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**Guest Editorial**

Towards the science of family poultry – a multidisciplinary approach

J.G. Bell

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[Dr. Jonathan G. Bell has been working on family poultry since 1987, and has been an active member of the network since the Thessaloniki meeting in 1990. His speciality is the epidemiology and control of Newcastle disease in African family poultry, and he has worked in Morocco, Mauritania, Benin, Cameroon and Tanzania. He is currently a research agreement holder for the IAEA/FAO project on family poultry.]

Typically, our scientific meetings are attended by animal production specialists, nutritionists, veterinarians, and maybe geneticists. Yet, there are many other disciplines where current knowledge could contribute to the scientific study of village poultry. Take, for example, population biology. The village chicken is nearly, but not quite, a feral animal. The only things that distinguish it are small feed supplements, off take for sale and consumption, and sometimes night housing, assuming there are no medical interventions. In many of our surveys we need to know the numbers of eggs, chicks, growers and adults, and are interested in the variation of this population with time. So why not tap the expertise of theoretical population biology? Predators have been shown to be a significant cause of loss of family poultry in a number of countries. A lot of theoretical work has been done on cycles in predator-prey populations, which could be applied to the study of this constraint in family poultry. What is the other prey for the predators that prey on poultry? What other factors affect the population of the predators? There is more to find out than just the numbers of birds that have been removed from poultry flocks, and maybe there is more that we can do than just providing housing, or painting the chickens a different colour (as was suggested in our recent electronic conference). The same goes for ecology. We often talk of the “scavenging feed resource base”, but how many of us discuss our models with professional ecologists, to put questions such as: ‘what is the interspecific competition for the scavenging feed resource base?’ or ‘is the diversity of species relevant?’

Those of us who are concerned with infectious diseases of family poultry inevitably practice epidemiology, and we know the basic principles of the science. If we look across to human epidemiology we find that advanced mathematical models have been developed to explain cycles of infectious diseases. Indeed, it seems that human epidemiology in general is somewhat more advanced than veterinary epidemiology, which is surprising considering the greater facility with which veterinary experimental work can be conducted. Perhaps the models developed for human epidemiology would help us elucidate the cycles of infectious diseases in family poultry. They could also be used to predict the effect of interventions such as vaccination.

Techniques in molecular biology are already widely applied to infectious diseases of animals, but not so much yet in the case of family poultry. I don’t mean to say that you need to set up a molecular biology laboratory in an African village; this just isn’t possible without an industrial infrastructure. The same results, however, can be obtained through collaboration. There are people in existing laboratories with
theoretical interests just waiting for your virus isolates to do oligonucleotide fingerprints on them. The results from this sort of study could be of great help in understanding the epidemiology of the diseases that infect family poultry. Similar prospects exist with molecular genetics. While the ‘city chicken’ has already been bred almost beyond its biological limits – one only has to think of the buckling legs of the modern broiler breeders – his country ‘cousin’ still has a diverse genetic patrimony hiding riches that perhaps we do not realise we are in danger of losing.

What I am saying is that I would like to encourage those of us fortunate enough to have access to a multidisciplinary academic environment to present their results before a wider audience within the biological sciences, and to discuss experimental protocols, and even field trials, with those outside their immediate disciplines. Already the ongoing project on family poultry with the Animal Production and Health Section of the Joint FAO/IAEA Division is being run with a holistic approach.

This has the advantage that the different factors affecting the poultry are not considered in isolation. For example, people working on viruses are talking to people working on worms (even if they don’t always agree). But I am suggesting that we go one step further, and instead of just talking to other people working on poultry, we talk to those with a more theoretical interest in biology. If we tap existing resources in the more theoretical biological sciences, we could save ourselves a lot of work in the scientific study of the populations of fowl that are such a valuable resource to rural families around the world.

________________________________________________________

Research Reports

Muscovy duck (*Cairina moschata*) rearing in urban households of N’Djaména, Chad

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[Article shortened and translated from the original French - ED]

SUMMARY

The survey was carried out on 100 duck farms with 902 birds. These farms were distributed over 3 administrative districts consisting of 6 sub-districts and 20 blocks in N’Djaména city. It was found out that duck houses are mainly made of threshed mud. Feed is principally composed of cereal brans and of small-scale brewery by-products. A few breeding birds are selected according to their origin (males descended from prolific mothers), conformation, weight and plumage colour. Mean age at culling of males is 2.6±1.2 years. Average clutch per year is 2.2±0.7, with a mean egg number of 33±12 and a mean clutch size of 14 or 15 eggs.

Hatchability varies from 80 to 85 percent during the rainy season (between June and November) and from 59 to 78 percent during the dry season (between December and May). Mean brooding period is
63±28 days, and survival rate at 2 months ranges from 67 to 71 percent during the dry season and from 71 to 85 percent during the rainy season. Out of the 1,068 ducks kept by farmers, 54 percent were consumed and 46 percent were sold. Diseases, thieves, accidents and the raving constitute the major constraints. An adequate technical assistance for better management and appropriate feeding strategies could improve performances of ducks.

Key words: Chad, family poultry, Muscovy duck, socio-economics, urban area.

INTRODUCTION

N’Djaména, the capital city of Chad, had in 1993 a population of 531,000 inhabitants, representing about 9 percent of the total population and a demographic growth rate amounting to 7 percent per annum (Anonymous, 1995). In addition, according to estimates of the ‘Direction de l’Elevage et des Resources Animales’, the national poultry flock amounted to 24 million birds in 1997. Chickens, ducks and guinea fowls, in that order, constitute the most important species. The sale of poultry enables poultry keepers to acquire usual consumer goods. Products (meat and eggs) represent sources of cheap animal protein of high quality and are available to urban and rural households (Mopate et al., 1997).

The successive droughts occurring since 1973 have led to a change and a disorganization of the human population structure. Migratory phenomena and the diversification of production activities accelerate. The insecurity resulting from the civil wars and the devaluation of the CFA franc are the main causes of the important movement of rural population towards the capital. This situation has contributed to a rapid expansion of the rearing of short-cycle animals, in particular the Muscovy ducks.

To our knowledge, no work has been done to investigate the rearing and the productivity of Muscovy ducks in Chad. Yet, some poultry keepers claim that they prefer rearing Muscovy ducks than chickens because of the rusticity of ducks and their resistance to avian diseases.

The present survey on Muscovy duck rearing in N’Djaména, based on interviews, was carried out in order to characterize keepers, husbandry practices, performances, the exploitation (socio-economics), and to identify the constraints.

MATERIALS AND METHODS

The retrospective transversal investigation was conducted during the rainy season (August) 1998 in three districts of the city (first, second and fifth), divided into wards and squares. The selection criterion of these districts is the existence of a significant number of Muscovy duck keepers. Districts involved were Melezi, Madjorio and Farcha for the first district, Sabangali and Kabalaye for the second and Chagoua for the fifth. District, ward and square are administrative entities on which is exerted the communal authority.

During the pre-investigation period, information related to these entities, the number of duck keepers, the husbandry practices and the bibliographical data were collected. This information made it possible to prepare a questionnaire, to test it and to define sampling procedure. Thus, from the 50 randomly selected squares in 6 districts, 20 squares were randomly chosen. Out of these 20 squares to be sur-
veyed, seven are located in the first district, five in the second and eight in the fifth. On the basis of information collected during the pre-investigation phase, a rate of survey of 20 percent was used for squares consisting of 10 duck keepers and more, and the totality for squares of less than 10 duck keepers. On the whole, 100 duck keepers were interviewed (i.e. 50 in the first district, 12 in the second and 38 in the fifth).

The main points of the questionnaire turned on
- duck keeper (age, ethnic group, social status, professional activity, duration and reasons for presence in the city, possession of a house and number of years of experience in duck rearing);
- duck rearing (numbers, structure and origin of birds, types of duck housings for breeding and laying, healthiness of the housings, feeding, criteria for selection and culling of breeding drakes, performances of ducks and socio-economics of the production). Based on information gathered in pre-investigation as well as from the literature (Anonymous, 1976; Mourthe, 1989; Romboli, 1990), following age groups were considered: ducklings (0-2 months), growing drakes (3-6 months), growing ducks (3-5 months), adult drakes (7 months and more) and adult ducks (6 months and more). The exploitation of birds occurs only after two months of age.
- production constraints (causes and importance of losses, predators and obstacles to development), principal symptoms of diseases responsible for mortality and the attitude of duck keepers towards sick birds.

RESULTS AND DISCUSSION

Characteristics of duck keepers and other types of livestock: Duck keepers were men (53 percent), women (39 percent) and children (8 percent) with an average age of 42 ± 12 years. All stated to be owners and responsible for the rearing of their flock. The majority (92 percent) was married with on average 1.17 ± 0.5 women, and there were 7 ± 4 persons per household. The average number of persons per household was higher than the value (5.3) reported by Anonymous (1998). Nevertheless, this reference

The survey was carried out during the rainy season, but reproductive performances of the ducks were also asked about over the other seasons. This poses a problem of reliability (memory and experience of duck keepers) with regard to the information collected. The names of the seasons were given in the local Arabic language, the majority of urban dwellers usually speaking it fluently. The cold season (‘Shitet’) goes from December to February, the dry and hot season (‘Seif’) from March to May, the first rains (‘Rouchach’) in June, the rainy season (‘Kharif’) from July to October and the post-rainy season (‘Darat’) from October to November.

Information relating to number of eggs laid, number of ducklings hatched and those still alive at 2 months of age was also collected. Similarly, some weighing was performed on young birds (males or females) and adults (males and females) in order to estimate the average live weight at sale within the age group. The survey was conducted within the homesteads, in presence of duck flocks in order to better fix the attention of duck keepers and to precise flock sizes and duck categories.

Data registration as well as calculation of frequencies and average mean values were carried out using the ‘Epi-info’ software (Dean et al., 1990).
indicates that, in households whose heads are about forty years old, values range from 6 to 9 persons.

What is in conformity with our findings? Duck keepers had on average $7 \pm 6$ years of experience in the venture and live, for the majority (93 percent), in their own house. They belonged to the following ethnic groups: the Kabalaye (28 percent), originated from the prefecture of Tangilé; the Sara (37 percent), native of the prefectures of the Western Logone, Eastern Logone and the Mid-Chari; the Banana and Massa (34 percent), from the Mayo-Kebbi region and the Hadjarai (1 percent) from Guèye. They have lived in N’Djaména for $24 \pm 12$ years. This is to be related to the turbid periods of the country. The reasons for the presence of duck keepers in N’Djaména city and their activities are presented in Table 1.

**Table 1: Reasons for presence of duck keepers in N’Djaména and their activities**

<table>
<thead>
<tr>
<th>Reason for presence in N’Djaména</th>
<th>Activity of duck keepers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reason</td>
<td>Frequency (%)</td>
</tr>
<tr>
<td>Employment*</td>
<td>31</td>
</tr>
<tr>
<td>Education</td>
<td>5</td>
</tr>
<tr>
<td>Migration</td>
<td>11</td>
</tr>
<tr>
<td>Family**</td>
<td>4</td>
</tr>
<tr>
<td>Marriage</td>
<td>33</td>
</tr>
<tr>
<td>Birth</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>

* Persons assigned to N’Djaména or exerting a remunerated employment; ** Persons having followed their parents

Agricultural activities consisted of food crops, truck farming and the maintenance of orchards. With regard to pastoral activities, besides ducks, rearing of small ruminants and other monogastric animals is practised. Average flock sizes in the surveyed family farms were: sheep ($2 \pm 1$, $n=10$ households); goats ($6 \pm 5$, $n=33$); pigs ($13 \pm 5$, $n=6$); rabbits ($3 \pm 1$, $n=4$); chickens ($7 \pm 6$, $n=41$); guinea fowls ($5 \pm 3$, $n=7$); pigeons ($9 \pm 7$, $n=8$) and geese ($2 \pm 0.7$, $n=5$).

These multi-species farming systems were observed in 56 percent of surveyed farmers and the exclusive rearing of ducks in 44 percent of them. Farms, which in addition to ducks, had one or more other poultry species (chickens, guinea fowls, geese, pigeons) represented 15 percent, and 4 percent of homesteads associated ducks with other monogastric animals (pigs, rabbits, chickens). Slight differences noted between the results of our study and those reported by other authors (Centrê, 1996; Thiombiano and Mattoni, 1995; Missohou et al., 1995) are explained by the fact that we targeted only areas where duck rearing does exist. For example, the north-eastern part of the city where the rearing of chickens and small ruminants is important was not considered during the present survey, because of the absence of duck rearing.

**Production characteristics:** The structure of the surveyed household ducks is presented in Table 2. A low number of growing birds (excluding the not-exploited ducklings) was noted. This indicates that a significant number of growing birds is removed from
the flocks. Theft, predation, mortality, consumption and sale are the principal causes of this.

Table 2: Structure of surveyed duck population in the N’Djaména city.

<table>
<thead>
<tr>
<th>Age group</th>
<th>Number</th>
<th>Frequency (%)</th>
<th>Mean ± standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ducklings (0 – 2 months)</td>
<td>509</td>
<td>56</td>
<td>7 ± 6</td>
</tr>
<tr>
<td>Male growers (3 - 6 months)</td>
<td>68</td>
<td>8</td>
<td>2 ± 1</td>
</tr>
<tr>
<td>Female growers (3 - 5 months)</td>
<td>74</td>
<td>8</td>
<td>2 ± 2</td>
</tr>
<tr>
<td>Drakes (7 months and more)</td>
<td>57</td>
<td>6</td>
<td>1 ± 0.4</td>
</tr>
<tr>
<td>Ducks (6 months and more)</td>
<td>194</td>
<td>22</td>
<td>2 ± 0.3</td>
</tr>
<tr>
<td>Total</td>
<td>902</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

The average flock size was 9 ± 6 birds. This result is close to that reported by Kuit et al. (1985) in rural areas of Central Mali. On the other hand, it is lower than those observed by Ajala et al. (1998) in rural Nigeria and by Kuit et al. (1985) in urban areas. In surveyed households, a ration of about one duck per person was observed.

With 665 duck keepers counted during the pre-investigation phase in the 6 districts, duck number was estimated at approximately 6,000. By adding to it those of the four other wards of the city (Ardepdjournal, Moursal, Dembé and Amtougou) where the rearing of Muscovy duck is significant, an estimate of 9,000 to 10,000 ducks for N’Djaména is plausible. The duck to drake ratio was 3.4. These stocks were founded at the origin by purchase (74 percent), gift (23 percent) and inheritance (3 percent). The socio-economic importance of poultry in the sphere of human relationships would explain differences observed between our results and those reported by other authors (Hassan and Aliyu, 1996; Ajala et al., 1998).

Duck housings and their maintenance: Duck houses made of threshed mud were largely used (93 percent), and other possibilities were: no housings (3 percent), houses made of clay with straw roof (2 percent) and straw houses (2 percent). These small-sized duck houses are hastily built in a corner of the homestead. All categories of ducks shelter there all the year round. Laying nests were located, in majority (81 percent), in duck houses, but also in humans’ dwelling houses (14 percent) and kitchens (5 percent). The number of poultry placed is in conformity with that reported by Kuit et al. (1985) in Central Mali.

Cleanings were ensured irregularly: at least once per day (14 percent), at least once per week (69 percent), once per month (7 percent) and once per year (10 percent). It is in these housings or their small yard that feeds and drinking water for ducks were supplied in various utensils.
Feeding: Cereals brans (sorghum, maize, rice, etc.), local brewer’s grains (sorghum and rice) and residues from the preparation of indigenous alcohol were the principal feed resources (Table 3). They were distributed to ducks by 97 percent of farmers, at least once a day and without any distinction of age. The remaining percentage of farmers (3 percent) supplemented ducks at least once a week. Feeds were bought (72 percent), produced (25 percent) or received at no cost (3 percent) by farmers. Our results are higher than those reported by Kuit et al. (1985) in Central Mali. Moreover, despite supplementary feeds, the scavenging system of rearing remains dominating.

Table 3: Types of feeds supplied, feeders and drinkers used for Muscovy ducks in N’Djaména.

<table>
<thead>
<tr>
<th>Feed Type</th>
<th>Frequency (%)</th>
<th>Feeder Type</th>
<th>Frequency (%)</th>
<th>Drinker Type</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brans</td>
<td>50</td>
<td>Plate/tray</td>
<td>48</td>
<td>Cup</td>
<td>25</td>
</tr>
<tr>
<td>Brewer’s grains</td>
<td>38</td>
<td>Half-can/old helmet</td>
<td>33</td>
<td>Cement hole</td>
<td>24</td>
</tr>
<tr>
<td>Cereals</td>
<td>6</td>
<td>Piece of vessel</td>
<td>8</td>
<td>Piece of vessel</td>
<td>20</td>
</tr>
<tr>
<td>Food leftovers</td>
<td>6</td>
<td>At ground</td>
<td>7</td>
<td>Old helmet</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Old bag/winnowing basket/mat</td>
<td>4</td>
<td>Half-can</td>
<td>12</td>
</tr>
</tbody>
</table>

Total 100 100 100

Feeders and drinkers were used for all age groups. Springs for the watering of ducks were traditional wells (76 percent) and drinking water drillings or taps (24 percent).

Management of the reproduction and performances of ducks: More than half of poultry farmers (57 percent) had a breeding drake. The remaining percentage counted on breeding drakes of the neighbourhood to ensure mating of their ducks. These breeding drakes were chosen mainly within farmers’ duck flocks (56 percent), from the neighbourhood (22 percent), at the market or from another district (22 percent). This demonstrates a certain confidence that duck farmers place on the genetic stocks, as they know their origin. However, the risk is that this practice could, in the long run, pose problems of consanguinity in their flocks.

Farmers chose breeding drakes either before 7 months of age (12 percent) or after (46 percent). The others (42 percent) were ignorant of the exact age of choice or did not take it into account. No exchange of breeding drakes between farmers from different wards of the city was reported. The majority of duck farmers (60 percent) did not privilege any criterion for the choice of future breeding drake.

On the other hand, 40 percent adopted the following criteria: the colour of plumage (white or grey-white) 16 percent, the origin for males descending from prolific ducks 23 percent, the weight and the format 48 percent, and finally, the colour of plumage, the weight and the format together 13 percent. Improvement of the farming system and seeking for aesthetics (colour of plumage) were the mentioned purposes. Average age for culling breeding drakes was 2.6±1.2 years, this value being close to that reported in Anonymous (1976). Old age of birds and financial needs were the dominant reasons (64 percent). Sale
was the mode of culling for the majority of duck farmers.

Duck lays on average $2.2 \pm 0.7$ times per year, with an average clutch size of 14 or 15 eggs and an average number of eggs of $33 \pm 12$ per year. The average number of clutches per year as well as the number of eggs per laying are consistent with values reported by Mourthe (1989). On the other hand, the number of eggs per year observed during our investigation is lower than the production level reported in Anonymous (1991b). The differences between these results might be explained by fluctuating feeding during the year. Feed intakes while scavenging during the day does not make it possible for ducks to balance their daily rations.

The distribution of duck performances according to seasons highlights average parameters given in Table 4. In the wet season (from June to November), ducks showed better reproductive performances. The decrease in temperature during this season and the existence of many temporary ponds in certain wards of the city would, thus, create favourable conditions for the reproduction of ducks. During this period, greenery also appears in the surroundings of these ponds.

### Table 4: Average reproductive performance parameters of local ducks according to seasons in N’Djaména city.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>‘Shitet’ (Dec.-Feb.)</th>
<th>‘Seif’ (March-May)</th>
<th>‘Rouchach’ (June)</th>
<th>‘Kharif’ (July-Sept.)</th>
<th>‘Darait’ (Oct.-Nov.)</th>
<th>Overall mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eggs/clutch</td>
<td>13.9±3.3</td>
<td>14.1±3.6</td>
<td>14.5±3.4</td>
<td>14.7±3.7</td>
<td>14.3±3.8</td>
<td>14.3±0.3</td>
</tr>
<tr>
<td>Hatched ducklings</td>
<td>10.8±3.3</td>
<td>7.9±3.9</td>
<td>11.9±4.4</td>
<td>12.2±3.7</td>
<td>11.2±4.1</td>
<td>10.8±1.7</td>
</tr>
<tr>
<td>Hatching rate, %</td>
<td>77.8±18.4</td>
<td>58.6±24.9</td>
<td>79.9±19.0</td>
<td>84.5±22.4</td>
<td>81.6±21.4</td>
<td>76.5±10.3</td>
</tr>
<tr>
<td>Surviving at 2 months</td>
<td>7.4±3.7</td>
<td>5.9±4.8</td>
<td>9.3±5.3</td>
<td>9.8±3.8</td>
<td>9.8±4.6</td>
<td>8.4±1.7</td>
</tr>
<tr>
<td>Survival rate at 2 months</td>
<td>66.9±24.5</td>
<td>71.4±29.6</td>
<td>70.5±28.8</td>
<td>80.4±20.6</td>
<td>84.7±18.0</td>
<td>74.8±7.5</td>
</tr>
</tbody>
</table>

Hatching rates ranged from 80 to 85 percent during the rainy season (between June and November) versus 59 to 78 percent during the dry season (from December to May). Low performances were recorded during the warm period (‘Seif’) where average temperatures in the shade oscillate between 30 and 45°C. The low hatching rate is explained, then, by the rotting of eggs during this period. The differences noted between the seasons were, however, not significant. On the whole of the year, the hatchability is close to those reported by other authors (Romboli, 1990; Guèye, 1999), but lower than that reported by Hassan and Aliyu (1996).

Average age at weaning of ducklings was $63 \pm 28$ days. However, 56 percent of duck farmers mentioned it to be between 45 and 60 days. This result is consistent with that reported by Hassan and Aliyu (1996).

**Socio-economics of the production:** The production efficiency rate was approximately 120 percent, which appears low. Purposes for keeping ducks were: sale and home consumption at the same time (53 percent), home consumption only (39 percent), sale of ducks only (5 percent) and sale of duck eggs only (3 per-
Consumption of duck meat occurred usually within the homestead (61 percent), during feasts (25 percent) and as special banquets for family guests (14 percent).

For 90 percent of duck farmers having consumed 579 ducks and 52 percent having sold 487 birds in a year, average numbers were 6 and 9 birds, respectively. Sales took place mostly on farms. Indeed, the price differences being insignificant between wards of the city, which are the production areas, and the various markets of N’Djaména, duck keepers do find it profitable to sell ducks on farms or to neighbours. Centrés (1996) made the same observations on the production of urban farmers in Bamako, Mali. Out of 1,068 studied ducks, 54 percent were consumed and 46 percent were sold in a year (Table 5).

**Table 5:** Numbers consumed and sold in a year, average prices per unit, average liveweights per duck category and receipts from sales in the studied sample.

<table>
<thead>
<tr>
<th>Category</th>
<th>Consumption</th>
<th>Sale</th>
<th>Average price FCFA*</th>
<th>Average liveweight g</th>
<th>Receipts FCFA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growing drake (3 - 6 months)</td>
<td>279</td>
<td>238</td>
<td>1,900</td>
<td>2,242</td>
<td>452,200</td>
</tr>
<tr>
<td>Growing duck (3 - 5 months)</td>
<td>166</td>
<td>198</td>
<td>1,500</td>
<td>1,605</td>
<td>297,000</td>
</tr>
<tr>
<td>Adult drake (7 months and more)</td>
<td>117</td>
<td>51</td>
<td>2,500</td>
<td>3,246</td>
<td>127,500</td>
</tr>
<tr>
<td>Adult duck (6 months and more)</td>
<td>17</td>
<td>2</td>
<td>1,500</td>
<td>1,852</td>
<td>3,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>579</strong></td>
<td><strong>489</strong></td>
<td><strong>879,700</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* 1 US$ is about 600 FCFA

Home consumption, which is more important than sales, contributes thus to the improvement of the protein supply to town dwellers. It also enables duck keepers (salaried or not) to save money in the household budgets devoted to food expenses. Food expenses amount to 41 percent of the budget of salaried persons and to 60 percent of that of non-salaried persons (Anonymous, 1998).

The 579 ducks consumed by the surveyed farmers were equivalent to savings of FCFA 1,097,100 for the households. Assuming an average price of FCFA 2,000 per unit, for all duck categories, the average value of annual production (average values of sales and consumption) per household is estimated at FCFA 30,000, the average income per inhabitant amounting to about FCFA 98,000. For the whole city, the global turnover of this production might be of the order of 18 to 20 million FCFA.

The average annual receipts earned by duck keepers from sales were about FCFA 17,000, i.e. FCFA 879,700 (total receipt from sales) divided by 52 (number of duck keepers having actually sold ducks). The generated money was used to purchase cereals (36.5 percent), clothes (25.0 percent), school fees and health care (30.8 percent) and payment of the civic tax (7.7 percent).

Finally, it should be pointed out that, by comparison with prices of local chickens raised traditionally, ducks are cheaper. In N’Djamen, a 2-kg-chicken costs less than FCFA 2,500 whereas this price allows to acquire a duck weighing more than 3 kg. Moreover, the supply of ducks to markets is not regular all the year.

**Production constraints:** Diseases, thefts, accidents
and predation constitute major concerns for duck farmers. Out of 996 losses (all age groups) recorded in a year, diseases were responsible for 57 percent of cases, thefts for 19 percent, accidents for 14 percent and predation for 10 percent. Children and road traffic were the major causes of accidents. Pigs and dogs were the most reported predators. Besides these constraints, duck keepers identified the absence of technical assistance (42 percent), the lack of means (35 percent), the problem of space in terms of availability or absence of fence (15 percent) and the quality of feeds (8 percent) as major obstacles to the expansion of their farm.

Nervous symptoms, especially the paralysis of growing ducks of less than 5 months (58 percent), the inflammation of the pigial gland (36 percent), digestive symptoms of which the white, yellow or green diarrhoea (3 percent) and respiratory symptoms (3 percent) were responsible for the mortality of ducks.

Health problems relating to digestive disorders reported by farmers were probably linked to parasites. A coproscopic study (Ngolao, 1998) carried out on 115 ducks from these farms revealed a parasitic prevalence of 53 percent, main parasites being *Eimeria spp.*, *Ascaridia galli*, *Trichomonas spp.* and *Hymenolepis spp.* This situation is attributable to the defective hygiene (feeding, housing) and to the predominance of the scavenging husbandry system. Cases of paralysis, inflammations of the pigial gland and stiff neck were also reported.

CONCLUSIONS

The study shows that the rearing of ducks is practised by all family members (men, women and children) in N’Djaména, Chad. Different socioprofessional groups are devoted to this activity and consider it as a secondary occupation. Most farmers raise ducks along with other animal species. Housing and feeding practices are still, in most cases, rudimentary. Even if they are rounded up in a house during the night, ducks scavenge in the daytime. Besides these practices, diseases, thefts, accidents and lack of technical assistance constitute major constraints.

Socio-economic elements demonstrated genuine advantages of this venture. It plays a significant role in the supply of animal produce to the town. The selling of the production does not pose a problem. Reproductive performances are however low. They can be improved through a balanced feeding which should be distributed in adequate hygienic conditions. Similarly, a better care of ducklings during the first weeks after hatching as well as good housing conditions would give positive results. Furthermore, health-related problems and production parameters deserve a thorough investigation. They could be resolved through interventions in the domains of technical assistance and advice to duck farmers. A development programme would be highly appreciated by duck keepers.

Acknowledgements: We would like to express our gratitude to Mr. Denis Bastianelli of the CIRAD-EMVT for his pertinent observations.
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The effect of feed energy level and particle size on performance of broilers under farmers management

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[Article shortened - ED]

ABSTRACT

In this study, the effect of feed energy level and particle size on the performance of broiler chicks under farmer’s management was tested. Birds were reared under deep litter management system with wood shavings as the litter material. Broiler chicks were placed with ten farmers around Nairobi. Each farmer received 3,000 day-old broiler chicks. Farmers were managing the flocks after being trained. Eight different feed rations were used: four in the 21-day starter period (SP) and four in the finisher period (FP). For each rearing period, two levels of energy (high and low) and two modes of presentation (crumb and mash or pellet and mash) were considered. Feed and water were provided ad libitum, and birds were vaccinated against infectious bronchitis, Newcastle disease and Gumboro disease. Mature birds were slaughtered on day forty-two.

Better performances in terms of mortality, feed conversion ratio, production index number and gross profits per bird placed were obtained with broilers fed on mash rations compared to those birds fed on pelleted rations. The combinations of high-energy starter and high-energy finisher rations give also good results. It was concluded that mash rations should form the major component in broiler feed management under tropical conditions.

Key words: Energy, farmer management, feeding, mortality, particle size, performance, tropics

INTRODUCTION

Broiler farmers have a wide range of feed rations to choose from. These include pellets, mash, crumbs, low-energy, high-energy and special formulations as agreed between the miller and the farmer. Feed management still poses problems to broiler farmers worldwide, particularly in developing countries (Adegbola, 1988). Currently feed takes about 65-70% of the total cost of rearing broilers to market weight (Reddy, 1996). Research emphasis within the last three decades has been on fast weight gain without considering factors like climatic conditions, eating habits, availability of raw materials for feed manufacturing, exchanges rates, levels of farm inputs and knowledge in broiler rearing at farm level. Yet, these factors influence the rearing of broilers.

Feed costs are continuously increasing. This constitutes a major problem facing broiler industry in poor countries, especially in Africa. There is an urgent need to conduct research activities in order to find ways of optimizing the use of feeds and, thus, to reduce their costs. With the aim of contributing to overcome this constraint, the present trial carried out. This investigation focuses on feed management at farm level. The objectives of the study were:

(i) to identify the best feeding programme suitable for rearing broilers in developing countries under farmers’ management conditions;
(ii) to investigate disease and production factors associated with feed particle size and energy levels; and

(iii) to identify feeding strategies that give maximum economic returns.

MATERIALS AND METHODS

Thirty thousand Arbo Acres day-old chicks were used in this study. The chicks were purchased from a local poultry integrated firm in Kenya.

Eight different feed rations were used in this study. The rations were:

(1) High-energy broiler starter crumb ration (HEBSC) with 13.40 MJ Metabolisable Energy (ME)/kg feed;
(2) High-energy broiler starter mash ration (HEBSM) with 13.40 MJ ME /kg feed;
(3) Low-energy broiler starter crumb (LEBSC) with 10.47 MJ ME /kg feed;
(4) Low-energy broiler starter mash (LEBSM) with 10.47 MJ ME /kg feed;
(5) High-energy broiler finisher pellet (HEBFP) with 11.72 MJ ME /kg feed;
(6) High-energy broiler finisher mash (HEBFM) with 11.72 MJ ME /kg feed;
(7) Low-energy broiler finisher pellet (LEBFP) with 10.05 MJ ME /kg feed; and
(8) Low-energy broiler finisher mash (LEBFM) with 10.05 MJ ME /kg feed.

All the different feed rations were purchased at prevailing market values. The market values were: Kenya Shillings (Kshs.) 1,640 per 70-kg-bag of HEBSC and HEBSM; Kshs. 1,440 per 70-kg-bag of HEBFM and HEBFP; Kshs. 1,200 per 70-kg-bag of LEBSC and LEBSM; Kshs. 1,100 per 70-kg-bag of LEBFP and LEBFM. (1 US Dollar \(\approx 75\) Kenya Shillings).

The 30,000 Arbo Acres broiler chicks were randomly divided into ten batches of 3,000 chicks each and fed the following rations under farmers’ management practices: Batch 1 (HEBSC-HEBFP), Batch 2 (HEBSC-HEBFM), Batch 3 (HEBSC-LEBFP), Batch 4 (HEBSC-LEBFM), Batch 5 (LEBSC-HEBFP), Batch 6 (LEBSC-HEBFM), Batch 7 (LEBSC-LEBFP), Batch 8 (LEBSC-LEBFM), Batch 9 (LEBSM-LEBFM) and Batch 10 (HEBSM-HEBFM). Broiler starter and finisher rations were each fed to birds for twenty-one days. There were one feeder for 50 birds and one drinker for 60 birds. Feed and water were provided \textit{ad libitum}. Birds were on light for twenty-four hours. At night, light was provided using paraffin lamps. The stocking density was one bird per square foot. Heat was provided by charcoal stoves.

The experiment was participatory with farmers managing the flocks after being trained. Therefore there was no replication. Chicks were transported to the farms.

Mature broilers were bought at live weight prices. First quality birds were bought at Kshs. 102 per kg live weight. Second grade birds were bought at Kshs. 80 per kg live weight. Birds were slaughtered at forty-two days of age. Carcasses were graded after dripping. The grading parameter was the dressed weight. The following grading scale was used: Springs (400-800 g), Grillers (800-1000 g) and Campions (more than 1000 g).

All birds were vaccinated against infectious bronchitis, Newcastle disease and infectious bursal disease.

Post mortem examination was carried out on all dead
Production number index (PIN) is defined as the percent survivors multiplied by average body weight divided by the product of the multiplication between feed conversion ratio with age. The resulting figure is multiplied by 100 (Vest, 1995).

RESULTS AND DISCUSSION

Table 1 shows that overall mortality was higher in broilers fed on pelleted feeds, in comparison with those birds fed on mash rations. No effect of the energy level of the feed on mortality was observed. This is contrary to the findings of Shrek et al (1963) who reported a low mortality with pellet fed broilers. Higher mortality was due to ascites. This agrees with the findings of Dale (1994) and Maxwell (1990). They reported that feeding mash might result in minimizing ascites.

Some authors (Maxwell, 1990; Lee, 1997) indicate that ascites has also many other causes such as poor ventilation, use of some drugs such as furazolidone, vitamin E and selenium deficiencies, increased sodium (salt) in the drinking water or diet, disease, altitude, genetics and stress. The incidence of ascites is closely linked to the excessive water intake. Control of ascites through skip a day feed program (Maxwell and Robertson, 1997), may lead to severe coccidiosis challenge because birds tend to scavenge on the litter. This method may only be successful in well-managed farms typical in developed countries.

Mortality due to SDS ranged from 0.7 to 3.8 percent (Table 1). Higher incidence of SDS was also noted in birds fed on pellet compared to those fed on mash. This agrees with the results of Proudfoot et al. (1982) and further confirms that mash is the feed for tropical conditions where stress due to heat is a major poultry production problem (Adegbola, 1988).

<table>
<thead>
<tr>
<th>Feed batch</th>
<th>Batch No.</th>
<th>Total</th>
<th>Ascites</th>
<th>SDS</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEBSC+HEBFP</td>
<td>1</td>
<td>15.0</td>
<td>8.3</td>
<td>3.8</td>
<td>2.9</td>
</tr>
<tr>
<td>HEBSC+HEBFM</td>
<td>2</td>
<td>6.4</td>
<td>1.8</td>
<td>1.3</td>
<td>3.3</td>
</tr>
<tr>
<td>HEBSC+LEBFP</td>
<td>3</td>
<td>12.7</td>
<td>6.7</td>
<td>2.3</td>
<td>3.7</td>
</tr>
<tr>
<td>HEBSC+LEBFM</td>
<td>4</td>
<td>4.4</td>
<td>1.1</td>
<td>0.7</td>
<td>2.6</td>
</tr>
<tr>
<td>LEBSC+HEBFP</td>
<td>5</td>
<td>9.9</td>
<td>7.0</td>
<td>1.3</td>
<td>1.6</td>
</tr>
<tr>
<td>LEBSC+HEBFM</td>
<td>6</td>
<td>5.7</td>
<td>1.7</td>
<td>1.4</td>
<td>2.6</td>
</tr>
<tr>
<td>LEBSC+LEBFP</td>
<td>7</td>
<td>11.4</td>
<td>5.5</td>
<td>1.5</td>
<td>4.4</td>
</tr>
<tr>
<td>LEBSC+LEBFM</td>
<td>8</td>
<td>5.4</td>
<td>2.0</td>
<td>1.2</td>
<td>2.2</td>
</tr>
<tr>
<td>LEBSM+LEBFM</td>
<td>9</td>
<td>4.2</td>
<td>0.6</td>
<td>0.8</td>
<td>2.8</td>
</tr>
<tr>
<td>HEBSM+HEBFM</td>
<td>10</td>
<td>4.1</td>
<td>0.8</td>
<td>1.3</td>
<td>2.0</td>
</tr>
</tbody>
</table>
Highest PIN values as well as gross profits per bird placed were obtained with the combinations of high-energy starter and high-energy finisher rations (Table 2). Good performance of mash rations may be due to the associated low mortality. This further emphasizes that livability is a key parameter in the profitability of rearing broilers. This has often been over-shadowed by the need for high body weight particularly where farmers are paid for it.

Table 2: Production parameters.

<table>
<thead>
<tr>
<th>Batch</th>
<th>Weight at slaughter, g</th>
<th>Feed conversion ratio</th>
<th>Production Index Number</th>
<th>Gross profit per bird placed, Kenya Shillings</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEBSC+HEBFP (1)</td>
<td>1,679</td>
<td>2.34</td>
<td>145.1</td>
<td>34.9</td>
</tr>
<tr>
<td>HEBSC+HEBFM (2)</td>
<td>1,565</td>
<td>2.24</td>
<td>155.7</td>
<td>42.0</td>
</tr>
<tr>
<td>HEBSC+LEBFP (3)</td>
<td>1,365</td>
<td>2.93</td>
<td>97.0</td>
<td>22.0</td>
</tr>
<tr>
<td>HEBSC+LEBFM (4)</td>
<td>1,286</td>
<td>2.61</td>
<td>111.9</td>
<td>31.6</td>
</tr>
<tr>
<td>LEBSC+HEBFP (5)</td>
<td>1,310</td>
<td>2.41</td>
<td>116.4</td>
<td>25.3</td>
</tr>
<tr>
<td>LEBSC+HEBFM (6)</td>
<td>1,306</td>
<td>2.39</td>
<td>122.5</td>
<td>29.5</td>
</tr>
<tr>
<td>LEBSC+LEBFP (7)</td>
<td>1,286</td>
<td>3.22</td>
<td>84.1</td>
<td>22.1</td>
</tr>
<tr>
<td>LEBSC+LEBFM (8)</td>
<td>1,150</td>
<td>2.87</td>
<td>90.2</td>
<td>22.2</td>
</tr>
<tr>
<td>LEBSM+LEBFM (9)</td>
<td>980</td>
<td>3.05</td>
<td>73.4</td>
<td>3.5</td>
</tr>
<tr>
<td>HEBSM+HEBFM (10)</td>
<td>1,350</td>
<td>2.16</td>
<td>132.7</td>
<td>40.0</td>
</tr>
</tbody>
</table>

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions can be drawn from this study:

- For successful rearing of broilers in the tropics, mash rations ought to be included in the feed management program;
- More mash should be used during the second rearing phase after brooding to control ascites and SDS;
- An all mash feed ration is more suitable where feed management may be a limiting factor, especially in countries where the extension services do not exist or are not effective; and
- All stakeholders (breeders, hatchery managers, farmers, processors, consumers and policy makers) in the poultry industry should work together at all levels.

Therefore the following recommendations are made:

- Pellet and mash rations should be used together during a broiler rearing cycle;
- A standard minimum energy level in broiler feed rations should be set;
- Feed manufacturers should be compelled to indicate the feed energy level on the bag; and
- More research should be done to:
  - determine causes in upsurge in mortality after introduction of finisher rations in a broiler rearing cycle;
  - identify optimal energy levels in pelleted and mash feed rations to achieve minimum mortality in broilers under tropical and farmers’ management conditions; and
– develop broiler rearing systems based on Hazard Analysis and Critical Control Points under farmers’ management conditions.

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Summaries of Theses on Family Poultry

Ecotypes and natural disease resistance among scavenging local chickens of Tanzania

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[Master of Science Thesis, 1998, Department of Veterinary Microbiology, The Royal Veterinary and Agricultural University, Copenhagen, Denmark]

This work is divided into two parts. Part one contains four chapters on introduction, literature review, general results and conclusions, and Part two contains Appendices 1-4 covering the current research findings. Chapter one covers the general aspects of the chicken industry in Africa with emphasis on scavenging local chicken sector. Literature on social and economical importance of local chickens as well as the major constraints to this sector is reviewed. A brief review on natural disease resistance is included. Appendix 1 provides a preliminary insight to pheno-typic characterization of the local scavenging chickens of Tanzania. Local scavenging chickens in Tanzania have always been considered as a distinct breed of chicken different from the known commercial hybrids such as commercial layer or broiler chickens. This study has provided preliminary facts, which reveal that the local chicken population is a pool of heterogeneous individuals, which can be separated by geographical locations henceforth, referred to as ecotypes. Differences in adult body weight and size,
comb type, body length, shank length and egg weight were shown to exist in scavenging local chickens ecotypes studied. The results are in agreement with the findings by other authors who have reported differences in phenotypic characters of the scavenging local chickens. In this study, five types of scavenging local chickens were identified namely, Mbeya, Morogoro-medium, Morogoro-short, Mwanza and Tahora.

Immunocompetence has been used extensively as an indicator trait in disease resistance of chickens. In assessing the immunocompetence of the Tanzania scavenging local chicken ecotypes, using both the humoral and the cellular immune responses, it was found that differences were as pronounced within ecotypes (where some individuals had a high response while others had a lower response) as between ecotypes. Results from this investigation which are presented in Appendix 2, suggest the existence of high responder and low responder chickens in all ecotypes with reference to the multi-determinant antigen system - Sheep erythrocytes

Appendix 3 presents an investigation of the susceptibility of the Tanzania scavenging local chicken ecotypes to experimental infection with Newcastle disease virus and Salmonella gallinarum. Results from Newcastle disease experiment revealed that all chickens included in the experiment were susceptible to the virus. This is in agreement with the current view that Newcastle disease is the number one killer in the local chicken sector. However, in the S. gallinarum experiment chickens from the Mwanza ecotype survived the challenge, suggesting a possible natural resistance to this pathogen. This is the first report on resistance to experimental infection with S. gallinarum in scavenging local chickens in Tanzania. Other reports on resistance to S. gallinarum were in some lines of White Leghorn chickens.

The chicken MHC (Major Histocompatibility Complex) or the B-Complex has been associated with natural disease resistance and production traits. Serological method of typing is a useful and simple technique employing specific alloantisera (B-F and B-G).

In Appendix 4, results of a preliminary serological MHC typing of the scavenging local chicken ecotypes are presented. The results from this experiment suggest that the scavenging local chicken ecotypes in Tanzania may share some cell membrane antigens (B-G and B-F) with some of the standard B haplotypes of International reference populations. Inability of some of the standard alloantisera to type the local chickens was interpreted as a testimony of a possible existence in the local chicken population of B haplotypes outside the standard repertoire.

The present study has revealed phenotypic differences between scavenging local chicken ecotypes. Furthermore an ecotype from Mwanza has indicated a possible resistance to S. gallinarum, and a possibility of the presence of B-haplotypes of known potency in disease resistance and productivity has been revealed. Taking these three major findings and that of differences in immunocompetence between individual chickens within ecotypes, it is evident that more work is required to expound the role of each of these findings in relation to the survival of the scavenging local chickens as well as their productivity.
Productivity and nutritional status of local chickens under village management conditions

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The aim of this M.Sc. study was to determine the productivity and nutritional status of local chickens under village management conditions.

This work is divided into three chapters. In Chapter 1, the Introduction includes a literature review on breeds of local chickens, management, nutrition and productivity of local chickens. A brief review on predators, parasites and diseases in rural chickens has also been given. Chapter 2 includes the objectives of the study, materials and methods, general results and discussion, conclusions and finally references. Chapter 3 consists of two manuscripts of papers on which the thesis is based.

In the first paper, a study was carried out to determine the productivity of local chickens under village management conditions in Morogoro, Tanzania. Six villages, two in each climatic zone (warm and wet, warm and dry, cool and wet) were studied. The data were obtained by actual measurement, on-spot observation and interview of members of the household directly responsible for the care of chickens. The overall mean flock size was 16.2 with a range of 2 to 58. Flock size was significantly higher (P<0.05) in the warm and wet zone than in the other two zones. The overall mean clutch size, egg weight and hatchability were 11.8, 44.1g and 83.6%, respectively. The overall mean chick survival rate to the age of eight weeks was 59.7 percent and mean body weight for cocks and hens were 1,948.1g and 1,348.0 g, respectively. The mean cock to hen ratio per household was 1:4.3. The overall mean growth rate to the age of 10 weeks was 4.6 and 5.4 g/day for female and male chicks, respectively. No significant differences (P>0.05) were observed among the three zones for the above-mentioned productivity variables. Age at first lay ranged between six and eight months with a hen having an average of three laying cycles per year.

Management of local chickens with regard to housing, feeding and health care has also been described. The results of this study indicate that the productivity of local chickens is low with regard to egg production, egg weight, growth rate and chick survival rate. Chicken housing, feeding and health care were below standard.

A study on nutritional status of local chickens under village management condition in Morogoro, Tanzania has been presented in the second paper. A total of 144 chickens, adults and growers in equal number were randomly purchased and slaughtered for crop content collection. These consisted of 48 chickens from each of the three climatic zones (warm and wet, warm and dry, cool and wet). Seventy-two chickens were slaughtered in each season (short rainy, long rainy). Crop contents were physically and chemically analysed. Cereal grains, bran, green forages, insects and worms were main crop components, and their average composition varied in relation to season and climatic zone. Dry matter (DM), crude fibre (CF)
and calcium (Ca) content did not differ significantly (P>0.05) between the two seasons while crude protein (CP) ether extract (EE), ash and phosphorus (P) content were significantly higher (P<0.05) during the short rainy season than during the long rainy season. CP content was significantly higher (P<0.05) in growers than adults, while Ca content was significantly higher (P<0.05) in adults than in growers. DM, EE, CF, ash and P contents did not differ (P>0.05) with age. DM content was significantly higher (P<0.05) in crop contents of chickens from warm and dry zone than in the other two zones. EE was significantly lower (P<0.05) in the warm and dry zone than in the other two zones. CF content was significantly higher (P<0.05) in crop contents of chickens from the warm and wet zone than in the other two zones. Ash, Ca and P contents were significantly lower (P<0.05) in the warm and wet zone than in the other two zones. Chemical composition of the common feed supplement (bran) was 79.9, 10.8, 2.9, 9.6, 17.2, 0.29 and 0.57 percent for DM, CP, EE, CF, ash, Ca and P, respectively.

These results indicated that the nutritional status of local chickens under village management condition was below the recommended level for optimum growth and egg production. The present study has also shown variation of nutritional status with respect to season, climatic zone and age. The common feed supplements (cereal bran) alone cannot fully supplement the observed deficiencies in crop contents.

**Diseases and constraints of productivity in traditional poultry keeping systems in northern Malawi**

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*[Doctoral Thesis, 1999, Institute for Parasitology and Tropical Veterinary Medicine, Free University of Berlin, Germany – The thesis is written in German]*

This epidemiological survey on health and productivity in traditional poultry keeping systems in northern Malawi was carried out in cooperation between the Deutsche Gesellschaft für Technische Zusammenarbeit GmbH (GTZ) and the Ministry of Agriculture in Malawi. The collected data was required to support small-scale farmers, including village chickens as a component of MGBAHSP (Malawi German Basic Animal Health Service Project).

Therefore characteristics of the traditional poultry keeping system were revealed, serological and fecal examinations were done and various interventions were tried in 4 villages from July 1995 to June 1996. These interventions can be subdivided into 2 categories: external input through drug supply, and improved husbandry and management through intensive extension services. In one village, the chickens were vaccinated against Newcastle disease (ND) twice, using the lentogenic, heat-resistant V4 strain. Additionally, an acaricide was applied monthly to the chickens’ surroundings, and flea infestation was treated in a traditional way.

In another village, shelters were used to rear chicks, and individual extension work was done monthly. In a third village, all mentioned interventions were combined, and a fourth village was taken as control-group. A total of 71 chicken flocks in these 4 villages were visited monthly to collect socio-economic data as well as data on flock dynamics, husbandry and occurrence of endo- and ectoparasites.
Seroprevalences were determined for ND-, infectious bursal disease (IBD), infectious laryngo-tracheitis (ILT) and *M. gallisepticum*-infections.

Like in other African countries, the traditional poultry keeping system in northern Malawi is a scavenging system, characterized by low-input and low-output. The average flock consists of 17 local birds, which are kept for consumption, sale or barter. Chickens are also important for several social functions. The annual egg production is 36 eggs per hen brooded in 3-4 clutches. The average hatching rate is 74.6%. Due to high losses and low productivity the poultry production does not provide sufficient animal protein to cover family’s requirements. Losses occur in eggs (14.1%) and birds of all age groups. The mortality rate of 31.9% monthly is mainly caused by losses in chicks, which reach up to 58.9%.

According to the serological investigations, ND and IBD are endemic in this area. Antibodies against ILT were found in all examined samples, and the seroprevalence of *M. gallisepticum* was above 80%.

Endoparasites found in the faeces were cestodes with a prevalence of 13%, nematodes (17%) and coccidiosis (6%). The infestation was generally little, whereas the infestation with ectoparasites was more severe than expected. Prevalences increased with the age of the birds and reached up to 95%. In most cases a mixed, low to moderate infestation with fleas, lice, ticks and scaly leg mites was found.

ND, *M. gallisepticum*-infections and infestation with blood-sucking ectoparasites were restricting productivity. Besides, uncontrolled reproduction, lack of or insufficient rearing management, poor knowledge about prevention, spread and control of diseases and partly social functions of the chickens are limiting factors in the examined poultry keeping system. A negative influence of poor husbandry or feeding on productivity was not ascertained.

The effect of the different interventions on productivity was various: Vaccination against ND did not increase the specific antibody-titres in all birds. Yet different application methods (oral vaccination via the drinking water and single vaccination by eye-drop method) led to the same results. Application of acaricides in the surroundings of the birds showed no effect on spreading or intensity of infestation with ectoparasites, neither did the traditional treatment of flea infestation by dripping paraffin on the parasites. Only the use of shelters to rear chicks had a distinct influence on productivity, reducing the mortality rates in chicks significantly. The impact of extension work was difficult to rate since it was done individually, but a clear effect of this measure on productivity was not found.

Best results were achieved by combining all interventions, which presents a promising way to increase the productivity of the traditional poultry keeping system in northern Malawi. In this connection, social aspects and flock performance are decisive for good acceptance and sustainable implementation of measures.
Hatchability of Muscovy duck (*Cairina moschata*) eggs and energy metabolism of ducklings in a tropical climate

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In developing countries rural poultry production plays an important role as a source of animal protein in the household economy. In rural tropical areas where meat cannot be conserved for long time chickens and ducks are protein sources of a suitable size for one or two days consumption by a family. In these countries poultry is generally scavenging around the houses where they find their own feed or sometimes are supplemented with household waste.

Within poultry species, ducks are probably the most adequate birds in a scavenger system, because they possess a remarkable ability to glean and subsist on feeding materials that are not used by man or not retrievable by chickens or other domestic animals. The most common duck breed found in rural areas of Africa and in particular in Mozambique is the Muscovy duck. Compared to other duck species the economic importance of the Muscovy duck as a meat type bird is growing both in traditional extensive and in modern intensive husbandry systems.

Due to its good foraging and incubation behaviour, Muscovy ducks are easily kept in scavenging systems. The scavenging system in Mozambique is found in rural areas where the majority of poor people live. In this system the flocks are usually comprised of two to ten ducks each. The eggs are naturally incubated for approximately 35 days, and the ducklings are generally raised by the mother duck for at least three weeks.

Modern intensive systems are found mainly in urban and peri-urban areas and are characterized by high investment costs in premises and high running costs in feeding. In these systems artificial incubation and rearing are generally used resulting in an increased egg production per year.

The Mozambican government, recognising the potential value of duck production to increase the consumption of animal protein per capita of the population living in rural areas, encouraged in 1976 the rearing of ducks and launched a project to promote Muscovy duck production at the national level. During the implementation of the project the duck population increased nation-wide. Farmers however learned by experience that management routines are also essential for a good development of their flocks.

In this context three practical questions related to duck management were brought to the attention of poultry specialists. The first question was related to the belief of farmers that absence of swimming water would lower productivity with natural incubation. The second question was why the hatching rate of artificial incubation was low (often less than 50%). The third question was why in a scavenger system most of the ducklings brooded by the mother duck died during the first three weeks of life?

The studies in this thesis were carried out to provide practical answers to the questions of the farmers. The results of our study are useful for increasing duck production with Muscovy ducks in a tropical climate.
The experiments reported in Chapters 2 to 7 were designed: (1) to investigate if accessibility to swimming water and nesting behaviour affect the hatchability of Muscovy duck eggs under natural incubation, (2) to get insight in the role of egg characteristics (for instance egg-mass, shape, porosity) on embryo growth, metabolic rate and hatchability of eggs during artificial incubation, and (3) to understand the development of thermoregulation of Muscovy ducklings and to determine which factors are responsible for the high mortality during the first three weeks of life.

To answer the question about the necessity of access to swimming water, the natural incubation behaviour of Muscovy ducks was studied at the experimental duck unit of the Veterinary Faculty in Maputo, Mozambique. In Chapter 2 we describe the technique to determine the presence of the mother duck in the nest box using the interruption of an infra-red beam and a thermistor to sense the temperature changes. Through this measurement of nest attendance, the moment of egg laying, the start of incubation and the periods the duck left the nest during incubation could be determined.

Chapter 3 describes the influence of nesting and incubation behaviour on hatchability of the eggs during natural incubation. Muscovy ducks show a behaviour called ‘nest parasitism’, i.e. a duck lays her eggs in nests of other egg-laying ducks (dump nests). In the experimental duck unit we used this behaviour to put eggs of abandoned nests in nests where the duck just had started the incubation (artificial dump nests). The effect of the creation of artificial dump nests on the overall hatchability has been investigated. In some nests more eggs were found at the end of incubation than at the start. These eggs could be laid by the incubating duck after incubation had started or by another duck. However due to the used registration method for the presence of eggs no discrimination between the two possibilities could be made. The overall hatchability of the eggs in these kind of nests (nests with non-term eggs) was 25 % lower, most probably due to the short incubation time of the last laid eggs.

In order to analyse the difference in hatchability between nest types according to nesting and incubation behaviour as described in Chapter 3, statistical models (Weibull function and a beta-binomial model) are applied to quantify and predict nest hatchability. This is elaborated in Chapter 4.

Good hatching results during natural incubation are only possible if knowledge of nesting behaviour as described in Chapter 3 is taken into account during management of duck flocks. Our data show that hatchability is only decreased by 10 % for artificial dump nests, despite the fact that 40 % of the eggs were derived from abandoned nests that were otherwise certainly lost.

As the hatchability rate obtained in natural incubation is higher than in artificial incubation, natural incubation is recommended, provided that the knowledge of nesting behaviour is applied in the management of duck flocks during the breeding season. The analysis by the statistical models shows that almost 60 % of the variation of hatchability of Muscovy duck eggs under natural incubation can be explained by clutch size, nesting behaviour and duration of egg-laying and incubation. Results reported in Chapters 2 to 4 show that, although the Muscovy duck is a waterfowl, access to swimming water is not essential and does not affect hatchability. Breeding biology of the domesticated type of Muscovy ducks under natural incubation was found to be similar to that of the wild type.
To study the question about the low hatchability in artificial incubation, laboratory experiments on Muscovy duck eggs were carried out at the Department of Veterinary Physiology (Utrecht). Data on embryonic growth and on the pattern of heat production during hatching reported in Chapter 5 are essential to understand the incubation process and to maximise hatchability.

The results show that weight of the embryo, length of beak and shank are useful parameters to estimate at which age the embryo died. The hatching process starts with a internal perforation of the air chamber by the duckling (internal pipping), followed by cracking the egg shell (external pipping) and emerging the egg. Of the embryos that died during artificial incubation most of them died in the period after the duckling had cracked the egg shell to start the hatching process. Compared to natural incubation, the time necessary for a duckling to hatch lasted longer in artificial incubation, and the hatching process is not synchronized as is usually observed for precocial birds. The longer hatching period can be explained by the fact that the synchronization sound made by the emerging ducklings is drowned out by the noise of the incubator.

The weight of the duckling at hatching is influenced by egg weight and the length of the incubation period.

Chapter 6 describes the use of statistical discriminant analysis to study the effect of spraying and cooling the eggs on the embryonic metabolic rate and the hatchability. It is shown that:
1. eggs with a more round shape have difficulties in hatching;
2. an incubation temperature of 37.5°C with spraying and cooling benefits the hatchability of the bigger and more porous eggs;
3. embryo death after external pipping is associated with insufficient energy during hatching, and
4. the egg size variation and the different way of heat source application in natural and artificial incubation seem to be the more important factors responsible for the low hatching rate during artificial incubation of Muscovy duck eggs.

Therefore in artificial incubation with spraying and cooling it is recommended to avoid egg shape variation by a prior selection.

The question why in a scavenger system most of the ducklings brooded by the mother duck die during the first three weeks of life was also addressed in laboratory experiments performed in Utrecht. The situation of young scavenging birds was simulated by a period of controlled underfeeding which kept their body weights constant. In Chapter 7 the effects of underfeeding and age on the development of thermoregulation in Muscovy ducklings are described. It is shown that Muscovy ducklings are more vulnerable at low ambient temperatures than other duck species. Therefore they are more dependent on an additional heat source (e.g. a heating lamp or parental brooding), especially during adverse weather conditions in tropical areas with temperatures below 10°C. In the scavenging poultry production system where there is a shortage of food in quality and quantity, the time that a scavenging duckling spends being warmed by its parent is lost for feeding activity. This leads to a reduced level of food intake, and thus to growth retardation and difficulty in maintaining homeothermy. For the development of thermoregulation the availability of food is more important than age. Under these conditions growth rate of scavenging ducklings can be enhanced by supplementing them with some extra food, which facilitates endurance to environmental cold stress and permits growth. This knowledge contributes to reduce the early mortality
rate of young ducklings due to adverse cold effects.

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**News**

**First INFPD/FAO Electronic Conference on Family Poultry**

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As decided by the General Meeting of the INFPD (International Network for Family Poultry Development) held in 1997 in M’Bour, Senegal, the First INFPD/FAO Electronic Conference on Family Poultry was run from 7 December 1998 to 5 March 1999. However, because of the great interest of subscribers and their active participation, the duration of the Conference was extended until 22 July 1999. The general theme of the Conference was: “The Scope and Effect of Family Poultry Research and Development”. The objectives were to (a) collect information related to all aspects of family poultry production systems from various parts of the world, (b) disseminate available information for discussion among participants, (c) identify where information is currently missing and set an agenda of priorities for research and development, (d) investigate approaches, methods and tools which could contribute to identifying at farm level the most relevant family poultry farming systems. The identified production systems could then be disseminated in the areas where they are most appropriate.

This Conference included 151 participants from more than 50 countries, among them 35 developing countries, as well as many international organizations (FAO, CTA, IDRC, ACIAR, IFAD, etc.), NGOs (DANIDA, FUNDACION HERENCIA VERDE, VETERINAIRE SANS FRONTIERES, PROSHIKA, etc.), Universities and Research Centres. Participant profile of the Conference was as follows: Researchers and extension workers (27 percent), teachers and lecturers (25 percent), staff of international organizations (19 percent), consultants and advisors (12 percent), programme co-ordinators (6 percent), students (4 percent), management/policy level (4 percent) and editors of scientific journals (3 percent). Among the subscribers, 41 participated actively either through sending articles or making comments. This represents about 27 percent active participation, which is a high level, since values of about 20 percent or less are generally regarded as typical and acceptable figures.

The papers included one introductory paper, five lead papers from selected authors and 14 free communications. These initiated discussions: about 50 comments/observations/queries/replies were exchanged among participants, excluding the final comments/appreciation/remarks.

All papers and comments are available on the Internet:

An association of volunteers working for rural self-empowerment in the Democratic Republic of Congo

The "Association des Volontaires pour l’Auto-promotion Rurale" (AVOLAR), a non-profit development non-governmental organization (NGO), was set up in May 1992 in the Democratic Republic of Congo. Its objectives are to:

- promote peasants’ self-empowerment;
- raise interest for agriculture and family livestock farming as well as the setting-up of co-operatives;
- introduce new methods in agriculture and family livestock farming;
- encourage the participation of farmers’ families, especially the women and the most disadvantaged categories, in socio-economic activities in rural areas;
- promote the introduction and the spread of technologies that are most appropriate for the villages;
- produce and distribute
  a) high-yield seeds for vegetable growing and food crop,
  b) food and agricultural inputs,
  c) improved livestock breeds.

In the domain of poultry keeping, it should be mentioned that AVOLAR provides technical assistance concerning the domestication of the wild quail. The meat of this poultry species is highly valued by consumers and is regarded as delicacy in some restaurants of urban centres.

For further information please contact:

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