Despite their low performance, IC are highly adapted to harsh production environments, preferred by consumers compared to commercial breeds (Bett, 2012) and possess high genetic variability (Mwacharo et al., 2007; Fotsa et al., 2011; Goraga et al., 2011) which could be exploited through selection for their genetic improvement.

### 1.4 Productivity improvement efforts of the Kenyan indigenous chicken

The popularity of IC among the Kenyan households has been on the increasing trend. This has been demonstrated by the ever escalating prices of IC products compared to those of the commercial chicken and the consumers’ willingness to pay more for IC products (Bett et al., 2011). This high demand, has forced farmers, researchers and government institutions to look into ways through which their productivity can be improved. The major constraints to IC production has been identified as poor quality and inadequate feed resources, healthcare, marketing, housing and lack of breeding stock (Gondwe and Wollny, 2007; Halima et al., 2007; Okeno et al., 2010; Bett et al., 2012). The improvement of IC has been attempted by researching on different models of nutrition such as supplementation at different times and stages of growth and production and improving the protein and energy content of the feeds (Okitoi et al., 2009; Kingori et al., 2010b; Ochieng et al., 2011). Although, these models resulted to improved productivity both under on-farm and on-station production environments, their adoption and sustainability has been hindered by scarcity of raw materials especially cereals, which form the major component of poultry feeds. The low genetic potential of IC for egg production and growth to meet the farmers desired production levels could also explain the low adoption rates as farmers find it uneconomical to invest in management strategies, but get low returns.

The genetic improvement of IC was initiated in 1976 through a crossbreeding programme undertaken by the National Poultry Development Programme (NPDP) (Wainaina, 1994). The programme used cockerels and pullets of Rhode Island Red, White Leghorns, Light Sussex and Black Australorp breeds to cross with IC with an objective of improving eggs and meat production, thereby increasing smallholder farmers’ income and protein intake through commercialization of IC production. This programme was accompanied by a massive vaccination programme of IC against Newcastle disease and training of farmers on chicken management strategies to minimize mortality. Although, the programme resulted to improved performance in the crossbreds, the desired performance in subsequent crosses was not realized. Similar situations were also reported in other developing countries where such programmes were initiated (Muchadeyi et al., 2005; Gondwe and Wollny, 2007; Dana, 2011;
Natukunda et al., 2011). The NPDP was terminated in 1993 and its failures were attributed to poor planning and understanding of the IC sub-sector in terms of production environment, needs of actors in the IC value chain, lack of clear breeding objectives and lack of an operational breeding programme to ensure constant supply of purebred breeding stock (Wainaina, 1994; Magothe et al., 2012b; Ndegwa et al., 2012). The second attempt was initiated in 2006 through a collaborative programme, the Smallholder Indigenous Chicken Improvement Programme (INCIP). The objective of this programme was to undertake a comprehensive analysis of the entire IC value chain for the purpose of understanding the entire sub-sector. Such studies help to provide insight into the existing situations in terms of strengths, weaknesses, dynamics and complexities, which are important in formulating solutions (Bitsch and Olynk, 2007; Gizaw et al., 2010; Nonis et al., 2010). Through INCIP, the marketing structure of the IC sub-sector has been characterized (Bett, 2012), the on-station performance parameters of different IC genotypes and ecotypes estimated (Ngeno, 2011; Magothe, 2012), on-farm IC disease and parasites prevalence determined (Kaingu et al., 2010) and genomic characterization of different IC genotypes and ecotypes is ongoing. There is still however, a need to develop a breeding programme for IC by taking into account the factors which led to failure of NPDP. Such a programme require characterization of the production systems, development of realistic breeding objectives accounting for the needs of all stakeholders along the production value chain and designing of appropriate selection and mating schemes for efficient dissemination of superior genetic materials in to the entire population.

1.5 Rationale and objectives of the study

The roles played by IC in the livelihood of the resource poor rural households especially; women, widows and orphaned children cannot be over emphasized. Although, IC exhibit high between and within ecotype and genotype variations (Gondwe and Wollny, 2005; Muchadeyi et al., 2007; Dana et al., 2010; Lwelamira and Kifaro, 2010; Magothe et al., 2010), they have remained less competitive compared to exotic breeds due to their low productivity. This has hindered their exploitation to improve the living standards of the producers and bring about rural development. Previous attempts to improve their productivity through crossbreeding with commercial chickens proved unsustainable because the resultant genotypes could not survive under extensive production systems. This was attributed to poor understanding of the IC production systems as it was assumed that all production systems were homogenous with similar production objectives and management interventions (Wainaina, 1994). The best way to promote the competitiveness of IC is to improve their
productivity without altering their morphological and adaptation characteristics. This calls for characterisation of their production systems and identification of the existing IC genotypes and their attributes to producers as the first step. Characterization would help in formulation of reliable breeding objectives that are relevant to existing and future production circumstances. Formulation of breeding objectives requires identification of traits of economic importance and estimation of their economic values which is currently lacking. There is also a need to design a sustainable breeding programme that will promote the conservation and utilisation of the IC genotypes with unique adaptive and productive characteristics. Globally, there is increased realisation to expand the narrow range of chicken breeds/ecotypes used in industrial chicken production to improve food security (Jiang, 1999; Gondwe, 2004; Dana, 2011). The unique characteristics of the IC genotypes could be incorporated into industrial stocks to improve their adaptation to the harsh climatic and management conditions prevailing in developing countries of the tropics. This study is envisaged to explore the IC production environment to provide the insight of the sub-sector and use the information generated to develop realistic breeding objectives and sustainable breeding programme for genetic improvement and conservation of IC genetic resources in Kenya. The same principles could also be applicable to other developing countries in the tropics.

1.6 Objectives

The overall objective of this study was to contribute to improved productivity of IC through characterization of production systems, development of breeding objectives, and designing and evaluation of alternative selection schemes for genetic improvement, conservation and utilisation of IC genetic resources in Kenya. To achieve this objective the following specific objectives were formulated:

1. To characterise the production systems under which IC are raised, determine their relative importance to farmers, asses the flock structure and dynamics and production constraints.
2. To determine the farmers breeding practices and breeding goals and identify traits of economic importance for IC genetic resources as perceived by farmers, marketers and consumers.
3. To construct a bio-economic model for economic analysis of different IC production systems accounting for different risk-attitudes of farmers.
4. To develop alternative breeding objectives for specialised pure line IC production and compare them with farmers’ breeding objectives.
5. To construct a realistic selection scheme for purebred and crossbred IC and determine their genetic and economic merits.

1.7 Thesis outline

This thesis is organised in 8 chapters. **Chapter 1** introduces the overall background and rationale of the study. It highlights the relevance of poultry production in general and chicken domestication and production in Kenya. The chapter provides an overview of the attempts made to improve IC productivity and the challenges encountered. It also identifies research gaps which need urgent mitigations to realise the improved productivity of IC which forms the basis of this research. The overall and specific research objectives are also presented. **Chapter 2** reports the findings of a comprehensive field survey undertaken to characterize the entire IC production system to provide the insight of the existing situations in the IC sub-sector. This chapter describes the existing IC production conditions, management practices, flock structure, dynamics and performances at farm level, reasons why farmers keep IC and constraints to their production. **Chapter 3** describes the breeding practices of the IC farmers, the diversity of the IC in terms of the existing genotypes and ecotypes in the farmers’ flocks and their perceived attributes. Using participatory approach, this chapter also identifies the breeding objectives of IC farmers and links them to the needs of the marketers and consumers. In **Chapter 4**, the bio-economic model constructed to economically evaluate the three main production systems identified in Chapter 2 is presented. This chapter systematically describes how the biological and economic aspects of the IC were integrated in the model to evaluate short and long-term economic worth of the three production systems. Using the bio-economic model developed in Chapter 4 and traits of economic importance identified in Chapter 3, the economic values of breeding objective traits for the IC were derived in **Chapter 5**. The chapter also explains how simple and risk-rated profit model functions were utilised to derive economic values with- and without risks for all traits in the breeding objective under three production systems and two production circumstances. Since disease resistance was identified as one of the priority traits to be improved in Chapter 3 and inability of the bio-economic model developed in Chapter 4 to derive its economic values due to environmental, nonlinearity effects and interactions complexities; the economic values for disease resistance indicator traits were derived in **Chapter 6**. This chapter highlights how both simple and risk-rated economic values for two disease resistance indicator traits (faecal worm egg count and immune antibody response) were derived using selection index methodology. It also explains how different trait combinations under different selection schemes would affect genetic gains when disease resistance is included in the breeding
programme. **Chapter 7** examines the efficiency of the farmers’ breeding objective identified in Chapter 3 and alternative breeding objectives developed in Chapter 5 and 6 in terms of genetic and economic gains. The chapter compares the efficiency of these breeding objectives under within IC population selection (pure line selection) and crossbreeding strategies. It also analyses the feasibility of establishing a breeding programme for genetic improvement of IC. Finally, **Chapter 8** integrates all the methodological approaches and results from Chapters 2 to 7 and relevant information from the literature into a general discussion. It also presents the conclusions based on the findings of this study and recommendations on implementation of the IC improvement programme.

**References**


