for better range utilization by egg- laying birds (hens), particularly in the warm wet climate.

Keywords: tropical forages; egg-laying birds; outdoor systems; forage intake; hen welfare; egg production.

Introduction

In recent years, there has been a rapid increase in organic animal Agricultural practices in many countries. This development was as a result of increasein the consumer demand for products that are perceived to be fresh, wholesome and flavoursome, free of hormones, anti-biotics and harmful chemicals. These productsare produced in such a way that there are sustainable environmentally without the use of gene-modified (GM) crops (Blair, 2008). However, there is the issue of animals which allow them to perform a wide range of social behaviours (Berg, 2002). AS a result, international regulations have been developed to ban or restrict the use of conventional systems and greater use has been made of free-range systems (Berg, 2002; American Veterinary Medical Association, 2010; Lay *et al*., 2011).

Despite the wide increase in the use of outdoor poultry production systems, studies with various genotypes under different managerial conditions and various climatic zones, particularly in the warm wet climate (tropics) to avoid production seasonality, still remain to be done. This review discusses the findings of the existing research related to the topic of outdoor egg production using local forages. The utilization of some leaf meals in laying hen's diets, the importance of forage for chicken welfare and the various methods used in measuring forage intake of outdoor chickens are presented. Besides, the welfare of outdoor hen's behaviors and

recommendations for the range utilization by free range hens are also discussed.

Potentials for alternative poultry production systems in developing countries

Alternative poultry production is growing due to consumer demand for specially products from cage free and free range birds. Organic poultry production is globally considered as a type of outdoor production (Fanatico, 2006). Free range system allows animals and poultry to perform natural behaviour and provides sun-light, fresh air and access to ample space, which can support better health and provide a low-stress environment (Fanatico, 1998; Berg, 2002; Lomu *et al.*, 2004). Free range producers should keep in mind the reasons that made producers in the nineteenth century move from production systems based on outdoor access to indoor production only. This was due to concerns about predators, diseases (cocidiosis and round worms), injuries due to pecking and production on an intensive scale with automated feeding and watering (Fanatico, 2006). Developing countries, of which the majorities are situated in tropical regions, have challenges in meeting the animal protein requirements for humans (Sarmiento, 2001). Therefore, the use of intensified poultry production is of great importance as a rapid protein source to meet this need. For instance in Mexico, poultry participation amounted to 63.48% (33.8% Broilers, 29.52% eggs and 0.15% Turkeys,) of the total livestock production in 2010, versus 36.52% participation of beef, sheep, pork and honey bees. Indeed, the current acute short supply of animal protein in most developing countries is a major obstacle in banning of conventional poultry production systems. This makes it difficult to implement organic production.Increasing organic production dedicated for export purposes could be profitable for producers in developing countries. Mexico is a good example of countries following this strategy. Although their organic production is increasing progressively, they use only 10% of their total organic products, while the other 90% is reserved for export markets, primarily the USA and some European countries (GAIN Report, 2006; Blair, 2008). For that reason, they depend on certifying their organic products by following the recommendations announced by internationally recognized organizations in order to seek the import approvals from the destination country.

Importance of forage for sustainable poultry production

Organic farming is defined as the approach to agriculture in which the aim is to create integrated, humane, environmentally and economically sustainable agricultural production systems. Therefore, reliance is placed on local or farm-derived resources (Blair, 2008). In addition, the acute short supply of animal protein, especially in developing countries, necessitates several investigations into the potentials of some novel feed resources for livestock (Agbede, 2003). Utilization or forage as a feedstuff for livestock is considered a sustainable and natural feed resource crops which has gained increasing attention in poultry production. In addition, forage crops were reported to have a major role in improving the productivity of smallholder farming systems and breaking the cycle of poverty and source degradation in many countries and regions in the world, such as Central America, West America, Colombia, China, Costa Rica, Bolivia (Peters *et al.*, 2001). Besides, higher utilization of forages as a local feed resource is important as a factor to facilitate the transition to 100% organic feed supply for

organic egg producers (Horsted, 2006).

Feed represents about 70% of all costs involved in poultry enterprises worldwide. The main two ingredients involved in poultry diets worldwide are maize and soybean meal. Maize represents about 60 -70%and soybean meal represents about 20 – 25% of poultry diets. Unfortunately, such ingredients are usually expensive and there is a continuous competition with other livestock for feed or a human food. This problem is increased in developing countries which import most of their feedstuffs. In this regard, there is an increasing interest in using the no-conventional feedstuffs. Seemingly, forage-based leaf meals are good alternative sources of protein for commercial livestock and poultry where they are easily available and inexpensive (Makkar and Becker, 1997; Agbede, 2003; Kaijage *et al.,* 2004; Kakengi *et al.,* 2007; Atawodi *et al.,* 2008). Poultry may be fed fresh forages inside their pens, leaf meals incorporated into their diets or as a stand plants in case of outdoor production.

Digesting forage materials

In adult chickens, the caeca (which is very short) is the unique place where digestion of plant fibre takes place where the major concentration of intestinal micro-organisms and volatile fatty acids are found. It has been shown that no more than 25% of the total dry matter passing through the intestines enters the caeca (Son *et al.,* 2002). Chickens lack the anatomical adaptation and have a lower microbial mass to support fermentation, which is necessary for efficient utilization of fibrous feeds that could support part of their nutrients needs from forages, as compared to those placed in ruminants or even in the omnivorous like swine (Esonu *et al.,* 2006; Ige *et al.,* 2006). Some other avian species, such as geese and turkeys can obtain more nutrients from forage because they are better suited to digest fibre. Therefore, the low capacity of the chicken digestive system to utilize high fibre materials limits the use of leaf meals in poultry diets to a high degree. Also, Nyman *et al.* (1990) suggested that the lower digestibility of crude protein reported in high fibre diets may be due to the indigestible cell wall material which reduces the digestion and absorption of protein overall. Similarly, grass was reported to be high in indigestible organic matter and up to 20% of the nitrogen in dry matter may be present as non-protein compounds (Bolton and Blair, 1974).

Conversely it has been reported that when chickens consume forage, their caeca retain microbes with the capacity to digest fibre and become enlarged compared to the caeca of chickens that do not eat forage. For instance, Sarmiento *et al.* (2002) reported that the length and weight of the caeca, both as absolute and relative measurements, from broilers fed on a control diet were lower than those of birds fed on diets containing 15 or 25% Chaya leaf meal. Similarly, Leeson *et al.* (1997) reported that caecal mass and total bacterial counts increased in high crude fibre (CF) diets. On pasture, birds may consume enough forage to replace 5-10% of diet; however, when formulating rations, it may be best to assume zero contribution from pasture because it is difficult to determine what nutrients will be supplied and what amount (Mattocks, 2002; Fanatico, 2006; Blair, 2008). In free-range broilers, Rivera-Ferre *et al.* (2007) showed that broilers consumed 10.7 g DM forage per bird per day, which met 7% and 3% of their daily protein and energy requirements, respectively.

Leaf meal utilization in poultry production

Over the last three decades, there is increased interest in the use of fodder tree and shrub leaf meals as a source of protein and other nutrients for non-ruminant

animals. The recommendations of some research on the use of leaf meals in diets of laying hens and growing chickens are listed in *Tables 1 and 2*, leaf meals are distinguished by their high crude protein content and contain high amounts of Vitamins, minerals (Ca and P) and have a good profile of amino acids, in addition to an average content of metabolizable energy for poultry. The leaf meals have an important role in mitigating the regional shortage of protein sources for non-ruminant animals where they are easily available and inexpensive.

Table 1: Chemical composition and accepted incorporation levels of some leaf meals in broiler and growing pullet diets.

Leaf meal	Nutrients content (% of DM)				Energy (MJ/kg)	Tested levels	Accepted Level (%)	Reference
	CP	CF	Ca	P				
Leucaena leucocephala	20.6	19.0	0.75	0.1	16.5 ME	0, 5, 10, 20	5%	Mutayoba *et al.,* 2003
Moringa oleifera	27.44	9.1	1.42	0.35	12.47 ME	0, 5, 10	Up to 5%	Olugbemi *et al.,* 2010
Moringa stenopetala	30.6	8.3	2.09	0.37	12.53 ME	0, 2, 4, 6	Up to 6%	Melesse *et al.,* 2011
Azolla (Azolla pinnata)	25.78	15.7	-	-	-	0, 5, 10, 15	5%	Basak *et al.,* 2002
Centrosema pubescens	22.45	6.4	0.80	0.53	18.43 GE	0, 2, 4, 6	2%	Nworgu and Fasogbon, 2007
Chaya (Cnidoscolus aconitifolius)	30.5	12.0	1.53	0.31		0, 15, 25, 35	Up to 25%	Sarmiento *et al.,* 2002
Cassava (Manihotesculentacrantz)	25.1	11.4	1.4	0.3	-	0, 5, 10, 15	5%	Iheukwumere *et al.,* 2008
Wild sun flower (Tithonia	18.4	-	-	-	-	0, 5, 10, 15	Up to 5%	Togun *et al.,* 2006
Diversifolia, Hemis. A. Gray)						20, 25, 30		
Ipomea sarifolia	32.0	16.9	-	-	11.56 ME	0, 5, 10, 15	5. 10%	Ekenyem and Madubuike, 2006
Azolla pinnata	21.4	12.7	1.29	1.25	8.54 GE	0, 5, 10, 15	Up to 10%	Alalde and Lyayi, 2006

Source: ABOU-ELEZZ *et al.,* 2012.

Table 2: Chemical composition and accepted incorporation levels of some leaf meals in laying hen diets.

Leaf meal	Nutrients content (% of DM)				Energy (MJ/kg)	Tested levels	Accepted Level (%)	Reference
	CP	CF	Ca	P				
Leucaena leucocephala	23.61	25.7	1.62	0.18	19.79 GE	0, 5, 10, 15	Up to 10%	Abou-Elezz *et al.,* 2011
Leucaena leucocephala	22.76	22.3	1.94	0.25	-	0, 5, 10, 15	5%	Atawodi *et al.,* 2008
Leucaena leucocephala	24.9	14.2	1.8	1.1	10.77 ME	0, 7, 14, 21	Up to 21%	Ayssiwede *et al.,* 2010
Moringa oleifera	19.76	27.11	2.13	0.24	18.64 GE	0, 5, 10, 15	Up to 10%	Abou-Elezz *et al.,* 2011
Moriga oleifera	29.7	22.5	2.79	0.26	7.86 ME	0, 10, 15, 20	10%	Kakemgi *et al.*, 2007
Gliricidia sepium	24.38	12.4	-	-	-	0, 5, 10, 15	5%	Odunsi *et al.,* 2002
Siam weed (Chromolaena odorata)	18.67	11.7	-	-	-	0, 2, 5, 5.0,7.5	Up to 5%	Fasuyi *et al.,* 2005
Gliricidia sepium	24.38	12.4	-	-	-	0, 5, 10, 15	Up to 15%	Ige *et al.,* 2006
Hedge Lucerne (Desmathus virgatus)	-	-	-	-	-	0, 4, 6, 8	Up to 6%	Suksombat and Buakeeree, 2006
Lablab (Lablab purpureus)	23.4	8.3	-	-	-	0, 5, 10, 15	Up to 10%	Odunsi, 2003
Mangrove leaves	9.26	8.2	-	-	-	0, 5, 10	Up to 5%	Al-Harthi, 2006
Tephrosia bracteolate	20.3	17.0	1.3	0.53	10.1 ME	0, 2, 5, 5, 7.5	Up to 5%	Akande *et al.,* 2008
Calliandra calothyrsus	-	-	-	-	-	5, 7.5, 10	Up to 5%	Paterson *et al.,* 2000
Neem (Azadirachta indica)	20.68	-	-	-	-	0, 5, 10, 15	5 to 10%	Esonu *et al.,* 2006
Alchornia cordifolia	18.7	16.4	-	-	19.31 GE	0, 2.5, 5.0, 7.5, 10	5%	Udedibie and Opara, 1998

Source: Source: ABOU-ELEZZ *et al.,* 2012

Research has indicated that leaf meals could be acceptable in chicken diets in limited amounts. This limitation is due to the high fibre content, which results in increased diet bulkiness and low digestibility of crude protein, energy and sulphur-amino acids. The presence of certain anti-nutritive substances in some leaf meals is a contributing factor in their poor utilization observed in chickens. Most researchers (*Tables 1 and 2)* indicated that leaf meals from various forages could be incorporated and used safely up to 5% in broiler diets and up to 10% in layer diets even though these recommended levels are low, but they would have a noticeable impact in reducing production costs (Mattocks, 2002; Horsted, 2006). Prevoius studies showed that the leaf meals of *Leucaena leucocephala, Moringa oleifera, Gliricida sepium, Cnidoscolus acontifolius, Sesbania seban, Azadirachta indica*are the most popular types that have been widely used in poultry feeding.

Importance of *leucaena leucocephala* and *moringa oleifera* leaf meals

Leucaena leucocephala

Leucaena leucocephala is well-known leguminous tree, which is estimated to cover 2-5 million acres worldwide (Brewbaker and Sorensson, 1990). During the 1970s and early 1980s, *L. leucocephala* was known as the 'miracle tree' because its success as a long-lived and highly nutritious forage tree (Shelton and Brewbaker, 1994). As well as forage, *leucaena can* provide firewood, timber, human food, green manure, shade and erosion control and other environmental services. It has its origins in Central America and the Yucatan Peninsula of Mexico where its fodder value was recognized over 400 years ago by the Spanish Conquistadors (Brewbaker *et al.*, 1985). From there, it has adapted for various regions and sites outside its natural distribution area (Parrotta, 1992). Botanically, *leucaena belongs* to the family *Mimosaceae.* Formerly known as *L. glauca,* it is a thornless long-lived shrub or tree which may grow to heights of 7-18 m. Leaves are bi-pinnate with 6-8 pairs of pinnae bearing 11-23 pairs of leaflets 8-16 mm long (Shelton and Brewbaker, 1994). The chemical analysis of *L. leucocephala* leaf meal (LLM) reported by ABOU_Elezz *et al.* (2011) showed that it comprised of 91% DM, 24% CP, 25% ADF, 40% NDF, 1.6% Calcium, 0.2% phosphorus, 8% ash and 19.8 MJ/kg gross energy. Atawodi *et al.* (2008) showed similar analysis of LLM, reporting 7% moisture, 23% crude protein, 22% crude fibre, 5% fat, 10% ash, 37% nitrogen free extract, 1.9 mg/g calcium and 0.25 mg/g phosphorus. Similarly,

Moringa oleifera

Moringa oleifera is a multipurpose tree native to Himalaya but which has spread almost world-wide (Kakengi *et al.,* 2007). *M. oleifera* is a fast-growing leguminous tree which can reach 12 m in height at maturity, yielding up to 120 t DM/ha/yr when planted very densely for use as forage (Price, 2000). It consists of two or three pinnate leaves growing mostly at the branch tips. They are 20-70 cm long, grayish-downy when young, with long petioles with 8-10 pairs of pinnate each bearing two pairs of opposite, elliptic or obviated leaflets and one at the apex, all 1-2 cm long with glands at the base of the petioles and pinnate. The proximate analysis of *M. oleifera* fresh leaves as been reported whereby it contained 74% moisture, 17% CP, 3.5% crude fibre, 8% ash, 1.7% oil, 0.20 mg/100 calcium, 0.13 mg/100g magnesium, 0.08 mg/100g potassium and 0.03 mg/100g phosphorus. Similarly, the chemical analysis of *M. oleifera* leaf meal (MOLM), reported by ABOU- Elezz *et al.* (2011), showed that it contained 91% DM, 20% CP, 27% ADF, 44% NDF, 2.1% calcium, 0.24%

phosphorus, 10% ash and 18.6 MJ/kg gross energy. Kakengi *et al.* (2007) reported that MOLM showed 86% dry matter, while crude protein, crude fibre, ash, ether extract, calcium, phosphorus, and nitrogen free extract were 297, 225, 147.7, 43.8, 27.9, 2.6, and 106 g/kg DM, respectively and metabolizable energy was 7.9 MJ/kg DM basis. Laboratory analysis made by Makkar and Becker (1997) showed that the protein concentration in *M. oleifera* leaves was about 27% with negligible amounts of tannins (1-23 g/kg DM) in all fractions of the *M. oleifera* plant, and high levels of sulphur-containing amino acids. Saponin content was similar to that present in soybean meal, while no trypsin inhibitors or lectins were detected, and the phytate content was 3%.

Estimation of chickens forage intake

Having an accurate technique for investigating the actual forage amounts consumed by hens has proven difficult to obtain. In addition, the amount of forage consumption is globally affected by some factors; i.e. quality of supplemented forage, type of supplementary feed, feeding system, genetics, and birds age. Besides, forage intake varies depending on the length of adaptation period (Horseted, 2006).

The sward method (herbage removal)

The 'Sward method' depends on measuring the herbage amount found in some range plots and comparing it to the corresponding amounts found in other similar plots visited by hens. The difference is then considered to have been consumed by the hens. Among the investigations following the idea of herbage removal technique was that of Hughes and Dun (1983), who estimated that layers consumed 25-48 g/DM per hen daily of grass when their nutrient requirements were met through *ad libtitum* balanced feed. Similarly, some other reports revealed estimated daily grass intake ranging from 10-30 g Dm/hen for hens fed *ad libitum* home mixed diet. In a more recent study, Horsted *et al.* (2006) estimated similar values of herbage intake by outdoor hens, which ranged from 9-31 g DM/hen. However, they reported a huge variation. In another experiment they obtained 51-73 g DM/hen/day of chicory removal when hens were fed on complete feed or wheat, respectively. In free range broilers, Rivera-Ferre *et al.* (2007) estimated 10.7 g Dm herbage intake per broiler per day, irrespective of vegetation type.

There are some disadvantages of this method which may contribute to unreliable values. For instance, the low amounts of chicken grass intake along with the different growth rates of plants between the tested plots would make it difficult to detect accurately by the Sward method. Besides, Horsted *et al.* (2006) has suggested that not all the removed herbage had been eaten by hens, since the uprooting and discarding of herbage by hens could not be quantified.

The crop content method

As digestion of feed progresses, it is easy to identify the feed items existing in the crop. ANALYSING the crop content has been reported to be the most reliable method in studying the feeding habits of hens in the outdoor run (Jensen and Korschgen, 1947; Horsted *et al.*, 2007). Antell and Ciszuk (2006) found 1.66 g DM of grass in the crop, which represented 11% of the total content found in the layers crop at 9.00 pm. They also reported that the amount of grass found in the crop at the end of the day was significantly correlated with the total intake of grass. Consequently, they proposed the equation $y=0.144x-0.178$; where y is the amount of grass found in the crop and x is grass intake (on an air-dried basis) during the last day before slaughter, which

consequently estimates to 13 g/hen/d. According to that equation, Horsted *et al.* (2007) found that the herbage intake amounted 12.7 and 13.4 g DM in both groups fed on concentrate with access to either grass/clover or mixed herbs, respectively. Indeed, studying the crop content has an additional advantage when compared with the Sward method, as it gives better knowledge about the other feed items that may be obtained from the range, such as insects, earth worms, snails, oyster shells, grit stones or soil.

Forage refusals methods

This method could be used for introducing a meal of fresh forage to the hens inside their pens. In this method, the added and refused forages are weighed. In addition, the dry matter of each added and refused forage samples is measured in order to calculate the actual dry matter consumed where forage DM intake = DM added – DM refused. Following a similar method, Steenfeldt *et al.* (2007) estimated the intake from maize silage, barley-pa silage, and carrot intake by indoor-raised laying hens amounted to 59, 58, 108 g/day respectively, which represented 33, 35 and 48% of the total intake (layer diet + forage material) on as fed basis, respectively. The same authors reported 32, 22, 8-12.5% dry matter content of those tested forages, respectively.

Importance of forage for hen's welfare

Roughage material is commonly recommended as a supplement for welfare reasons and for improving chicken's behaviour (Wechsler and Huber – Ehicher, 1998; Mattocks, 2002; Horsted, 2006). Chickens have an innate attracting to forage and they have been reported to be motivated to consuming forage even when provided with adequate food (Cooper and Albentosa, 2003). Feeding hens on foraging material (bulky ingredient) typically results in them having fuller crops and gizzards for a longer time. This makes the birds feel more satiated and clamed, which consequently reduces the incidence of pecking. In addition, the hens may spend more time in feeding and consequently less time pecking (Steenfeldt *et al.*, 2007). Interestingly, various investigations reached the conclusion that forage alleviated the incidence of cannibalism and feather pecking (Wechsler and Huber – Eicher, 1998; Aerni *et al.*, 2000, El-Lethy *et al.*, 2000; Kjaerand Sorensen, 2002, Mahboub et *al.*, 2004; Horsted, 2006; Seinfeld *et al.*, 2007).

Other feed items obtained from the range area

Various feed items were reported to be obtained by the outdoor hens, such as insects, worms, larvae, and snails which were reported to be rich in protein and metabolizable energy (Lomu *et al.*, 2004; Horsted *et al.*, 2007). The common house fly (*Musca domestica*) was reported to contain about 60% CP and 2500 kcal ME/kg. Mormon cricket meal contains 58% CP, grass hopper meal 76% CP, and snail meal 60% CP and 3400 kcal ME/kg. However, it has been observed that feed items were consumed by chickens when used either live or dried as a protein source resulting in performance comparable to that of chickens fed on commercial diets. In addition, laying hens could obtain high amounts of oyster shells and grit stones, which are usually used by birds as a source of calcium and in enhancing the mechanical digestion in the gizzard, respectively (Adeniji, 2010).

The use of range by laying hens

A majority of investigations reported that a low percent of hens used the range area, which reduces the expected benefits of the free range system. Low range utilization

by outdoor hens was reported by other studies, for instance 12% by Bubier and Bradshaw (1998), from 11 to 23% between 7 and 11 weeks of age reported by Mirabito and Lubac (2001), 9% by Hegelund *et al*. (2006). Average of 18% with a range between 7 to 38% reported by Hegelund *et al.* (2006) Maximizing the benefits of the outdoor system is highly correlated with the range utilization by hens. Outdoor and organic poultry producers, especially in tropical regions, should keep in mind that any production system should be easy to use continuously all year, not only during a specific season. Therefore, producers should focus their efforts on avoiding factors that reduce the range utilization by hens and seek new ways to attract more hens to use the range area.Good management especially protection from bad weather is the most important factor in avoiding production seasonality, especially in the tropics. In a study by Hegelund *et al.* (2005), they showed that the number of hens on the range increased until temperature reached about 17^0C, after which the number decreased. At this point they preferred to stay inside in shadow. Therefore, providing outdoor hens with adequate natural or artificial shed structures is of great importance especially in the tropical regions. Apart from safeguarding of the birds, age, strain and poor management affects range utilization (Mahboub, 2004; Hegelund et *al.*, 2005). In addition, Bubier and Bradshaw (1998) recommended avoiding the use of feed restriction, which would prevent the hens from staying in or near the house in anticipation of specific feeding times. In addition, they suggested using a combination of vegetation, including shrubs or trees which would make the range more attractive and increase outdoor activity.The availability of high quality plant vegetation was reported to be an attracting factor for free - range hens. Mahboub *et al.* (2004) reported differences in range utilization between the laying hen strains .The movement (frequency of changes) between the indoor areas amounted to 45% Z versus 29% for white Lohman Selected Leghorn (LSL) versus Brown Lohman Tradition (LT) hens, respectively. However LT hens spent more time in grassland than LSL hens.

Space and distance for outdoor hens

Access to forage materials is dictated by movement of the birds across the available forage area. There are recommendations for free range hen densities, *i.e.* European recommendations specified the stocking densities at 1.2 ft^2 per hen or 250 cm^2 (38.8in^2) of litter area. Maximum stocking density for outdoor area are 1 hen/4m^2 (1 hen/43ft^2), of litter which is equivalent to 2500 hens/hectare or 1000 hens/acre). Similarly, for free range meat-type chickens, the maximum density for outdoor area is one chicken per 10.8 ft^2, which is equivalent to 4033 chickens per acre. Whilst sufficient outdoor access' is required by the USDA it does not give a specific space requirement for free – range poultry (Fanatico, 2006). There are no specific recommendations regarding adequate range for laying hens. The literature showed that majority of free range hens were observed to concentrate closest to the houses. Therefore, it should be kept in mind how far hens would regularly move across the range. The results obtained by Zeltner and Hirt (2003) indicated that the hens which used the whole range area represented 22%, and the percent of hens that stayed in closer quarter to the poultry house (69.5%) was higher than the percent found in the farther quarters, the second (15.7%) third (8.7%)and fourth (6.8%). The range distance visited by hens could be increased by the increased range familiarity.

Mirabito and Lubac (2001) reported that mean distance visited by hens increased in numbers and within the nearest 10m from the house than the majority of hens. Similarly the findings of Hegelund *et al.* (2005) indicated that the majority of the hens stayed in the closest and middle distances from commercial organic egg- producing flocks consisting of 1200-5000 hens, Hegelund *et al.* (2006) showed that in most cases over 40% of the hens stayed very close to the hen house, the farmer succeeded in attracting the hens way from the direct vicinity of the hen house (less than 40% of the hens were zone 0 – 5 m), but even then less than 20% of the hens was more than 35 m from the house. Only one flock showed a more or less equal distribution of hens over the four zones in the outdoor run. In free range broilers, Rivera – ferre *et al.* (2007) suggested that 20m could be a critical distance. This was seldom surpassed by even when provided by extra shelters.

Conclusion

This review report discusses and interprets the findings of existing research reports surrounding outdoor egg production using local forages partly in tropical regions. Several observations are worthwhile remembering. Firstly, several leaf meals contain a high protein percent and could be incorporated up to 5% and 10% in broilers and layers diets, respectively. Secondly, whilst conventional poultry production systems are important in developing countries with animal protein shortages, the organic production destined for export is gaining more interest in countries such as Mexico. Thirdly, estimating the forage intake by analyzing the crop content of free-range hens (ranges 12.7 to 13.4g DM/hen/d) is considered the most reliable informative method. This gives a better knowledge about the other items obtained from the range area. Finally, protecting the outdoor raised hens from extreme weather and predators as well as the availability of good vegetation would be very helpful. It was observed that the hens do not adequately use the range they are given. Their foraging opportunities for consumption of these alternative feeds were limited.

References

Abou-Elezz, F.M.K, Sarmiento-Franco, L.., Santos-Ricalde, R. and Solorio-Sanchez, F. (2011). Nutritional effects of dietry inclusion of *leucaena leucocephala and Moringa oleifera* leaf meal on Rhode Island Red hens' performance. *Cuban Journal of Agricultural Science* **45(2):** 163-169.

Adeniji, A.A. (2010). Effect of diets grit inclusion on utilization of rice husk by pullet chicks. Tropical and subtropical agrosystems.12: 175- 180.

Aerni, V., El- Lethy, and Wechsler, B. (2000). Effect of foraging material and form on feather-pecking in laying hens. *British Poultry Science Journal 41:16- 21.*

Agbede, J.O. (2003) Equi- protein replacement of fish meal with *Leucaena* leaf protein concentrate: an assessment of performance characteristics and muscle develop-ment in the chicken. *International Journal of Poultry Science.2(6):421-429.*

Antell, S. and Ciszuk, P.(2006). Forage consumption of laying hens- to the crop as an indicator of feed intake AME contentof ingested feed. *Archive furgeflugrlkunde*.70: 154-160

Akande, T.O., Adeyeri, M.K. and Longe, O.G. (2008). Nutritional and economic value of leaf meal *(Tephrosia bracteolate)* in Diet of laying hens.

*Journal of Animal and Veterinary Advances***7(7):** 786-788.

Alalde, O.A. and Lyayi, E.A. (2006). Chemical composition and the feeding value of Azolla *(Azolla pinnata)* meal for egg-type chicks. *International Journal of Poultry Science* **5(2):** 137-141.

AL-Harthi, M.A. (2006). Increasing Mangroof leaves meal allowance in layers diets through enhancing its nutritive value. *International Journal of Poultry Science* **5(6):** 502-516.

Antell., S. and Ciszuk, P. (2006). Forage consumtion of laying hens – the crop as indicator of feed intake and AME content of ingested feed. *Archive fur geflugelkunde* 70: 154-160.

Atawodi, S.E., Mari, D., Atawodi, J.C and Yahaya, Y.(2008). Assessment of *Leucaena leucocephala* leaves as feed supplement in laying hens. *African Journal of Biotechnology* **7(3):** 317-321.

Ayssiwede, S.B., Dieng, A., Chrysostome, C., Ossebi, W., Hornick, J.L. and Berg,C. (2002) Health and Welfare in organic poultry production. Acta. Veterinarians Scandinavia 43 (suppl 1)s37-s45. Doi10.1186/1751-0147-43-SI-S37.

Basak, B.M.D., Pramank, A.H. and Rahman, M.S. (2002). Azolla *(Azolla pinnata)* as a feed ingredient in broiler ration. *International Journal of Poultry Science* **1(1):** 29-34.

Blair, R.(2008).Nutrition and feeding of Organic Poultry. Book.CAB. International, Faculty of land and food systems the University of British Columbia. Vancouver, British Columbia, Canada. Bubier, N.E. Badshaw, R.H. (1998) Movement of flock of laying hensin and out of the hens house in four free range system. *British poultry Science 39:S3-s18*.

Cooper,J.J. and Albentosa, M. J. (2003). Behavioral priorities of laying hens. *Avian and Poultry Biology Reviews 14:127-149.*

Ekenyem, B.U. and MadubuikeF.N.(2006). An assessment of *Impomoea asarifollia* leaf meal as feed ingredient in broiler chick production. *Pakistan Journal of Nutrition* **5(1):**46-50.

Emiol, I.A., Ojebiyi, O.O., Hamzat, R.A., Rafiu, T.A., Ogunwui, G. and Lawal, A. (2006). Growth response, nutrient digestibility and organ characteristics of broiler chicken fed graded levels of Kola pod husk meal in a derived Savannah zone of Nigeria. *International Journal of Poultry Science* **5(9):** 885-889.

Esonu, B.O., Opara, M.N, Okoli, I.C., Obikaonu, H.O., Udedibie, C. and Iheshiulor, O.O.M. (2006). Physiological Response of Laying Birds to Neem (*Azadiracha indica)* Leaf Meal-Based Diets: Body Weight Organ Characteristics and Haematology. *ONLINE Journal of Health and Allied Sciences* 2:4.

Fasuyi, A.O., Fajemilehin, S.O.K and Omojola, A.B.(2005). The egg quality characteristics of layers fed varying dietary inclusions of Siam weed (*Chromolaena odorata)* leaf meal (SWLM). *International Journal of Poultry Science* **4(10):** 752-757. Harlanda, --matauschet, A.Felsenstein,

Fanatico, A. (2006). Alternative poultry production systems and outdoor acess. A publication of ALTRA- National sustainable Agriculture information service, 10, 800-346-9140. Online in URL address: http:// attra.ncat.org/ attra-pub/poultryoverview.htm)

Hegelund, L., Sorensen, J.T., Kjaer, J.B. and Kristensen, I.S. (2005). Use of the range area in organic egg production system: Effect of climatic factors, focksize, age and artificial cover. *British Poultry Science.46(1) 1-8*.

Hegelund, L., Sorensen, J.T., and Hermansen, J.E. (2006). Welfare and productivity of laying hens in commercial organic egg production system in Denmark. NJAS, Wagneningen *Journal of Life sciences. 54(2): 147-155*.

Horsted, K., (2006). Increased forage in organic layers. Ph.D thesis, University of Aarhus, faculty of Agricultural Sciences, Department of Agro-ecology, Denmark.

Horsted, K., Marianne, H.J. and Hermansen, J.E. (2006). Short time effect on productivity in nutrient restricted organic layers versus non-organic layers with access to different forage crops. Acta Agriculture Scand 56: 42-54.

Horsted, K., Hermansen, J.E. and Ranvig, H. (2007). Crop content in nutrient restricted versus non restricted organic laying hens with access to different forage vegetations. *British Poultry Science 48: 177-184.*

Hughes, B.O. and Dun, P. (1983). A comparison of laying stock housed intensively in cages and outside on range. Research and development publication no, 18.

Ige, A.O., Odunsi, A.A., Akinlade, J.A., Ojedapo, L.O., Ameen, S.A., Aderinola, O.A.and Rafiu, T.A..(2006). *Gliricidia* leaf meal in layer's diet effect on performance, nutrient digestibility and economy of production. *Journal of Animal and Veterinary Advances* **5(6):** 483-486.

Iheukwumere, F.C., Ndubuisi, E.C., Mazi, E.A. and Onyekwere, M.U. (2008). Performance, Nutrient utilization, and organ characteristics of fed cassava leaf meal *(Manihot esculenta crantz). Pakistan Journal of Nutrition* **7(1):** 13-16.

Kakengi, A.M.V., Kaijage, J.T., Sarwatt, S.V., Mutaoba, S.K, Shem, M.N. and Fujihara, T. (2007). Effect of *Moringa oleifera* leaf meal as a substitute for sun-flower seed meal on performance of laying hens in Tanzania. *Livestock Research and Rural Development*, Vol.19 (120).

Kjaer, J.B. and Sorensen, P.(2002). Fether-pecking and cannibalism in free-range laying hens as affected by genotype, level of dietary methionine+cystine, light intensity during rearing and age at access to the rande area. Applied Animal behavior Science76: 21:39.

Lay JR., D.C., Fulton, R.M, Hester, P.Y., Karcher, D.M., Kjaer, J.B., Mench, J.K., Mullens, B.A., Newberry, R.C., Nicol, C.J., O'sullivan, N.P. and Porter, R.E.(2011). Hen welfare in different housing systems. Poultry Science 90: 278-294.

Lomu, A., Glatz, P.C. and RU, Y.J. (2004). Metabolizable energy of crops contents in free- range hens. International Journal of poultry Science. 3(11) 728-732.

Mahboub, H.D.H (2004). Feather pecking, body condition and outdoor use of two genotypes of laying hens housed in different free- range system. Ph.D Thesis. Faculty of Veterinary Medicine, University of Leipzig, Germany

Mahboub, H.D.H (2004) Muler, J. and Von-Borell, E.(2004).Outdoor use tonic immobility, heterophil/lymppocytes

ratio and feather condition in free-range laying hens of different genotype. British poultry Science. 45(6) 738-744.

Melesse, A., Tiruneh, W. and Negesse, T.(2011). Effects of feeding *Moringa stenopetala* leaf meal on nutrient intake and growth performance of Rhode Island Red chicks under tropical climate. *Tropical and Subtropical Agroecosystems***14:** 485-492.

Makkar, H.P.S. and Becker, K. (1997).Nutrient and anti quality factors on different moppological parts of moringa tree. *Journal of Agricultural Science.* 128: 311-322.

Mattocks, J. (2002 Pastured - raised poultry nutrition. Book. The fertel company prepared for Heifer international.

Melesse, A.,Tirunne, W. and Negesse, T. (2011). Effect of feeding moringer stenopetala leaf meal on nutrient intake and growth performance of Rhode Island Red chicks under tropical climate. *Tropical and subtropical Agro-ecosystems.* 14: 485-492.

Mirabito, L. and Lubac, S. (2001). Descriptive study of outdoor run occupation by Red label type chickens. British Poultry Science. 42(Supp.): S16-S17.

Missohou, A.(2010).Digestibility and metabolic and nutritional value of *Leucaena leucocephala* (Lam.) leaves meal incorporated in the diets of indigenous Seneghal chickens. *International Journal of Poultry Science* **9(8):** 767-776.

Mutayoba, S.K., Mutayoba, B.M. and Okot, P**.** (2003). The performance of growing pulletsfed diets with varying energy and *leucaena*leaf meal levels. *Livestock Research and Rural Development* **15(8).** Online in URL Address[http://www.lrrd.org/lrrd15/8/ muta158.htm], consulted on 29 September, 2012.

Niebuhr, K. and Troxler, J. (2006). Effect of pop holes dimensions on the number of laying hens outside in the range. British Poultry Science.47(2):131-134.

Nworgu, F.C. and Fasogbon, F.O.(2007) Centrosema (*Centrosema pubescens*) leaf meal as Protein Supplement for Pullet Chicks and Growing Pullets. *International Journal of Poultry Science* **6(4):** 225-260.

Odunsi, A.A., Ogunleke, M.O., Alagbe, O.S. and Ajani, T.O. (2002) Effect of feeding *Gliricidia sepium* leaf meal on the performance and egg quality of layers..*International Journal of Poultry Science* **1(1):** 26-28.

Odunsi, A.A. (2003) Assessment of Lablab *(Lablab purpureus)* leaf meal as a feed ingredient and yolk colouring agent in the diet of layers. *International Journal of Poultry Science* **2(1):** 71-74.

Olugbemi, T.S., Mutayoba, S.K. and Lekule, F.P**.** (2010). Effect of Moringa *(Moringa oleifera)* inclusion in Cassava based diets fed broiler chickens. *International Journal of Poultry Science* **9(4):** 363-367.

Paterson, R.T., Rootheaert, R.L. and Kiruiro, E. (2000). The feeding of leaf meal of *Calliandra calothyrsus*to laying hens. *Tropical Animal Health and Production* **32:** 51- 61.

Rivera, -ferre, M.G., Lantinga, E.A. and Kwakkel R.P. (2007). Herbage Intake and use of outdoor area by organic broilers: effect of vegetation type and shelter addition. NJAS Wageningen Journal of life sciences 54-3: 279-291.

Price, L.M. (2000). The moringatree. Online URL address: http://www.

biotechforlife.com.ph/allaboutmalunggay//images/20% moringa,20% tree.pdf) consulted 18 April 2011.

Steenfeldt, S.,Kjaer, J.B. and Engberge, R.M.(2007). Effect of feeding silages or carrots as supplements to laying hens on production performance, nutrient digestibility, gutstructure, gut microflora and feather pecking behaviour. British Poultry science. 48(4): 454-468.

Sarmiento, F.L., Mcnab, J.M., Pearson, R.A. and Belmar-Casso, R. (2002). Performance of broilers fed on diets containing different amounts of Chaya *(Cnidoscolus aconitifolius)* leaf meal. *Tropical Animal Health and Production* **34:** 257-269

Suksombat, W. and Buakeeree, K.(2006). Utilization of Lucerne meal *(Desmathus virigatus)* as protein supplement in layer diets. *Suranaree Journal of Science and Technology* **13(2):** 181-187.

Togun, V.A., Farinu, G.O., Ojebiyi, O.O., Akinlade, J.A. and Laogun, T.A.O. (2006). Performance of Isa Brown egg-type pullets fed diets containing graded levels of wild sun flower *(Tithonia diversifolia),* Hemls. a. Gray-forage meal as replacement for maize *World Journal of Agricultural Science* **2(4):** 443-449.

Udedibie, A.B.A. and Opara, C. C. (1998). Response of growing broilers and laying hens to the dietary inclusion of leaf meal from *Alchrornia cordifolia. Animal Feed Science and Technology* **71(1):** 157-164.

Wechsler, B. and Huber-Eicher, B. (1998). The effect of foraging material perch on feather pecking and feather damage in laying hens. Applied Animal Behavior Science. 58: 131.

Zeltner, E. and Hirt, H. (2003). Effect of artificial structuring on the use of laying hen in a free-range system. *British Poultry Science* 44: 533-537.