Chapter 1

1.1 Introduction

The village chicken production system in Africa is mainly based on scavenging indigenous chickens (Kitalyi, 1998). In Zimbabwe, the village chicken population is estimated at 30 million (Mhlanga *et al.,* 1999; Kusina *et al.,* 2001). These chickens play an integral role in the smallholder farming systems. They are used to meet the multiple household social, economic and cultural needs. Of more importance to the rural communities worldwide is the role of indigenous chickens to biodiversity (Delany, 2003). Village chickens are part of the total poultry genetic diversity that comprises of chickens, turkeys, quails, ducks, goose, guinea fowls and pheasants. This diversity is needed for future advances and improvements in response to changing environments and consumer demands. Genetic variation enables both adaptive evolutionary changes and artificial selection. Local chicken populations are seen as an important genetic reservoir developed over thousands of years and successful in extreme and unusual environments with limited veterinary and management input (Hall and Bradley, 1995). The shift towards free range organic farming systems might see higher dependency on local chicken genotypes that already exist in similar production systems (Hall, 2004). Village chickens might have valuable genetic variation that could be transferred through marker assisted selection and genetic engineering to high performing commercial populations.

Despite their current importance and future potential, very little is known about the genetic composition of local chickens in Zimbabwe and most developing countries. Although village chickens are considered an important genetic reservoir (FAO, 1999; Delany, 2003; Hall, 2004), the genetic diversity contained in these populations and its distribution has not been comprehensively quantified. At present local chickens in Zimbabwe are commonly referred to as ‘village’ or just ‘indigenous’ chickens without differentiating them into any populations. The Zimbabwe chicken population, however, consists of different phenotypic variants raised by communal farmers in five agro-ecological zones (eco-zones) of the country. It is not known whether village chickens found in different eco-zones reflect pronounced population boundaries. In other countries such as Tanzania and Ethiopia, the term ‘eco-types’ has been adopted to describe chickens from different farming systems (Tadelle*,* 2003; Msoffe *et al.,* 2005).

There are several hypotheses why eco-regions should be used to define village chicken population boundaries. Chickens in different agro-ecological zones could have originated

from different founder populations. Geographical isolation of chicken populations in different eco-zones could lead to substructuring as each eco-type experiences different forces of evolution particularly drift, mutation and natural selection. The different climatic, social and economic factors determine the importance and the degree to which village chickens are integrated in contrasting agro-ecological zones. Chicken management is likely to differ between eco-zones depending on farmer production goals. Artificial selection for certain production traits influences the type of chickens that are kept or culled in different agro-ecological zones. In addition to these factors, differences in disease prevalence, nutritional supply and other environmental factors between agro-ecological zones can result in different genotypes being favoured or selected against in contrasting regions. In such instances eco-types would refer to populations adapted to local conditions within the agro-ecological zones.

The characterisation of village chicken populations requires a holistic approach. The production systems (intensive, extensive or semi-intensive) housing village chickens have a major influence on the extent to which they are integrated in farming communities (Steglich and Peters, 2004). The feasibility of breeding programmes and *in situ* conservation programmes depends on whether they are tailor made for the particular production systems. An understanding of the production systems should therefore be coupled with an assessment of the genetic diversity within and between assumed population boundaries. Within population diversity describes the genetic flexibility of a population and how it responds to different selection pressures. Between population diversity reflects the degree to which populations differ. Genetically distinct populations might carry unique genetic features due to unique alleles and allelic combinations.

Microsatellites are codominant, highly polymorphic markers that are commonly used for assessing genome-wide genetic diversity (Baumung *et al.,* 2005; Soller *et al.,* 2006). They are assumed to be neutral to selection and can therefore give an insight into both current and unknown future genetic value of populations. They have been used in many diversity studies and have been found to give reliable estimates of genetic diversity within populations as well as the level of differentiation between breeds (Weigend and Romanov, 2001). As a global initiative, the Food and Agricultural Organisation (FAO) has recommended use of microsatellites to assess genetic diversity in domestic animal genetic resources (FAO, 2004).

Chicken mitochondrial DNA (mtDNA) is maternally inherited (Watanabe *et al.,* 1985). The simple sequence organization, maternal inheritance and absence of recombination make mtDNA an ideal marker for assessing historical genetic structure and the geographical distribution of genetic diversity of populations (Avise *et al.,* 1987; Harrison, 1989). The distribution of mtDNA haplotypes can be used to investigate whether chickens from different agro-ecological zones originated from the same founder population. On the other hand, the rapid rate of sequence divergence allows differentiation of recently diverged lineages.

1.2 Justification

The population structure of the Zimbabwe chickens is not clearly defined. Currently, all the local chickens in Zimbabwe are considered as one population. The question whether different agro-ecological zones define distinct populations needs to be resolved. The recognised role of indigenous animal genetic resources (AnGR) to smallholder farming communities and even commercial agriculture has raised interest in the conservation of these local resources from extinction and displacement. The methods used to prioritise populations for conservation depend on pre-defined existing populations (eg Reist-Marti *et al.,* 2003; Mateus *et al.,* 2004; Simianer *et al.,* 2005) and not individual chickens. It is therefore necessary that accurate population boundaries are drawn. The poor inventory of local chickens in Zimbabwe is a sign of little regard of their value as an important genetic resource. This poses a big threat to local chicken populations because proper conservation and breed improvement programmes can not be initiated. Such a scenario is not unique to Zimbabwe but pertain to most developing countries in Africa and the rest of the world (Weigend and Romanov, 2001). The characterisation of the Zimbabwe local chickens will therefore be an important step towards establishing inventory data that might be used as case study for similar chicken production systems.

1.3 Objectives

The overall goal of this study was to characterise diversity of the local chicken population in Zimbabwe

The specific objectives were to:

(i) Characterise the farming systems in Zimbabwe agro-ecological zones and identify possible threats and opportunities to the existence of local chicken populations.

(ii) Investigate the existence of chicken strains and evaluate the breeding goals and strategies used by village chicken farmers in Zimbabwe.

(iii) Evaluate genetic variability within and between the chicken populations from the five agro-ecological zones of Zimbabwe, and

(iv) Determine the level of population differentiation between Zimbabwe and other village chicken populations from similar extensive systems of production and purebred closed populations.

1.4 Hypotheses

To achieve the goals of this study, the following hypotheses were tested:

(i) There is variation in the production systems across the agro-ecological zones of Zimbabwe. This variation in the climatic and socio-economic factors results in different chicken production goals and influences breeding practises.

(ii) Genetic diversity in the Zimbabwe chickens is high

(iii) The village chicken populations in Zimbabwe are genetically substructured according to agro-ecological zones.

(iv) The Zimbabwe chicken eco-types are a unique population, genetically distinct from other village chickens from similar production systems and from purebred lines.

Identifying and Characterising Genetic Diversity of Extensively Raised Chicken Populations

Literature Review

Chapter 2

2.1 Introduction

In Zimbabwe, almost every household in the communal areas owns local chickens *(Gallus gallus domesticus)*. These village chickens are reared within a mixed crop-livestock farming system (McAinsh *et al.,* 2004; Maphosa *et al.,* 2005). They are used to meet the multiple household objectives that include income generation, food and social security (Kitalyi, 1998, Muchadeyi *et al*., 2005). Indigenous chickens also contribute to genetic diversity (Delany, 2003).

Fewer efforts have been made to characterise and conserve the local chicken populations. In Zimbabwe as in most developing countries there is scant information on village chicken genetic resources. National statistics are based on estimations of human populations in the communal areas.

2.2 Objectives

The overall goal of this article was to review information available on role of chicken genetic resources in Zimbabwe and other developing countries, the village chicken production systems, and the definition of genetic diversity in light of village chicken production systems. The methods with which village chicken diversity can be assessed are discussed. Lastly alternative methods with which priorities are set to conserve chicken genetic resources and the possible conservation programmes are highlighted.

2.3 Role of chickens in the smallholder farming sector

Increasing affluence especially in the developing world is expected to increase meat demand from 200 million tonnes to 327 million tonnes in 2020 (Hall, 2004). There is a shift towards pig (in non-Muslim communities) and poultry meat in both the developed and developing world. The worldwide chicken population is estimated at 1.3 billion with major producers in Sub Saharan Africa being Nigeria and South Africa (FAOSTAT, 2005). Although Zimbabwe is a net exporter (FAOSTAT, 2005), all of the reported chicken meat and eggs are from the commercial sector that makes use of imported genotypes. These commercial hybrids also play an important role in urban areas. Indigenous birds provide the bulk of the poultry meat and egg requirements for the subsistence and smallholder communities (Mhlanga *et al.,* 1999).

There is however, no national censuses on the total meat and egg output from the indigenous chickens. The village chicken population in Zimbabwe is estimated at 15-30 million based on 1 million communal farmers each owning ~20birds (Mhlanga *et al.,* 1999; Kusina *et al.,* 2001). Surveys (Kusina and Kusina, 1999a), and monitoring studies (Pedersen, 2002; Maphosa *et al.,* 2005; Muchadeyi *et al.,* 2005) have revealed that village chickens are a readily available source of protein and income to smallholder communities whose livelihoods depend on farming. The situation is similar in other African countries for example in Ethiopia (Tadelle *et al.,* 2002), Malawi (Gondwe, 2004), Botswana (Badubi *et al.,* 2006) and Ghana (Aboe *et al.,* 2006). Surveys world wide have also shown that village chickens provide meat and eggs for home consumption in the rural communities (Gueye, 2002).

According to Anderson (2003) and Gueye (2002), livestock including chickens are often used as buffers to shield rural households from risks such as food insecurity and cash deficits. The rain-fed agricultural production system leaves a lot of rural households prone to seasonal starvation and malnutrition (Anderson*,* 2003). Village chickens have been shown to offset this seasonality by complementing with other enterprises and providing meat and eggs for consumption (Kitalyi, 1998; Muchadeyi *et al.,* 2004).

Village chicken production is one of the few agricultural enterprises used to address gender issues in developing countries (Kitalyi, 1998; Dolberg and Peterson, 2000). In Kenya, Roberts (1996) observed that women, young males between 6 – 15 years and the elderly (above 65) spend considerable time engaged in livestock activities. Unlike with large animals, women are reported to have more control and decision making powers on chickens (Pedersen, 2002). Muchadeyi *et al.* (2004) observed that the proportion of chickens owned by women and children in Zimbabwe was higher than for any other livestock species. Aboe *et al.* (2006) observed a significant effect of sex of household head on chicken flock sizes, management practises and uses in Ghana. Ngo Thim *et al.,* (2006) and Gondwe (2004) made similar observations in village chicken production systems of Vietnam and Malawi respectively.

2. 4 Chicken production systems

In general, there are three chicken management systems namely intensive, semi-intensive and extensive or free ranging. The socio-economic factors in a community determine the type of management system practised (Sonaiya, 1990).

2.4.1 Intensive system

The intensive system is based on specialized phenotypes (egg or meat producing strains). Flock sizes in this production system are normally in thousands (Appleby *et al.,* 1992). The stocks of chickens contributing to the global production of meat and eggs are managed and designed by a few primary breeders in response to market demands (Delany, 2003). Elite lines of birds are intensively selected for performance traits to create the grand parent or parent lines. The parental lines are then crossed to create commercial lines that are supplied to the market.

The intensive production system is a high input - high output system. To achieve optimum genetic potential, the specialized breeds require quality management and controlled environmental conditions (Sheldon, 2000). In sub-Saharan African countries, 30 percent of the total chicken population is reared under the intensive system of production (Kitalyi, 1998). In Zimbabwe, over 55 percent of the total chicken meat produced comes from the intensive sector (Faranisi, 1995). Most farmers in rural communities cannot meet the standard management practices due to limited physical and capital resources as well as lack of technical knowledge.

The intensive production system is based on a restricted genetic base (Delany, 2003). Information on the features and number of lines involved in the creation of industry populations is not in the public domain. However with the consolidation of breeder companies (Aurthur and Albers, 2003), it is suggested that the number of elite pure lines is on the decrease. The intensity and duration of selection could probably result in loss of genetic variation through loss of alleles. A reduction in population heterogeneity creates selection walls that result in reduced response to future selections (Delany, 2003).

2.4.2 Semi-intensive system

As with the intensive system, the semi-intensive production system is based on specialised breeds. Flock sizes in the semi-intensive system range from 50 to 1000 birds (Sonaiya, 1990; Kitalyi, 1998). More labour is required to manage flocks in the semi-intensive system compared to the intensive system. In both intensive and semi-intensive systems, keeping of