CHAPTER FOUR

Phenotypic characterisation of native fowl in South Africa

4.1 Introduction

Native fowl are mostly associated with the developing world. This "developing world" is often seen as "a world of problems" ranging from famine, poverty, and over-population to economic and political problems (Alan & Thomas, 1992). In cases of famine or drought the groups of people that suffer most are the rural labourers, farmers and pastoralists (Crow, 1992). These groups are dependant on various farming activities for their livelihood and survival, but also at the same time are most vulnerable to the forces of nature, economics of scale and agricultural policies. Over the past two decades new approaches were introduced in trying to solve some of the problems of these rural farmers in the developing world, including the introduction and evaluation of indigenous stock found in these countries.

Since the nineties more studies have also been recognizing the contribution of indigenous and native poultry stock to household food security (Mukerjee, 1990). In the Philippines and Burma up to 57% of the total poultry population consist of indigenous chickens and are kept mainly in back-yard systems (Aini, 1990). It is estimated that in South Asian countries, 50% of egg production are from native fowls (Banarjee & Sharma, 1998). Indigenous fowl have an economic value in contributing to protein for the household and production of manure that can be used in vegetable gardens. Their feeding and housing requirements are low and therefore the ideal specie for integrated farming systems (Aini, 1990).

Studies on native fowl regarding their production traits are limited. Definitions of production systems also vary between countries, which make comparisons in terms of production difficult. Reports also refer to native, indigenous or village fowl and it is not always clear to what extent these birds have been subjected to selection or cross breeding and or upgrading. A brief summary of production traits for native fowl reported in literature is provided in the following Table 4.1

Table 4.1 Production traits of native chickens

Type of chicken	Production system	Live weight (kg) & age in weeks	Egg production (n weeks)	Egg weight (g)	Reference
Malayan village fowl	Free range	0.838 kg 20 weeks	60 50 weeks	42.5g	Ramlah, 1996
	Intensive	1.36 kg	133	46g	
Korean native Ogol fowl	-	1.39 kg ♂ 16 weeks 1.09 kg ♀	100 50 weeks	49g	Nahm, 1997
Village fowl Mali	Free Range	.600 kg ♂ 15 weeks .500 kg ♀	35-50 50 weeks	34.4g	Wilson *et al.*, 1987
Malawi local chicken (MLC)	Extensive	-	50-60	42.6g	Safalaoh *et al.*, 1996
Black Australorp cross MLC			100-120	49.7g	
MLC	Intensive	2.1 kg 20 weeks	232	-	
BA x MLC		2.2 kg	248 50 weeks	-	
Thai native chicken	Free range	2.2 kg 18 – 23 weeks	45-90 50 weeks	-	Catalogue of the Native Poultry of South-East Asia 1991
Country chicken of Taiwan	Intensive	2.2 kg 16 weeks	174 53 weeks	57.8g	

Native fowl vary in body size, from relatively small birds to larger birds with "long" legs. Their plumage is very colourful and feathers can also sometimes be found on the legs. Major genes such as the Naked Neck (*Nana*), Frizzle feathers (*Fz*) and Dwarf (*Dw*) are often found in the native fowl populations (Horst, 1991). In general the production of native fowls are poor in comparison to commercial stocks. Poor nutrition, housing and a lack of breeding principles, as well as cultural attitudes are the major constraints for successful rural poultry production in the South Pacific Region (Ajuyah, 1999). In Africa poultry are kept in semi-intensive systems (backyard system) with flock sizes ranging from 50-200 birds. Output is low due to low input and disease and poor nutrition limits production (Kitalyi, 1999).

Chickens are synonymous with many South African rural and peri-urban households. Primarily rural households keep them for household food consumption. Because they are left to scavenge, mostly native fowl and some dualpurpose breeds are being kept. Since these chickens are seldom recognised as contributing to household income, they are not included in census data and until recently have not been considered in research programs. In Africa as in many parts of the developing world, it is the women and children that take care of the chickens, which do not have the same status as other livestock species like cattle, which are associated with wealth and status (Kitalyi, 1999). Very little is known of their production potential and also of their contribution to food security.

The socio-economic changes in South Africa, since 1994, have emphasized the need to restructure rural agriculture in order to direct attention towards small-scale farming and household food security. The Poultry Supply Unit of the Animal Improvement Institute at the Agricultural Research Council (Irene), established a program, "Fowls for Africa" to conserve and promote native fowl populations found in South Africa. The aim of this chapter is to describe the populations, according to phenotype (production traits), which were genetically evaluated in Chapter Three.

4.2 Materials and Methods

Native fowl populations

The native fowl populations for phenotypic description are representatives of the "Fowls for Africa" program. Birds from the Koekoek, New Hampshire, Lebowa-Venda, Ovambo and Naked Neck populations were purchased from the Poultry Supply Unit at the ARC at Irene. The origin of these populations was described in chapter two. Commercial hybrid lines namely the Cobb broiler and Amberlink layer lines were included as benchmarks for meat and egg production respectively.

Growth and carcass traits

Trials were carried out at the Hatfield Research Farm of the University of Pretoria, to provide base-line data for growth and egg production, for the different populations. Groups of 160 Koekoek, 160 New Hampshire, 113 Naked Neck, 120 Lebowa-Venda and 105 Ovambo chickens, were tested for growth over a period of 77 days (11 weeks). A commercial broiler line, the Cobb, was included as a benchmark. There were three replicates for Naked Neck, Lebowa-Venda and Ovambo, consisting of between 35 and 40 chickens per replicate, while Koekoek and New Hampshire had four replicates with 40 chickens per replicate. They were kept in individual pens in an environmentally controlled house. Males and females were not separated. They were reared on a commercial broiler starter (22% CP, 12.5 MJ ME/kg DM), from 0 to 14 days, followed by a broiler finisher (18% CP, 13 MJ ME/kg DM) from 15 days to the end of the growth period (respectively 42 days for the Cobb broilers and 77 days for the other five populations). A vaccination programme, recommended for small farming enterprises by the Faculty of Veterinary Science at the University of Pretoria, was followed. Body weight and feed intake per pen were recorded on a weekly basis.

At the end of the growth trial ten birds of each population were randomly selected, weighed and slaughtered. The birds were electrically stunned and killed by manual exsanguination. Feathers, viscera and heads were removed and carcasses stored at -40°C until dissected. Live weight and carcass weight, with and without viscera and heads were recorded. Carcasses were thawed before dissection and the feet and abdominal fat were removed. The weights of the *M. pectoralis* and *M. supracoracoid,* as well as the appendicular and axial skeleton were recorded

The dissected carcasses, which included the muscle, bone, fat, skin and feet were grinded with a mincer to obtain a homogenous sample for subsequent fatty acid analysis (Webb *et al.*, 1994). Methyl esters were prepared. Lipids were extracted in duplicate by means of a modification of the chloroform: methanol (2:1 v/v) method (AOAC, 1975). Methyl esters of the fatty acid component of the neutral triglycerides were prepared according to the NaOH/methanol method (Slover & Lanza, 1979).

Evaluation for egg production

After completion of the growth trial of 77 days, the surplus males were discarded, while the females were raised up to 18 weeks of age. Twenty-four females of each of the native populations were randomly selected for estimation of egg production potential. The Amberlink (commercial layer line) was included as a benchmark. A natural ventilated house, equipped with a battery system was used, where the hens were kept in separate cages in order to record individual egg production. Hens were fed *ad lib.* a commercial layers mash (15% CP, 11.3 MJME/kg DM). Egg production per day per hen, as well as egg weight was recorded over a period of 50 weeks. Initial live weight was recorded when placed in the battery at 20 weeks of age and final weight at the end of the production trial (70 weeks of age). Birds were removed when they started to moult and stopped laying, which coincided with the end of the production period.

Statistical analyses

A General Linear Model (GLM) procedure of SAS (1992) was applied for analyzing the following traits:

Growth:

- Average chicken weight (ACW)
- Average feed intake per chicken (AFIC)
- Feed conversion ratio (FCR)

Carcass:

- Dressed carcass mass (DCM)
- Percentage muscle (% MS)

- Percentage breast muscle (% BMS)
- Percentage fat (% FT)
- Percentage % skin (% SK)
- Percentage bone (% BN)
- Dry matter (DM)
- Ash (A)
- Crude protein (CP)
- Crude fat (CFT)

Egg production:

- Total number of eggs at peak, 40 weeks and 51 weeks (end of production)
- Weight of eggs

4.3 Results

Growth (Live weight gain)

The growth of the native populations, were studied in terms of their weight gain over a period of 11 weeks. Weight at day-old, final weight, total feed intake and feed conversion ratio for the different populations, were summarised in Table 4.2. Significant differences were observed for economic traits namely the ACW ($P<0.0001$), AFIC ($P<0.0005$) and FCR ($P<0.0001$) among the six populations measured at 21, 42, 63 and 77 days (Table 3.4). New Hampshire showed the highest weight gain, with an average final weight of 1.21 kg, followed by Ovambo, which had the best gain of 1.18 kg of the native populations. Lebowa-Venda had the poorest weight gain and differed ($P<0.001$) from the other populations (Figures 1 & 2). Feed efficiency was poor for all populations, with feed conversion ratio, varying between 3.32 for the Koekoek to 4.06 for Naked Neck.

Table 4.2. Initial and final weights, cumulative feed intake and feed conversion for the different fowl populations

	Koekoek	New Hampshire	Naked Neck	Lebowa-Venda	Ovambo	Cobb
No of chickens	160	160	113	120	105	150
Initial weight in (g): day-old	35.4	30.0	35.5	33.5	27.0	0.40
Final weight in (g): 11 weeks	1114	1213	1062	.937	1183	2.00*
Total feed intake (g)	3680	3680	3720	3390	3610	4100
Feed conversion ratio	3.3	3.03	3.5	3.6	3.0	2.0

*Cobb was slaughtered at 6 weeks of age

Carcass composition

Carcass composition was evaluated according to dressed carcass weight, percentage muscle, breast muscle, bone, fat and skin and results are shown in Table 4.4. Cobb (broiler line) differed ($P<0.05$) from the native populations in terms of dressed carcass weight, muscle, breast muscle and fat percentage (Table 4.3). For the native populations Ovambo had the highest DCM (939.8 g), followed by New Hampshire (907 g). The percentage muscle was approximately 55% for all the native populations, except for Ovambo and New Hampshire, which only had a muscle percentage of 51%. Naked Neck had the highest percentage breast muscle (18.03% ± .5) compared to the other native populations.

Chemical analyses indicating dry matter, ash, crude protein and crude fat percentages are presented in Table 4.5. Significant differences ($P<0.05$) in CP and CFT were observed, where the lowest CP was found in Cobb and the highest in the LV. The native populations had significantly lower CFT in comparison with the commercial broiler (Table 4.4). The Lebowa-Venda chickens had the lowest fat percentage (0.42% ± .04), while Ovambo had the highest fat (2.5%) for the native populations.

Table 4.3 Least square means for growth(weight gain) traits for the different fowl populations

Line and number of chickens	Trait*	Day 1	Day 21	Day 42	Day 63	Day 77
Koekoek (160)	ACW AFIC FCR	0.035^{a} - -	0.108^{ac} 0.140^{ab} 2.58^{a}	0.347^{a} 0.325^{a} 3.708^{a}	0.718^{a} 0.494^{ac} 3.307^{a}	1.114^{a} 0.435^{ac} 3.323^{a}
New Hampshire (160)	ACW AFIC FCR	0.030^{b} - -	0.119^{b} 0.168^{a} 2.76^{a}	0.391^{a} 0.288^{b} 3.010^{b}	0.792^{b} 0.462^{ab} 3.091^{b}	**1.213^{b}** 0.459^{a} 3.831^{b}
Naked Neck (113)	ACW AFIC FCR	0.035^{a} - -	0.113^{ab} 0.132^{b} 2.54^{a}	0.359^{a} 0.268^{b} 3.673^{a}	0.713^{a} 0.503^{ac} 3.937^{c}	1.062^{a} 0.491^{b} 4.068^{b}
Lebowa-Venda (120)	ACW AFIC FCR	0.033^{c} - -	0.102^{c} 0.173^{a} 3.60^{b}	0.304^{a} 0.277^{b} 3.715^{a}	0.618^{c} 0.426^{b} 3.704^{c}	0.936^{c} 0.422^{c} 3.407^{a}
Ovambo (105)	ACW AFIC FCR	0.027^{d} - -	0.109^{ac} 0.114^{b} 2.26^{a}	0.365^{a} 0.284^{b} 2.979^{b}	0.781^{b} 0.508^{c} 3.462^{a}	1.183^{b} 0.453^{ac} 3.876^{b}
Cobb**(150)	ACW AFIC FCR	0.040^{e} - -	0.298^{d} 0.433^{c} 1.83^{c}	1.386^{b} 0.986^{c} 1.859^{c}	- - -	- - -
Standard error	ACW AFIC FCR	0.0007 - -	0.003 .01 .1	0.04 .02 .2	0.02 .02 .09	0.02 .01 .1

*ACW : Average chicken mass (kg)

AFIC : Average feed intake per chicken (g)

FCR : Feed conversion ratio (kg feed/kg gain)

**Control : Commercial broilers slaughtered at 6 weeks of age

abcde : Means within a column for the same trait with different superscripts differ (≤ 0.1)

Table 4.4 Least square means and standard errors for carcass traits for the different fowl populations

Population	Dressed carcass weight (g)	% Muscle	% Breast muscle	% Fat	% Skin	% Bone
Koekoek	831.6^{abc} ± 35.9	54.9^{ac} ± 0.81	17.0^{ac} ± 0.5	1.23^{ac} ± 0.47	10.6^{a} ± 0.5	33.2^{a} ± 0.9
New Hampshire	907.0^{be} ± 35.9	51.7^{ab} ± 0.81	15.9^{ab} ± 0.52	4.34^{b} ± 047	12.8^{b} ± 0.52	31.1^{a} ± 0.9
Naked Neck	795.6^{cd} ± 35.9	54.9^{c} ± 0.8	18.0^{c} ± 0.5	1.8^{a} ± 0.4	11.7^{ab} ± 0.5	31.5^{a} ± 0.9
Lebowa-Venda	703.9^{d} ± 35.9	53.0^{b} ± 0.8	15.2^{d} ± 0.5	0.4^{c} ± 0.4	10.3^{a} ± 0.5	36.2^{b} ± 0.9
Ovambo	939.8^{e} ± 37.5	51.^{9ab} ± 0.8	15.9^{ab} ± 0.5	2.5^{a} ± 0.4	12.1^{cb} ± 0.5	33.5^{a} ± 0.9
Cobb	1404.7^{f} ± 37.5	55.2^{d} ± 0.8	20.4^{d} ± 0.8	6.5^{d} ± 0.4	14.2^{bd} ± 0.5	24.1^{c} ± 0.9

*Dressed carcass weight: head and viscera removed.
Variables with different superscripts differ significantly (P<0.05).

Table 4.5 Least square means and standard errors for chemical analyses of carcasses of the different fowl populations

Population	Dry matter %	Ash %	Crude protein %	Crude fat %
Koekoek	35.4^{ab} ± 2.2	3.9^{ab} ± 0.36	46.1^{a} ± 1.2	28.5^{a} ± 1.6
New Hampshire	35.9^{ab} ± 1.93	3.78^{a} ± .32	42.2^{bc} ± 1.2	36.9^{bc} ± 1.6
Naked Neck	35.9^{ab} ± 2.0	3.9^{ab} ± 0.34	45.^{2ab} ± 1.2	34.9^{b} ± 1.6
Lebowa-Venda	31.4^{a} ± 1.9	4.7^{b} ± 0.31	49.6^{d} ± 1.1	28.8^{a} ± 1.6
Ovambo	38.5^{b} ± 2.2	2.7^{c} ± 0.36	44.8^{ab} ± 1.5	36.0^{bc} ± 2.1
Cobb	34.4^{ab} ± 1.7	2.4^{c} ± 0.28	39.9^{c} ± 1.1	40.6^{c} ± 1.5

Variables with different superscripts differ significantly (P<0.05)

Significant differences were found in the proportions of polyunsaturated fatty acids and particular, palmitoleic acid (16:1), linoleic (18:2) and linolenic acid (18:3). The highest proportion of 16:1 was observed in the Ovambo, New Hampshire and Naked Neck chickens. The proportions of linoleic and linolenic acid were the highest in Ovambo Koekoek and Lebowa-Venda (Table 4.5).

Table 4.6 Differences in fatty acid composition for the different fowl populations

Population	Fatty acids %						
	14:0	16:0	16:1	18:0	18:1	18:3	20:1
Koekoek	1.05	24.58^{abc}	7.92^{a}	8.23	45.28^{ab}	12.18^{bc}	1.54
New Hampshire	0.85	25.83^{bc}	9.85^{c}	7.74	44.27^{ab}	10.12^{ab}	1.92
Naked Neck	1.15	25.10^{bc}	8.19^{ab}	7.82	42.74^{a}	12.87^{c}	2.34
Lebowa-Venda	1.29	22.17^{a}	7.98^{a}	6.99	45.06^{ab}	14.44^{c}	2.05
Ovambo	0.92	23.71^{ab}	9.23^{bc}	6.07	46.68^{b}	12.72^{c}	1.33
Cobb	0.92	26.62^{c}	8.78^{abc}	8.37	43.11^{a}	9.58^{a}	2.42
P-value	<. 68	<0.023	<0.01	<0.318	<0.048	<0.01	<0.6
F-value	.63	.3.992	.4.80	1.32	3.15	4.88	0.76

Variables with different superscripts differ significantly (see P-value in table)

Egg production

Egg production was measured as the average number of eggs laid and total weight of eggs produced during production of 51 weeks. The average number of eggs laid per week, varied from as low as 2.1 for the Ovambo hens to as high as 4 and 6.1 for the Koekoek and Amberlink hens. Among the native populations, Koekoek had the best egg production of 204 eggs, while Ovambo produced only 91 eggs. The commercial hen line (Amberlink) had, as expected, the highest egg production of 311 eggs. Egg production was found to differ significantly (P<0.001) among the different populations (Table 4.6). Koekoek and Lebowa-Venda laid the heaviest eggs, excluding Amberlink, with an average weight of 52.14 g and 50.92 g respectively during the production. The Ovambo hens on average laid the smallest eggs weighing only 43.8 g (Table 4.6).

Table 4.7 Egg production traits for the different fowl populations

Line	Total eggs /hen	Minimum weight (g)	Maximum weight (g)	Mean egg weight (g); SE	Average hen weight hens (g)	#Productivity ratio
Koekoek	204	10.4	70.6	52.1 ± .09	2100	6.1
New Hampshire	189	13.2	69.9	48.0 ± .102	1997	5.4
Naked Neck	139	13.7	69.0	49.8 ± .120	1650	4.7
Lebowa-Venda	122	26.0	79.6	50.9 ± .120	1900	3.8
*Ovambo	91	20.6	66.1	43.8 ± .18	1900	2.5
Amberlink	311	19.7	82.5	58.7 ± .068	2250	9.9

*Based on 43 weeks of production.
Calculated as number of eggs x mean weight/average hen weight [75]

Koekoek and Lebowa-Venda produced light brown eggs and New Hampshire produced brown eggs. The egg colour of Naked Neck and Ovambo was a creamy (off-white) to light brown colour and varied among the birds.

4.4 Discussion

The evaluation of production traits of the native populations from the "Fowls for Africa" program was performed under commercial conditions. It is important to emphasize that the aim was not a comparison with commercial lines, but rather to asses these native populations, under standardized conditions to obtain a guideline of their "optimum" potential for a phenotypic description. It was assumed that a commercial production system, in a controlled environment, a balanced ration and disease control might serve as an equal environment to test for differences in growth, carcass and egg production traits among these populations, as it is very difficult to obtain accurate field data from low-input systems. The discussion will therefore emphasise differences among the native populations of the "Fowls for Africa" project and be compared with other indigenous fowl found in the developing countries of the world, which are kept for household food production.

Growth (weight gain)

Growth parameters, measured in terms of weight gain, feed intake and feed efficiency, as well as egg production (number of eggs laid and egg weight), showed significant differences among the native populations. As expected, the performance of all the native populations was very poor when compared to the commercial broiler and layer lines included as benchmarks in the study.

Results obtained in this study showed that the New Hampshire chickens had the highest average weight during the growth trial. However due to the origin of the New Hampshire, it cannot be regarded as "native", although often kept by rural households. When only comparing the native populations, the Ovambo chickens had the best growth performance with a final weight of 1.18 kg, followed by Koekoek (1.1 kg) and Naked Neck (1.06 kg), while Lebowa-Venda had a significantly lower final weight of only 0.936 kg. These results are comparable with weights reported by Honeyborne & Joubert (1998) for these fowls (Ovambo: 1.6 kg, Koekoek: 1.24 kg, Naked Neck: 1.16 kg) and Lebowa-Venda: 0.987 kg), at 12 weeks of age. Average weights for the South African native populations also compare well with weights at 16 weeks of age, reported for the Korean native fowl, a dualpurpose breed with an average mature weight of 1.390 kg for males and 1.090 kg for females (Nahm, 1997). Reports also indicate that the Malawi local chicken reached a body weight of 0.615 kg at 8 weeks of age and 2.1 kg at 20 weeks of age (Safalaoh *et al.*, 1996), which is comparable with the South African populations.

Weights at 10 weeks of age for Malaysian village fowl tested under intensive systems (mixed sexes), varied between 0.670 kg and 0.753 kg with final weights of only 1.1 kg at 15 weeks of age (Ramlah, 1996).

The total feed intake was very similar for all the populations (3.61 – 3.72 kg), except for the Lebowa-Venda chickens, which had a lower intake of 3.39 kg. Feed efficiency ratios varied from 3.0 to 3.6 for the Ovambo and the Lebowa-Venda populations respectively (Table 4.2). Feed efficiency ratios reported for the Malawi local chicken and the cross with the Black Australorp were 6.9 and 6.5, which are much poorer than for the South African fowl. A fair comparison is not always possible, as test and feeding conditions are not always clearly indicated by authors.

The native fowl seem to differ distinctly in feeding behaviour from the Cobb broiler. The native chickens had difficulty feeding from the feeding troughs during the first week and feed had to be provided on flat cardboard. The native birds also spent much more time feeding around the feeding troughs as well as scavenging in the pen. This behaviour might have had an influence on their performance. These results were obtained from an intensive system with adequate nutrition, housing and disease control. A poorer performance could be expected if they were left to scavenge, although the type of feed while scavenging in combination with their genetic potential to utilise poor feed should also be considered.

Carcass composition

Carcass traits summarized in Table 4.3, indicated that Ovambo had the highest dressed carcass mass of 0.939 g. Chambers *et al.* (1981) compared the modern type broiler with chickens representing broiler lines of 1958 and 1972. The dressed carcass weight reported for males at 47 days of age was 717 g (1958), 967 g (1972) and 1088 g for the modern broiler. The weights found for the native populations in this study compared with the weights for the 1958 and 1972 broilers. Literature reports on carcass characteristics of native populations are limited. Safalaoh *et al.* (1996) reported a breast muscle percentage of 14.81% for the Malawi local chicken, which is lower than the native populations studied, where percentage breast muscle varied between 18% for the Naked Neck and 15.2% for Lebowa-Venda. This is lower than the percentages of breast muscle reported by Chambers *et al.* (1981) for the broilers of 1958 (25.2%) males and 1972 (23.9%), respectively. Leeson & Summers (1980) reported a percentage of breast muscle of 31.3% for modern broilers slaughtered at 35 days of age. Wall & Anthony (1995) reported no significant differences in total breast weight (bone included) between Giant Jungle Fowl and broilers, but if deboned, the Jungle Fowl had less breast muscle.

The different native populations tended to have a higher percentage of bone (31.5% - 36.2%) than the control line (24.1%) (Table 4.3). The higher percentage of bone in the native fowl populations may be associated with their adaptation to flight and scavenging.

The chemical analyses indicated that there are significant differences between the Cobb and native fowls, for crude protein and crude fat (Table 4.4). A higher crude protein and lower crude fat were observed for the native populations, while the reverse was found for the Cobb broilers. The lower body fat in the native fowl can be associated with their slower growth and slower rate of maturing, while the commercial broiler was selected for fast growth resulting in reaching maturity at a younger age. If only the native populations were taken into consideration (New Hampshire excluded), the Ovambo hens, showed the fastest growth among the native fowls with a relatively high crude fat content in the body. The Ovambo also reached sexual maturity (first egg laid) at least 6 weeks before the Koekoek, Naked Neck and Lebowa-Venda hens. The higher body fat and faster growth of the Ovambo populations indicate an early maturing type. The Lebowa-Venda hens exhibited slower growth, had the lowest percentage of crude fat and were also slow to mature.

The proportions of fatty acids such as linoleic and linolenic acid, are influenced by the diet, as well as the feeding of dietary fat (Hrdinka *et al.*, 1996). Differences (see Table 4) were observed among the populations. Although, they all received the same diet, differences found are probably due to eating behaviour. The Ovambo, New Hampshire and Naked Neck birds tend to scratch more, while eating and could pick up particles more selectively than the broilers that are more "passive" eaters.

Although no differences were observed for stearic acid (18:0) and arachidonic acid (20:0), the percentage of palmitic acid (16:0) differed between the chicken populations (Table 4.5). Breed influences on the fatty acid composition of Dorper and SA Mutton Merino wethers have been reported that indicate to possible genetic differences Webb & Casey (1995). The native fowl populations in this study, were not subjected to selection other than to survive, therefore differences could be due to a genetic adaptation in metabolism, but further study will be required for confirmation.

Egg production

In the evaluation of egg production, differences were also observed among the populations. The commercial layers (Amberlink) commenced production at 20 weeks of age as normally expected from a commercial line, while the Ovambo hens already produced their first eggs at 16 weeks of age. The other native populations and New Hampshire only started laying between 17 to 22 weeks of age. An average age at first egg or age of sexual maturity of 24 weeks was reported for Lebowa-Venda and Naked Neck hens, which is comparable to the results found in this study (Joubert, 1996). Available literature indicated that native fowls were found to reach sexual maturity between 23 weeks (Nigerian local chicken) and 24 weeks of age (Korean native fowl) (Horst, 1997; Nahm, 1997).

The Ovambo hens not only reached sexual maturity at 16 weeks of age, they also reached peak production 8 weeks after being placed in the battery system, which was at least three weeks before the other hens. The Koekoek population for example reached peak egg production at 12 weeks. Although the Ovambo hens started production ahead of the other hens, egg production had decreased to zero by 43 weeks. The initial weights of the hens varied from 1.60 kg (Naked Neck, Lebowa-Venda) to 1.84 kg (Ovambo, Koekoek), when placed in the battery, while final weights varied from 1.78 (Naked Neck) to 2.34 (Koekoek). Although the Lebowa-Venda hens exhibited poor growth up to 11 weeks, the hens eventually compensated and ended being large and robust birds with an average weight of 2.17 kg.

Reports by Horst (1991) on the number off eggs produced by native fowl in the tropics, varied depending on the production systems applied. He found that fowls produced between 18-100 eggs under extensive conditions, while some birds produced between 25-150 eggs under intensive systems. Malawi local chickens were found to produce between 50-95 eggs per hen per year, depending on the feeding regime followed (Safalaoh *et al.*, 1996). In this study the Koekoek, Naked Neck and Lebowa-Venda hens produced 203, 151 and 122 eggs respectively, which is similar to egg production reported for natives fowl from Egypt, the Fayoumi (141) and Dandarawi (128). Except for the Ovambo hens, the other South African hens had a higher egg production than reported in literature. This could be ascribed to optimal feeding and housing conditions.

A relatively high variation was found in the weight of the eggs for the fowls in this study. The Koekoek (52.1 g) and Lebowa-Venda (50.9 g) hens had the highest average weights, while the lowest egg weight was found for Ovambo (43.8 g) (Table 4.6). Nahm (1997) reported egg weights of 49 g at 44 weeks of age for the Korean native fowl. Egg weights for the Malaysian fowls varied between 39.7 g and 46 g (Ramlah, 1996). Egg weights reported for different local chicken populations in the tropics were as low as 38 g and as high as 50 g (Horst, 1991). The fowl tested in this study were found to be quite similar to other native fowls for egg weight.

The growth potential of all the native populations were very poor and it will not be economic to keep and feed males for meat production. The populations in this study seem to be more suited for egg production, even when the relatively low production figures are taken into consideration. When total egg production and egg weights (Table 5) are taken into account, these populations have a potential of producing between 4.2 kg (Ovambo) and 10.6 kg (Koekoek) of edible protein for the household. The culled hens may also eventually be sold or slaughtered for meat. The fact that these chickens were tested under commercial conditions, especially in terms of nutrition, it can be assumed that these results are an indication of their best performance. Under scavenger or free-range conditions, with less food and poor disease control, poorer performance would be expected.

An interesting, but important feeding behaviour pattern was observed for the young chickens. The native day-old chickens were slow to start feeding, while Cobb and New Hampshire naturally fed vigorously from day one. The Koekoek, Naked Neck, Lebowa-Venda and Ovambo chickens huddled together and searched out the darkest corner of the pens, despite of ultra-violet light provided for warmth. The first three days the starter mash had to be placed onto cardboard, as they would not feed from the trays, but scavenged around them. Behavioural studies have shown that unselected village chickens had better scavenging abilities, when compared to crossbred chickens. Crossbred chickens tended to restrict their scavenging area close to the household (Gunaratne, 1999).

The Ovambo hens did not adapt well to the battery system. They showed signs of stress when feeding and cleaning took place. The Ovambo hens also became broody, which influenced their production negatively. On the other hand broodiness may be regarded as a positive trait when evaluated under extensive systems and considered economical to increase the flock for household production.

The behavioural patterns of the native fowl seem to be adapted to extensive free ranging conditions and an evaluation under such conditions could provide valuable information for selection purposes.

Households in some countries prefer native chickens. For example, in Taiwan, where traditional cooking methods require a well-muscled carcass that will not separate from the bone in the cooking process, these birds are favoured above the commercial broilers (Catalogue of the Native Poultry of South-East Asia, 1991). It is also believed that the African populations in general also prefer free-range village chickens, because of a firmer carcass when cooked and tastier meat. Further study on the acceptability and taste of the meat would of course be required to test and confirm this belief. It could however provide valuable information for application of these fowl in small farming systems for niche marketing and household food consumption.

Despite the expansion of the commercial poultry industry in the developing world, the native chicken, which is kept under scavenging, free range conditions in rural and peri-urban areas, is still believed to play an important role in household food security (Scherf, 1995). It is therefore important to note that the First Electronic Conference on Family Poultry (7 December 1998 – 5 March 1999) indicated a growing interest in improvement of the nutrition, selection, breeding and disease control of the village chicken.

Although most authors recognize the importance of the conservation of the native chicken as a genetic resource, there is a definite need to select for native or village chicken with improved growth and egg production, adapted to extensive systems (Horst 1997; Ramlah 1996; Banarjee & Sharma, 1998). The ability to adapt and thrive under adverse conditions may in some cases be of greater economic importance than higher performance that requires high economic inputs for environmentally controlled houses.

In Malaysia, under tropical conditions, commercial lines with combinations of major genes such as the Naked Neck gene, Frizzle feather gene and Dwarf gene were tested and found that they had a higher egg production than the commercial types (Horst, 1991). Similar results were found for an evaluation of the production performance of genotypes that included Naked Neck, Frizzle and Dwarf genes in Mozambique. Significantly higher egg production was found for genotypes with both Naked Neck and Frizzle genes in comparison to normal feathered birds (Garcês *et al.*, 2001). Upgrading, using improved male stock and the introduction of major genes in breeding programs could be considered to improve production, provided that the natural abilities to scavenge and adapt to adverse climatic conditions are considered in the selection process.

Genetic characterization, as described and discussed in Chapter Three, revealed a relatively high genetic variation among the native populations. This phenomenon is often associated with populations not subjected to formal selection. Genetic distances indicated that there are distinct differences among the populations. Significant differences among the populations were also found for the for production traits. When comparing genetic and phenotypic results, the Koekoek population (lowest genetic variation in this study) had the highest egg production and differed significantly from the other populations. The Koekoek population was found also to be unrelated to the other populations (Figures 3.3 – 3.5). The Ovambo population, which had the highest weight gain also showed less association with the other native birds, the New Hampshire, Naked Neck and Lebowa-Venda populations. Although the Lebowa-Venda population share genes, according to phylogenetic analyses with the Naked Neck and New Hampshire, it tended to be phenotypically more different. It is probably due to no selection for production over the years. The Naked Neck population exhibited the higher genetic variation and a close relationship with the New Hampshire fowls. These two populations also tended to be more similar for phenotypic traits (weight gain).

Both the genetic and phenotypic results indicate that the populations in this study could be distinguished as different populations, which is important for conservation of these groups, as well as selection for application in household food production.

CHAPTER FIVE

Critical review and recommendations

In general the Red Jungle Fowl (*Gallus Gallus*) is accepted as the common ancestor of the domesticated chicken. The original purpose of domestication was for cultural and religious purposes. From the centres of domestication (present Pakistan, Turkistan and Iran), fowls were distributed to most parts of the world, where they were incorporated into different cultures and environments, which influenced the development of specific regional types. It was only during the 20th Century that interest in fowls was directed towards commercial production of eggs and meat. A large variety of breeds existed at that stage as a result of the "hen craze of the 19th Century", and these breeds formed the basis for selection of improved lines for either meat or egg production. There can be no doubt on the success of selection for improved production of broilers and layers; the broiler of 1950 took 77 days to reach slaughter weight versus the modern broiler of the 21st Century, that is ready for slaughter at 43 days with an average weight of 2 kg and a feed conversion ratio of less than 2:1. Over the years the breeding and selection of commercial poultry have become concentrated in a few major companies in the northern hemisphere. It is inevitable that the intensive selection, including inbreeding and crossbreeding, may lead to a decrease in genetic variation within poultry breeds and the extinction of the breed itself.

Since the late eighties concerns have been raised by the scientific community regarding the conservation of genetic resources. This led to the establishment of a Global Management Program of Farm Animal Genetic Resources by the FAO during 1992, which includes the Domestic Animal Diversity Information System (DAD-IS) for describing all farm animals in existence. Information on South African farm animals is also submitted to DAD-IS, including the native or local breeds recognized by the Rare Breeds International (RBI) and Farm Animal Conservation Trust (FACT).

In South Africa, as in many other countries, commercial production of livestock has been of main interest and native or indigenous breeds of fowl, sheep and goats were often disregarded. Production performance was much lower than the highly selected commercial breeds and advancements in technology and research favoured commercialisation of livestock, including poultry. The demand for food by a growing population, resulted in focussing on intensive production and no real need for promotion of breeds and/or low-input systems.

In South Africa the changes in the political and socio-economic scene over the past years, also resulted in changes in agricultural policies. New policies now also recognize the need for small-scale farming and low-input systems, therefore it is required of animal scientists to investigate indigenous or native breeds that may contribute to improvement of rural food production. A program "Fowls for Africa" was initiated by the Poultry Supply Unit of the Animal Improvement Institute of the ARC at Irene during 1994, with the aim to conserve the population as a genetic resource, but also for promotion of the fowls for household food production. As no research has been done on these populations, it was decided to evaluate the native fowl populations of the "Fowls for Africa" with particular reference to their genetic and phenotypic production traits.

The native fowl populations were characterized genetically using microsatellite markers as described in Chapter Three. Microsatellite markers were decided upon for this genetic analysis, as numerous microsatellites have been mapped on the chicken genome. Microsatellites have been used successfully in biodiversity studies in various farm animals and other species. The techniques for microsatellite analyses are well described and these markers have a high reproducibility. The genetic variability measured as average heterozygosity over all the markers were found to be relatively high ranging from 54% to 64%. Although this high variability could be expected from populations that have not been subjected to formal selection, a low heterozygosity is sometimes found in very small non-selected populations due to inbreeding and drift (although not likely in these populations). The Koekoek population, which has been recognized as a breed for some years, exhibited the lowest heterozygosity in this study among the "Fowl for

Africa" populations. According to phylogenetic analyses, the populations are distinguished by three significant major groupings, grouping the Naked Neck, New Hampshire and Lebowa-Venda populations together, and Ovambo and Koekoek populations on their own. The genetic variability and relatedness supports the phenotypic results for the production traits and the native populations studied could be described as different populations for the Koekoek and Ovambo populations. The genetic relatedness among the New Hampshire, Naked Neck and Lebowa-Venda was less defined. The Naked Neck and Lebowa-Venda populations seemed to be genetically more similar, while phenotypic differences for egg production and weight gain were found to be significant.

The study was the first attempt to characterize the native fowl populations of the "Fowls for Africa" in terms of genotype and phenotype. The information obtained from this study must however now be put into perspective of conservation (preservation) and/or utilization of these fowl populations. Animal scientists differ in their approaches: The concern of the conservationist (preservationist) is to conserve the breed, identify and prevent the erosion of the population as a genetic resource, while the utilizationist has interest only in the genetic usefulness of the population (Mason & Crawford, 1993). Very often research on conservation and improvement of native stock is a controversial matter with many arguments for and against the economics for such an endeavour. Although the two approaches of conservation and utilization are rather conflicting matters, it could be argued that both approaches should be followed for the native fowl in South Africa, as we not only have a responsibility for keeping the native fowls as a genetic resource for the future, but also for immediate, practical application for household food security.

There are various reasons for conserving genetic variation in native farm animal populations (Gandini & Oldenbroek, 1999), which also apply to native fowl populations. Firstly, from the viewpoint of the conservationist, the native fowl populations should be conserved as a genetic resource against future disasters; commercial chicken stocks are always in danger of severe potential erosion by infectious diseases. Secondly, native fowls could be a source of unique alleles and contribute in the search for genes associated with health and quality traits. The high genetic variation in these populations may assist in detection of markers. The third reason for conservation is in the interest of both the conservationist and utilizationist, in preserving native fowl resources for their adaptation to harsh environments and higher survival rate under low-input systems. Fourthly, native fowls should be conserved for their socio-economic value and role in household food security. Native fowls may even contribute to organic food production and find their way into niche markets.

In addition to the reasons described above for conservation, native fowls in South Africa also have a cultural role and one would find native fowl in most rural households. Despite the development of a successful commercial poultry industry, a place has been reserved for the "chicken" in the rural household for cultural, social and food purposes. Although it is difficult to quantify, there will always be a need for fowl in many rural households, and native stocks can contribute to household security if conserved as a genetic resource, but also be applied productively in low-input systems.

Regarding conservation of the native fowls of "Fowls for Africa" it is recommended that breeding populations are kept as individual populations or breeds, especially for the Koekoek, Ovambo and Lebowa-Venda populations. The Naked Neck population should also form an individual population for utilization of the Naked Neck gene. It will be important to keep the minimum breeding animals as required by the FAO for conservation populations. To ensure that the genetic basis of the populations are not compromised over time, DNA should be stored and genetic analyses performed on a regular basis. It might be required to collect more native fowls from rural areas, not included when establishing the original population, to ensure the conservation of biodiversity in the native fowl populations of South Africa.

In addition to conservation of biodiversity, unique genetic characteristics, for example single genes (Naked Neck, Frizzle, and dwarf-gene) should be recorded for the populations and any other distinct genetic traits that may distinguish the populations from each other.

The phenotypic information obtained from this study was from trials conducted under controlled conditions. The behavioural patterns and poor adaptation to the commercial housing facilities indicated that it is probably not the ideal approach for studying these native birds. They still exhibit characteristics such as broodiness, and the need to roost and scavenge. The more appropriate approach for assessing their production potential would be under low-input systems, because this is where these birds are mostly found and expected to survive and produce.

It is clear from the phenotypic performance traits, that production is poor in comparison to commercial stocks. For wider application of "Fowls for Africa" one could consider the selection of an "improved" line for a low-input system. This project should of course be parallel to the conservation population, which implicates two groups of fowl for each population, one for conservation and the other for selection for improved production. A dualpurpose fowl for meat and egg production would be ideal. It is however important that inherent adaptive traits of these birds should not be compromised when selecting for improved production. In this study the Koekoek population presented itself as a reasonable egg producer, but it was under ideal conditions. Under low-input systems the native breeds (Naked Neck, Ovambo, and Lebowa-Venda) might exhibit a comparatively better performance. The ability to scavenge, broodiness, as well as adaptation to high temperatures, should be considered before selecting a line and/or crossbreeding of the populations for an improved "native fowl". Although Naked Neck genotypes have been shown to be better adapted to high temperatures (Horst, 1991), they are not always acceptable to all ethnic groups. Phenotypic traits such as colour and feathers that might influence the acceptability to the consumer or cultural rites or beliefs, should also be considered in the selection process.

The conservation of biodiversity unfortunately involves relatively high input costs, with very limited economic outputs for the present. The "Fowls for Africa" has the potential with promotion and distribution of native fowls or as improved "native fowl" to contribute to the maintenance of the project. It will however, to a large extent, always be the responsibility of government institutions to support research centre to maintain native fowl conservation populations.

The native fowl has been neglected to such an extent throughout the world that it now requires conservation more than any other domesticated specie (Crawford, 1990). The laws of nature will always dictate the necessity for genetic variation. It would be short-sighted to ignore the need for conservation of genetic variation for the future. In the quest for selection for the "best" and "maximum production" only, one could easily lose on what we have set out to achieve.

As early as 1966, Lerner and Donald stressed the need for conservation as follows (Crawford, 1990):
"It may soon become one of the implied responsibilities of any organization or institution, which control the genetic destiny of a whole species to maintain a reserve of variation for further improvements and for unforeseen shifts in the environment or in demand. Indeed, it may be said, that each generation has an obligation to see that genetic variation, like soil fertility, is not handed on to it's successors in an exhausted state".

Native fowl has survived throughout southern Africa and should be conserved and promoted in this context. In the developing world, interests and norms may differ and we should not fail to appreciate the role of native fowl in South Africa in their contribution to the livelihood of our rural communities.