ECONOMICS OF POULTRY PRODUCTION IN KHARTOUM STATE, SUDAN

By

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DEDICATION

To the memory of my Father

And to our Lovely Friends; Mutwakil

Mohamed; Yasir; Omer, and Ahmed,

Allah bless them
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Abstract

Poultry Production in Khartoum State is commercially practiced in open, semi-closed and closed-system farms. The closed-system farms are specialized in eggs and broiler production, while the open-system farms mainly produce eggs. In the open-system farms, poultry production is practiced in small, medium and large size feed producing and non-feed producing farms, but in the closed-system farms, producers prepare their own feed.

With the increase of consumer awareness of the nutritive value of poultry products, increase in production and the decline in prices relative to the higher prices of other types of animal proteins, the demand for poultry products is increasing rapidly. However, in spite of the increased investment in this industry, there is an obvious gap between the supply and the demand for poultry products. The high cost of inputs especially feed and day-old chicks, are hypothesized to be the most important factors limiting production.

The main objectives of this study were to study the economics of egg and broiler production and identify the factors affecting the cost of poultry production in Khartoum State. Poultry flocks were divided into three strata depending on the size of the flock. A field survey was conducted through a structured questionnaire from a sample of 48 poultry producers using stratified random
sampling technique. Secondary data were collected from different sources. Data collected were analyzed using simple statistical and Chi-Square analysis.

The analysis of costs of production revealed that, feed costs were the main item in poultry production, as it constituted about 70.3% and 67.5% of the cost of production in the feed-producing and non-feed producing farms of open-system, respectively. In the closed-system farms, it constituted about 73% and 44% of the total cost of egg and broiler production, respectively.

Chi-Square results indicated that, feed, labor, housing and equipment costs were the most important factors affecting the cost of production, whereas, the number of laying hens, presence of diseases and feed source (either produced or purchased feed) were the major factors affecting egg yield in the open-system farms. The study also revealed that, feed produced on farms is less cost than the purchased by 13-25%.
خلاصة الأطرحة

يمارس إنتاج الدواجن في ولاية الخرطوم تجاريا في مزارع النظام المغلق، شبه المغلق والمفتوح، مزارع النظام المغلق متخصصة في إنتاج البيض واللحم، بينما ينتج نظام التربية المفتوح البيض بصورة رئيسية.

يمارس إنتاج الدواجن في نظام التربية المفتوح في مزارع صغيرة، متوسطة وكبيرة الأحجام متوجه وغير متجه للعلف، بينما ينتج العلف ذاتيا داخل المزرعة في نظام التربية المغلق.

مع زيادة وعي المستهلك بالقيمة الغذائية لمنتجات الدواجن، الزيادة في الإنتاج، قللة أسعارها والزيادة النسبية في أسعار البروتينات الحيوانية الأخرى ازداد الطلب سرعة علي منتجات الدواجن. مع ذلك بالرغم من الزيادة في الاستثمار في هذه الصناعة نجد أن هناك فجوة بين عرض منتجات الدواجن والطلب عليها. التكلفة العالية للمدخلات خاصة العلف والكتاكية عمر يوم افترضا أنها من أهم العوامل التي تحد من الإنتاج.

الأهداف الرئيسية لهذه الدراسة هو دراسة اقتصاديات إنتاج البيض والدجاج اللحم وتحديد العوامل المؤثرة على تكاليف إنتاج الدواجن في الولاية.

تم تقسيم حظائر الدواجن إلى ثلاثة أقسام اعتمادا على حجم القطاع بالزراعة، تم إجراء مسح ميداني باستبان موجه بولاية الخرطوم في يونيو 2006م وجمع البيانات من عينة مكونة من 48 منتج دواجن باستعمال طريقة العينة الطبقية العشوائية. وتم
جميع البيانات الثانوية من مصادر مختلفة. تم تحليل البيانات باستخدام اختبار Chi-Square والتحليل الإحصائي المبسط.

أظهر تحليل تكلفة الإنتاج أن تكلفة العلف هي التكلفة الرئيسية في إنتاج الدواجن حيث كونت 70.3% من التكلفة الكلية لإنتاج البيض في المزارع المنتجة للعلف و67.5% من التكلفة الكلية لإنتاج البيض في المزارع غير المنتجة للعلف في نظام التربة المفتوح على التوالي. في مزارع النظام المغلق، كونت 73% من التكلفة الكلية لإنتاج البيض و44% من التكلفة الكلية لإنتاج اللحم على التوالي.

أوضحت نتائج تحليل Chi-Square أن تكاليف العلف والعمالة وبناء الحظائر والمعدات هي أهم العوامل المؤثرة على تكاليف الإنتاج بينما عدد الدجاج البيض، وجود الأمراض ومصدر العلف (منتج ومشتري) كانت أهم العوامل المؤثرة على إنتاج البيض في النظام المفتوح.

أيضًا أوضحت الدراسة أن العلف المنتج بالمزرعة أقل تكلفة من العلف الذي يشتري من السوق بنحو 13-25%.
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Chapter One

Introduction

Rapid technological progress in the poultry sector has resulted in a remarkable reduction in the cost of production and marketing of poultry products. Falling retail prices of poultry products relative to the cost of other animal products due to this improved technology has resulted in increased consumption of poultry products worldwide (Vocke, 1991). The recommended average daily intake of protein for the human is 0.6g/kg body weight. Protein intake varied between countries according to the availability of protein sources and prevailing economic or social factors. In the developed countries, about 50% of protein is obtained from red and white meat, while in the developing countries, it is between 15% and 20% and the rest comes from plant sources.

There are many species and breeds of poultry population used by man. The domestic chicken (Gallus domestic) is the most important one. Its products are rich in protein, minerals and vitamins. It accounts for more than 90% of the world's poultry flocks, ducks account for 5% and turkey for about 2%. The rest of poultry species accounts for about 3%, which includes geese, dove, pigeons etc (Suad, 1998a).

Poultry production is currently increasing in developing countries through the usage of small-scale production facilities and increased poultry husbandry skills. (Suad, 1998b).

Egg production is a highly competitive business that involves a substantial investment of capital and considerable risk. Demand for eggs is inelastic, so that relatively small changes in total egg production can cause sharp decline in the egg price. Broiler industry has been spectacular and followed by improvement in breeding, disease control and marketing practices (Laura L. Farrelly, 1996).
Poultry meat is the fastest growing component of world wide meat production, consumption, and trade, with developing and transition economies playing a leading role in the expansion. In addition to providing opportunities to increase poultry exports, rising poultry production spurs growth in global import demand for feeds and other inputs and generates up and downstream in investment opportunities (Regmi, 2001).

World poultry meat output increased nearly eightfold between 1961-2001, while the output in middle-income countries even rose more than twelve fold. The biggest global poultry meat producers are the United States, the EU, China, Brazil, Mexico, Canada and Japan. Among middle-income countries, China was the major producer in 2001, followed by Brazil, Mexico, Argentina, Iran, Russia, Egypt and Poland.

In 1961, middle-income countries produced 34 percent of world poultry meat, high-income countries 61 percent, and low-income countries the remaining 5 percent. By the mid-1990s, middle-income country production had reached a level of 47 percent of the output of high-income countries. By 2001, middle-income countries accounted for the major share of world poultry production (52 percent) compared with 42 percent in high-income countries and less than 6 percent in low-income countries (Regmi, 2001).

The commercial sector has achieved much, making eggs and poultry meat a nourishing and affordable dietary item for millions of people. However, despite the rapid development of commercial poultry systems worldwide, it has been estimated that still more than 80 per cent of the global poultry population is found in traditional family-based production systems and that the latter contribute up to 90 percent of the total poultry products in many countries. The large-scale commercial and small-scale rural family poultry sectors need not be mutually exclusive,
nor be in direct competition. Indeed, the commercial sector with its wealth of human, technical and financial resources could play a major catalytic role in promoting rural poultry production as a practical and viable option for poverty alleviation.

The challenge to reduce poverty and malnutrition cannot be achieved by one single intervention and, in isolation; no single activity will have a major impact. However, livestock, especially poultry species, have been shown to provide a practical and effective first step in alleviating abject rural poverty. Livestock provide a renewable asset, a ready source of cash, quality nutrients in the human diet, and are often essential for meeting important social and cultural needs and obligations. Targeting small-scale, family-based poultry systems as an effective entry point for poverty alleviation programmes is gaining widespread acceptance. Provision of an enabling environment that allows vulnerable and disadvantaged people access to credit, improved husbandry practices, goods, services, improved genotypes and better market opportunities can make a real difference. Unfortunately, there are policy distortions and trade practices that marginalize and exclude the poor; these need to be addressed to take advantage of the opportunities livestock offers for rural development and poverty alleviation.

Poultry keeping in Sudan is an old practice, where the domestic fowl has been kept for generations in villages and backyards of dwellings to supply both eggs and meat for own consumption. Recently, with increase in demand for poultry products, poultry production has witnessed an increasing intensification resulting in commercial poultry farming concentrated in Khartoum state, the capital of Sudan and in the peripheries of some other big cities. Other parts of the country depend on the governmental poultry units and small-scale farms (Sharabeen, 1996).
Khartoum state is an industrial center, where people migrate from all over the country to be employed; hence, Khartoum state is characterized by high population rate of growth and high demand for food.

1.1 Poultry Production in Khartoum State:

Commercial poultry production in the state is divided into three farm systems:

1.1.1 The Closed System:

In this system, poultry production is practiced by large companies under controlled environment and advanced managerial standards. They are the main source of chicken meat and eggs in the state. However, their production is less than their potential capacities. Many companies produce day-old chicks for their own rearing purposes and sell the excess to the private poultry producers.

1.1.2 The Semi Closed System:

In this system, poultry production is practiced by medium companies and large private poultry production farms under semi-controlled environment and advanced managerial standards. This system has been introduced recently by medium size companies and private producers to the State.

1.1.3 The Open System:

All the small, medium and some large poultry farms in Khartoum State are of this type. The farms have open sided houses with gable-shaped roofs, usually made of corrugated metal. The walls are constructed of bricks and the rest is covered with mesh network.

Broiler production in this system is limited, because it is affected by great losses due to the high temperature, diseases and low weight gain of broiler. Under this system broiler production takes place during the winter months.
There are different types of farms in this system as some farms own their feed while others purchase it according to flock size.

1.2 Problem statement:

With the increase in consumer awareness of the nutritive value of poultry products, increase in production and the decline in prices relative to the higher prices of other types of the animal protein, the demand for poultry products is increasing rapidly. However, in spite of the increased investment in this industry, there is an obvious gap between the supply and demand for poultry products. This deficiency in the egg and meat production in the state was estimated by the Ministry of Agriculture, Natural Resources and Animal Wealth (1991) to be 80%. To bridge this gap, production should be increased, as there are ready markets to get rid of the excess quantities, if produced at reasonable prices. The high cost of inputs especially feed and the insufficient supply of day-old chicks are hypothesized to be the most important factors limiting production in addition to diseases prevalence.

1.3 Objective of the study:

The overall objective is to study the egg and meat enterprises and determine the factors affecting the cost of production and marketing in Khartoum state. This could be analyzed in terms of the following specific objectives:

1- Review the existing situation of poultry production in the state.
2- Investigate the main factors contributing to the cost of egg and poultry meat production in the open, semi -and -closed system farms.
3- Determine the factors that affect egg and broiler yield.
4- Compare profitability in the different location and farm types, (egg and poultry meat).
1.4 Hypotheses:

1- The main hypothesis to be tested is that, feed cost is the main cost item in egg and poultry meat production in Khartoum state.

Other hypotheses are:

2- The high cost of day-old chicks, vaccines, labor and drug are limiting factors in egg and poultry meat production in the state.

3- The mortality rate is greater in the open-system farms than in semi-closed and closed-system farms.

4- The large-sized farms in open –system are more efficient in egg production than in the medium and small-sized farms.

5- Most of broilers productions are limited to the companies and large farms.
Chapter Two
Literature Review

2.1 Introduction:

In the developing countries, family poultry represents an appropriate system to feed the fast growing human population and to provide income to poor small farmers, especially women. It makes one of the best uses of locally available resources. Although requiring low resource inputs and generally considered secondary to other agricultural activities by smallholder farmers, this type of production has an important contribution in supplying local populations with additional income and high quality protein. Family poultry are also valued in religious and socio-cultural lives. However, high mortality, mainly due to Newcastle disease, especially in growers, constitutes one of the greatest constraints on development. Other problems are related to breeding, feeding and marketing. Appropriate development programmes are those, which adopt a holistic approach.

The Food and Agriculture Organization of the United Nations (FAO) is committed to family poultry development and, through the International Network for Family Poultry Development (INFPD), is ideally placed to co-ordinate family poultry development. Family poultry are within the Special Programme for Food Security (SPFS), launched in 1994 by Jacques Diouf, Director-General of FAO.

2.2 Background:

Although food availability has kept pace with the growing world human population during the last 30 years, there are still some 800 million people suffering from malnutrition. This problem is due not only to insufficient food production and inadequate distribution, but equally
to insufficient income to acquire food in adequate quantity and quality to satisfy family needs (FAO, 1993).

Livestock production constitutes an important component of the agricultural economy of developing countries, a contribution that goes beyond direct food production and includes multipurpose products and uses.

Furthermore, they are closely linked to the religious and socio-cultural lives of several million resource-poor farmers for whom animal ownership ensures varying degrees of sustainable farming and economic stability. However, official statistics generally underestimate the overall contribution provided by animals since they underestimate, or ignore, the multipurpose and culture roles played by livestock in food and agricultural production in developing countries.

The world human and livestock populations have increased considerably over the last three decades but at different rates. There are major differences between developed and developing countries, with the vast majority of all domesticated species found in the latter countries. Growth in human and livestock populations is both higher in developing countries than in the developed world. Although all categories of livestock have increased in numbers, the increase is much greater in poultry when compared to ruminants and pigs.

The world human population is expected to grow from 5,285 million in 1990 to 7,032 million in the year 2010; again this increase will take place largely in the developing countries (FAO, 1993). To feed the growing human population, more land will need to be devoted to staple food and cash crops as intensification has not occurred in Low-Income Food-Deficit Countries (LIFDCs). Because land is a finite resource, an increased use will reduce land for pasture and fodder, as has already occurred in Asia. This situation will largely determine the composition
of the livestock population, and will have a major effect on both the available natural resources and future demand for commodities and, consequently will determine the management systems adopted. What is clear to maintain food production will necessitate increased efficiency of resource utilization as well as developing alternatives, such as marine and freshwater fish culture in a sustainable way.

Poultry production represents one of these alternatives. Over the last decade, poultry population has grown spectacularly throughout the world: 23 percent in developed and 76 percent in developing countries, respectively (Ram Gopal et al 2000).

This increase, due to the commercial production, has been most notable in the Far East where growth averaged 90 percent. For example, in India, production has increased six fold in ten years. However, most of the conditions required by the commercial poultry sector are not met in LIFDCs, namely:

1. The ability to purchase most inputs, i.e. improved birds, feeds, vaccines, drugs and equipment.
2. The availability of a highly-skilled manpower.
3. The presence of a strict disease control.
4. The existence of national domestic markets able to absorb poultry products at attractive prices by consumers with a good purchasing power. In fact before developing medium to large-scale units, either for broiler or egg production, it is important to achieve either self sufficiency in cereal grains or to generate the necessary hard currencies provided by the export of oil or other expensive raw materials.

In many developing countries, poultry production is based mainly on traditional extensive poultry production systems (Aini, 1990, Spradbrow, 1994; Branckaert, 1996; Kitalyi, 1997; Guèye, 1998a; and
Sonaiya et al., 1998). All over the developing world these low input low output husbandry systems have been a traditional component of small farms for centuries and are assumed to continue for the foreseeable future. For example, it has been estimated that 80 percent of the poultry population is found in traditional family-based poultry production systems, which contribute up to 90 percent of poultry products in some countries. Approximately 20 percent of the protein consumed in developing countries originates from poultry (i.e. meat and eggs). Yet, despite the importance of family poultry (FP), relatively few field programmes have been initiated to improve the output.

Family poultry (FP) is an integrated component of nearly all rural, many peri-urban and some urban households and provides valuable protein and generates extra cash. All ethnic groups tend to be involved in FP production. Women, assisted in some cases by children, play a key role in this sector, as they are the main owners and managers of FP. For instance, according to Guèye (1998b), more than 85% of rural families in Sub-Saharan Africa keep one or more species of poultry, and more than 70% of chicken owners are women, while traditionally pigeons belong only to children.

Four management sub-systems have been described by Sonaiya (1990). These are the free-range system or traditional village system, the backyard (family or subsistence) system, the semi-intensive system and the intensive husbandry system. According to Guèye (1998a), the two first types are the most commonly practiced in rural Africa. There is no doubt that adoption of one or more management subsystem (s) is largely determined by the availability of resources and inputs i.e. housing, cages, feed, drugs and time. Also, these management sub-systems (s) frequently overlap, thus, free range is sometimes coupled with feed
supplementation, backyard with night confinement but without feeding; standard poultry cages in confined space, etc.

According to Sonaiya et al. (1998), FP contributes more than 70 percent to total poultry production in most LIFDCs, with some exceptions. FP flock composition is heavily skewed towards chickens in Africa, towards ducks in Asia and turkeys in Latin America. Household flock sizes range from 3 to 97 in Africa, 10 to 31 in South America and from 50 to 2,000 in Asia. Flock size is related to the objectives of the poultry enterprise. The level of productivity is very low compared to high input systems. For example, a scavenging hen lays only 30-50 eggs per year and up to 90 eggs per year under improved feeding and husbandry conditions. In contrast, commercial hens lays 280 eggs annually. Furthermore, studies in Nigeria estimate that the overall flock mortality may be as high as 90 percent in some areas.

2.2.1 Strategy for FP development:

To improve FP productivity, and move from backyard to semi-intensive commercial poultry production, a number of important constraints have to be overcome:

2.2.1.1 Disease control:

Newcastle disease (ND) constitutes the most serious epizootic poultry disease throughout the world, particularly in developing countries. No progress has been made in controlling ND in free ranging village flocks, which represent more than 80 percent of the total poultry population. For example, several surveys in Africa showed high rates of seropositivity in the absence of vaccination. In developing countries, ND occurs every year and kills on an average 70-80 percent of the unvaccinated village hens. It is very difficult to organize vaccination campaigns covering free-range birds and the main constraints are:
a. The difficulty of grouping together an adequate (large) number of birds in order to obtain an efficient vaccination rate.
b. Birds of various ages are usually raised together.
c. The need to maintain, at all stages, an efficient cold chain for proper vaccine conservation.

Furthermore the large number of farmers involved implies the need for considerable budgets (vaccines costs, transportation, refrigeration equipment, etc.) and makes actual vaccination programmes difficult to accomplish. In fact, planned vaccination programmes using existing commercial vaccines to control ND in village poultry have been successful, but the need for large labor and technical inputs has limited their efficiency. It should be kept in mind that, besides the vaccination, other general approaches can be used to control ND. Hygiene, slaughter of infected birds and selection for resistance to the disease or for a better immunological response. Moreover, ND does not represent the only disease affecting FP. Consequently, the following activities are recommended:

1. Epidemiological surveys at a regional level should be conducted in order to propose appropriate and low cost vaccination schemes.
2. Based on the survey results, appropriate vaccination programmes have to be established.
3. Training and use of paravets, preferably women, to undertake vaccination at group level.

2.2.1.2 Protection against various predators:

Predators such as snakes, rats, dogs, cats, foxes, raccoons and birds of prey represent the main causes of losses, especially in young birds. Human beings can also represent another important predator for adult birds.

Prevention can be contemplated through the following measures:
1. Proper housing that should be constructed using locally available materials.

2. Predators should be trapped, hunted or repelled by specific plants. For example, in Nigeria, sliced garlic (Allium sativum) is placed around poultry houses to keep off snakes.

**2.2.1.3 Feeding:**

Careful attention should be given to ensuring adequate feed resources, which represent 60 to 80 percent of the economic inputs in the commercial poultry sector. In LIFDCs, surplus of cereals is generally not available. It is, therefore, not advisable to develop a wholly grain-based feeding system. The recommended policy is to identify and use locally available feed resources to formulate diets that are as balanced as possible. Research capacities must be strengthened to develop strategies to optimize locally available feed.

Both conventional and alternative feed resources that are readily available to smallholder farmers should be identified. Shrub leaves (Leucaena sp., Calliandra sp., Sesbania sp., etc.), aquatic plants (Azolla sp., water hyacinths, etc.), insects (termites), fruits (palm-oil fruit, papaya, guava, etc.), small animals (e.g. snails, earthworms), etc. can all be used as poultry feed. These products are rich in protein as well as vitamins and minerals and are all appropriate for supplementing diets of scavenging poultry. All these products, and the list is far from being exhaustive, are available in some parts of a country and during certain periods of the year; however, people must be skilled in using them properly. This implies the need for extension officers and farmers to be trained in the use of these alternative feed resources.

**2.2.1.4 Family Poultry farmers' organizations:**

Organizing family poultry farmers is not an easy task. There are several reasons. Flock sizes are small and birds are maintained with
minimal land, labor and capital inputs. That means that farmers generally consider FP as secondary occupation compared with other activities in agriculture, trade, etc. nevertheless, it is essential to:

1. Develop producers groups which will:
   1. Allow the group members to have easier access to inputs: feed supplementation, improved birds, drugs and vaccines, technical advice, etc.
   2. Facilitate access to credit, training, transportation and marketing of poultry products.
2. Encourage educated people to initiate poultry farming as a secondary occupation, conducted at family level using medium-sized flocks.
3. Develop associated activities like market gardening that can utilize poultry manure and help to reduce or remove household waste and pests.

2.2.1.5 Genetic improvement:

Indigenous or local breeds are generally raised in FP production systems. These birds are usually selected for their hardiness and sometimes for meat production, but not for egg production. Hens are thus poor layers; however they are good hatchers, except for guinea hens. When farmers contemplate to adopt a more intensive poultry production system, they are eager to purchase more productive birds. There is a need to find the best method to provide them with such birds and the options are:

1. To supply hybrid strains which means the presence of well managed hatchery facilities and (grand) parent stock, or
2. To supply purebred breeds which allow the farmer to renew his flock and to remain independent from external suppliers.

Unfortunately, purebred breeds are more and more difficult to
purchase and produce less than hybrids. However, poor hatching is commonly observed from hatcheries in many developing countries, especially in sub-Saharan Africa. Also, regular imports of hybrid parent stock must be carefully planned because usually there are many obstacles to overcome, e.g. purchase of importing licenses, obtaining hard currency, adequate shipment and transportation facilities, customs clearance and ensuring excellent conditions for the reception of birds, etc. Smallholder farmers cannot afford to carry out these operations themselves, while government structures have proved unreliable and the private sector does not seem really interested.

However, some solutions have proved to be efficient:

1. Joint-ventures with multinational companies interested to distribute their own products.
2. Farmers Organizations that is able to provide their members with all necessary inputs, including imported birds.
3. It is also possible to import less productive purebred and robust breeds for distribution to farmers, and allow them to conduct their own genetic improvement. However, many of these operations like cock exchange programmes in the past have failed, essentially because there was a lack of proper and continuous monitoring and exotic birds did not survive under the harsh conditions prevailing in many developing countries.

2.2.1.6 Marketing facilities:

Poultry products in most developing countries, especially in Africa, are still expensive. The marketing system is generally informal and poorly developed. Unlike eggs and poultry meat from commercial birds derived from imported stocks, consumers generally prefer those from indigenous stocks. The existence of a local market offering good
sales opportunities and adequate transport facilities are obvious prerequisites for FP development. As most consumers with the greater purchasing power live in cities, intensification of poultry production should be initiated in peri-urban areas or, at least, in areas having a good road network.

2.2.1.7 Training and management:

Technical skills need to be considered at both farmer and extension levels. Training is essential for both farmers and extension officers in the following areas: disease control, housing and equipment, feeding, genetic improvement and marketing. A basic knowledge in specific features of poultry anatomy and physiology is also important to understand the basis of the above topics. Housing and management could be improved through appropriate farmer training, preferably conducted on-farm. Local craftsmen could be trained to manufacture small equipment, like feeders, drinkers, etc.

2.2.2 FAO and Family Poultry Development:

The Food and Agriculture Organization (FAO) of the United Nations is committed to support FP production (Branckaert, 1997). Its mandate targets the poorest and most disadvantaged groups in developing countries.

Many efforts to develop the commercial poultry sector have failed because of their dependence on imports of expensive inputs such as day-old chicks, cereals, drugs and pre-mixes (which need hard currencies) and because of periodic shortages of feed and other inputs. Moreover, the highly mechanized commercial sector does not provide many job opportunities. Thus, the wellbeing of small-scale poultry farmers, who represent the majority in developing countries, is not improved through this poultry sector.
The FAO, through its Animal Production and Health Division (AGA), has always supported rural FP development activities. In recent years, the importance of FP production has been the subject of various international workshops, seminars and conferences. Most of them have, totally or partially, been sponsored by FAO and have generally taken place in developing countries, mainly in Africa and Asia.

FAO encouraged the development of the ANRPD (African Network for Rural Poultry Development) in November 1989 in Ile-Ife, Nigeria. The network has been renamed INFPD (International Network for Family Poultry Development) or RIDAF (Réseau International pour le Développement de l’Aviculture Familiale, in French) and appropriate resolutions were adopted by the ANRPD General Meeting held on 13 December 1997 in, Senegal. It was decided that membership and coverage of Network be extended to Asia and Latin America and that all aspects of family-related poultry production be addressed. The network’s activities will focus not only on rural areas but also on other poor areas, like the peri-urban ones. In addition, development efforts should be devoted to other poultry species such as ducks, geese, guinea fowls, turkeys, quails, pigeons and even ostriches. Another important point adopted was to publish the quarterly and bilingual (English/French) INFPD Newsletter electronically, with a combined printed version produced twice a year for members without e-mail facilities (INFPD, 1998). Since 1990, FAO/AGA has supported INFPD (formerly ANRPD) through technical and financial assistance. The preparation, publication and distribution of its Newsletter have been financially supported by FAO through annual author’s contracts. Furthermore, the preparation of a Manual on Rural Poultry has been entrusted to Prof. E. B. Sonaiya, INFPD Co ordinator.
After editing, this manual will be published and hopefully translated in French and in Spanish.

The rewarding collaboration between INFPD and FAO/AGA should continue. Joint INFPD/FAO activities have already been planned up to the year 2000. Since November 1998 a young professional, Dr. E. Fallou Guèye, has been assigned to FAO/HQ in order to co-ordinate the various joint INFPD/FAO activities.

A data bank on improved FP in LIFDCs will be initiated and the types and sources of information to be collected have been identified (FAO, 1997). Training sessions in rural FP development through refresher courses and study tours are contemplated. Furthermore, for more than twenty years FAO/AGA has identified, formulated, backstopped and monitored, with the financial assistance of UNDP and FAO’s Technical Co-operation Programme (TCP), projects to support FP development activities. Countries involved were Bangladesh, Burundi, Democratic Republic of Congo, Ethiopia, The Gambia, Honduras, Democratic Republic of Korea, Madagascar, Nigeria, Philippines, Rwanda, Tanzania, Turkey, Union of Myanmar, Vietnam and Zimbabwe.

In 1995, Mrs. Dr. Aichi J. Kitalyi, a livestock specialist from Tanzania was awarded the André Mayer Research Fellowship. Her 18-month research project focused on the “Village chicken production systems in rural Africa: Household food security and gender issues”. She made some recommendations on the most cost-effective targets for FAO’s Technical Assistance, which should be focused on poverty alleviation among rural women (Kitalyi, 1998).

The FAO Special Programme for Food Security (SPFS) was launched in 1994 by the FAO Director-General to respond to the urgent need to boost food production. In 1997, improved household poultry
production - either peri-urban or rural was identified as a key element in
the overall Special Programme for Food Security approach, and a major
activity of the SPFS diversification component. For this purpose, various
documents were prepared by AGA in English, French and Spanish and
include:
1. Livestock within the Special Programme for Food Security.
2. Guidelines for the inclusion of improved household poultry
production.
3. Standard format for the diversification component.

The SPFS (i.e. at 31 January 1999) covers 39 countries: 23 in
Africa, 10 in Asia and the Near East, 3 in Latin America, 2 in Europe
and 1 in Oceania. It is rapidly expanding and more than 80 countries are
expected to join the SPFS during the next few years. The collaboration
between SPFS and INFPD will grow simultaneously. The development
of South-South Co-operation in the field of Rural FP is encouraged
through the use of TCDC (Technical Co-operation among Developing
Countries) experts. For this purpose, specific technical packages to be
used in SPFS pilot and expansion phases are being prepared.

Since 1997, Telefood has provided another important support: up
to US$ 10,000 per group has been distributed for small-scale poultry
projects in several countries.

It is important to mention that other international organizations
such as CTA (Technical Centre for Agricultural and Rural Co-operation,
Wageningen, The Netherlands) and IDRC (International Development
Research Centre, Ottawa, Canada) have provided constant and valuable
support to the INFPD, since its creation.

Other international institutions and NGOs have also demonstrated
their interest in the course of recent years, namely the Australian Centre
for International Agricultural Research (ACIAR), Veterinaries-Sans-
Frontiers (VSF) and the World’s Poultry Science Association (WPSA). Many national institutions in developed and developing countries are also closely collaborating with INFPD. It is strongly hoped that this rewarding and much appreciated collaboration will continue, especially with the future institutionalization of the INFPD.

In developing countries, the backyard poultry sector represents the basis on which a sustainable, well adapted semi-commercial sub sector could be progressively developed. As sustainability assumes preservation of natural resources, as well as economic usability and social acceptance, this evolution should be conducted in the most appropriate socio-economic way, taking into account the specific local features and constraints to be overcome. This means that after collecting the appropriate data on a poultry sector in a specific environment, an appropriate model must be designed and tested at farm level. This work must be done by multidisciplinary teams to ensure that the FP husbandry systems are fully understood and that their constraints are clearly identified. Detailed information will help to develop appropriate interventions in areas such as disease prevention and control, predator control, suitable feeding and watering systems, improved poultry housing, genetic improvement and marketing of poultry products, etc. that can strengthen FP in developing countries.

Family poultry development programmes will then be easier to initiate, implement, monitor and evaluate. Furthermore, the data collected from the FP sector must be part of the data on the national economy as a whole and FP development must be seen as an integral part of the national development policy. The existence of data can help to properly inform policy makers.
In addition, some small trials, as indicated above, are being conducted in Africa under support from FAO’s Technical Co-operation Programme (TCP) and with some NGO’s assistance.

Such approaches have only started recently. A successful project is presently being conducted in Bangladesh under IFAD and DANIDA financial support and its first results were published in the Symposium on Rural Poultry Production, which was held during the XX World’s Poultry Congress in New Delhi in September 1996. The INFPD has been set up to co-ordinate research, training and/or extension in relation to FP production.

One of the objectives of the INFPD is to encourage higher standards that can sustainably increase the sub-sectors productivity. This will be achieved through collecting results, providing advice and disseminating information through its quarterly and bilingual Newsletter and its annual electronic conference on FP.

2.3 The Contribution of Poultry to Rural Development:

More than a billion people currently live in extreme poverty: these people are powerless, isolated, vulnerable and malnourished. At the 2000 World Food Summit in Rome, Heads of State renewed their commitment to halve hunger and malnutrition before the year 2015. The indications are, however, that progress is not being made at the required pace.

Indeed, the International Food Policy Research Institute (IFPRI) predicts that the number of malnourished children will actually increase by 25% to 30% before 2020 if no major action is taken.

2.4 The Role of Small Holders Poultry Production:

In developing countries nearly all families at the village level, even the poor and landless, are owners of poultry. Furthermore, poultry are mainly owned and managed by women and are often essential elements of female headed households. Poultry are socio-culturally
important with few religious taboos attached. Production is feasible at village level, where only low cost technology is needed to improve production considerably. Low investments only are required to achieve such change, land ownership is not a constraint, and village production is environmentally friendly (Upton, 2004).

The role of family poultry in poverty alleviation, food security and the promotion of gender equality in developing countries is well documented (Guèye, 2000). Family poultry production represents an appropriate system to contribute to feeding the fast growing human populations and to provide income to poor small farmers, especially women (Gujit, 1994; Alders, 1996; Kitalyi and Mayer, 1998). It makes good use of locally available resources, requiring low inputs. Though generally considered secondary to other agricultural activities by smallholder farmers, poultry production makes an important contribution to supplying local populations with additional income and high quality protein. Poultry products can be sold or bartered to meet essential family needs such as medicine, clothes and school fees. Village chickens are active in pest control, provide manure, are required for special festivals and are essential for many traditional ceremonies (Alders et al., 2003).

A recent study in Mozambique (Harun, 2001) showed how village poultry play a key role in the local economy, and how increased production has the potential to improve food security, assist in poverty alleviation and mitigate the adverse economic impacts of HIV/AIDS for rural populations.

2.5 Major Poultry Development Initiatives:

For many decades development agencies, international agencies, governments and non-government organizations have been interested in helping the family poultry industry to develop because they realized its potential. The pace and scope of such support have expanded over the
last 20 years and some major initiatives have been undertaken. They include, among others:

**The Bangladesh Model and its replications:**

Dolberg (2003) and Fattah (2000) describe the evolution in the work of the government of Bangladesh, which led to the development of the Bangladesh Poultry Development Model and has been very effective in reaching and involving poor women in economic development. Bangladesh is a good example of how poultry can have an impact on the empowerment of the poorest women and on poverty reduction (Nielsen, 1998). During the 1980s the Department of Livestock Services (DLS) and the Bangladesh Rural Advancement Committee (BRAC) developed a model for semi-scavenging poultry production, based on women groups. The idea was to replicate large-scale commercial poultry production with service, production and consumer units, but bring it down to the village level where women groups would act as the production units.

The main feature of the model is that the supply of inputs and services is turned into an income earning opportunity for poor people carefully sequencing its components and ensuring appropriate linkages between various actors. The focus is on poverty reduction, i.e. distribution of benefits, rather than on increasing the supply of eggs and poultry meat. The main components are the involvement of NGOs that have access to groups of very poor women, the provision by NGOs of micro-credit and training to help groups establish small, semi scavenging, egg-laying units, and special training for poultry workers, feed distributors and egg traders.

Dolberg (2003) contrasts the Bangladesh experience to that of India where, in some States, the commercial sector has a strong presence. He stresses that project ‘models’ need to be adapted the
conditions prevailing in different countries. The smallholder concept developed in Bangladesh is currently in an adaptation process to conditions in Malawi (Jensen, 2001; Gondwe, 2001) and Southern Africa (Ahmed, 2000). The adaptation process is rather complicated as all stakeholders have to be involved and need to be convinced that the poorest segment of the village population is capable of contributing and managing an income-generating activity based on loans.

2.6 The Network for Poultry Production and Health in Developing Countries:

The Network for Poultry Production and Health is based on the poverty alleviation concept developed in Bangladesh with an integrated poultry chain as income-generating activity. The concept has been institutionalised through the Danida/IFAD-supported Smallholder Livestock Development Project (Jensen, 1998, 2000).

The vision of the Network is to build up, through a multi-disciplinary approach, the institutional capacity in Denmark and to establish one million smallholder units per year in developing countries for a donor cost of US$100 or less per participating family. The Network employs a three-pronged strategy to reach the planned institutional capacity. It facilitates human resource development in Denmark and in developing countries; coordinates research and development related to dissemination of the concept; and provides support to planning of pilot projects and to project implementation.

Lack of accessibility to literature, such as documents, guidelines, manuals, etc. is a major constraint of poultry development practitioners (Jensen, 2000). Previous experiences are often lost and new projects or programmes start from scratch. Even though interest is increasing and more development professionals than ever before are involved in rural
poultry keeping, ways of communication and sharing experiences are still in the conception phase.

From 1983 the Australian Centre for International Agricultural Research (ACIAR) started to support work on the development of Newcastle Disease vaccine and delivery programmes, focusing on village chickens. Progress had been made in Southeast Asia and Africa with initiatives spearheaded by ACIAR through the promotion of an oral/eye-drop vaccine based on a naturally attenuated Newcastle disease strain with the characteristics of heat resistance and an ability to spread horizontally within a flock. The promotion of this vaccine has been significant in reducing ND in village poultry (Alders et al., 2001; Amakye-Anim et al., 1998; Spradbrow, 1993-94; Harun et al., 2001).

2.6.1 The International Network for Family Poultry Development (INFPD):

This network, which started as the African Network for Rural Poultry Development (ANRPD), was set up in 1989. The name was changed to INFPD in 1997. INFPD is mainly a network for information exchange, one of its objectives being to encourage higher standards of husbandry that can sustainably increase the productivity of family poultry units. The aim is to achieve this through collecting data and detailed information about family poultry production systems and disseminating the information and distilled advice through a trilingual (English, French and Spanish) newsletter, which is produced twice a year.

2.6.1.1 International donor efforts:

Smallholder poultry production has been a frequent sub-component of donor funded projects, for example in International Fund for Agricultural Development (IFAD) loan projects, usually targeting poorer rural women (Nabeta, 1997 and IFAD, 2003). The most common
type of support provided has been credit for small-scale poultry enterprises. When women are given a choice of loan projects, they often choose poultry rising. They are familiar with the activity and set-up costs are relatively low. Frequently IFAD projects have also included other support activities, such as the strengthening of animal health services, the training of beneficiaries in health and husbandry practices, and on- and off-farm adaptive research on topics related to poultry production. The traditional scavenging system has been more successful with the IFAD target group than new semi-intensive systems.

In 2001, the Food and Agriculture Organization (FAO) of the United Nations launched an initiative to facilitate and support the formulation and implementation of policies and institutional changes that have a positive impact on livestock dependent poor livelihoods. The basic rationale is derived from the realization that technology oriented projects in the livestock and related sectors have failed to deliver significant improvements in the livelihoods of the poor, and that an enabling institutional and policy environment is indispensable for enhancing the impact and sustainability of pro-poor interventions. Positive steps would include efficient, fair and equitable access to input and output markets, improved access to livestock services, and development of grass-roots organizations that increase the negotiating power of marginalized groups. The initiative is managed by the Pro-Poor Livestock Policy Facility (PPLPF) based at FAO headquarters in Rome, funded by DFID (Department for International Development, UK), and will be complemented by ‘regional hubs’ in South Asia, South-East Asia, the Horn of Africa, West Africa and the Andean region.

2.6.2 Non Government Organizations (NGOs) and other agencies:

NGOs play a crucial role in development and are often uniquely placed to target poor livestock keepers without the constraints and by
larger national institutions. However, Jensen and Dolberg (2002) have argued that NGO groups using poultry production as an important tool for targeting poverty alleviation, to be successful, must include reliable ways to document the achieved results and work in an institutional and political environment in which sharing of information is encouraged.

2.7 Constraints:

Many constraints to the development of smallholder poultry production need to be addressed. These comprise disease control, protection against various predators, better feeding, genetic improvements, marketing, training and management, access to production inputs, infrastructure and capital, farmer organization, and, foremost, conducive institutions and governmental policies. However, addressing any one or several of these constraints without attention to all will do little to improve the situation (Permin et al., 2000).

Poultry production has undergone rapid changes during the past decades due to the introduction of modern intensive production methods, new breeds and improved preventive disease control and bio-security measures. These intensive production methods place high demands on proper health, hygiene and management and require only a small, but very skilled labor force. This type of production has also been adopted in developing countries but the scope of adoption has been limited due to the high inputs and skills required. The progress in industrial poultry production methods has however had little effect on subsistence poultry production methods in rural and peri-urban areas, where inputs into disease control remain minimal. Although this is true in general, there are some geographical hot spots where industrial poultry production and small holder village poultry systems have both massively grown in close geographical proximity, notably in Thailand, Indonesia, and China.
The intensification of segments of poultry and pig industries, combined with and in proximity to areas of ever more dense human populations, in conjunction with the increasing ease of travel/transport, has led to ‘production’ environments, in which the spread and impact of formerly uncommon diseases, such as avian influenza, is greatly heightened and which promote the emergence of new diseases. Either these factors place animals in increased contact with a previously unfamiliar disease agents or their natural host, provide potential pathogens with a novel host, or favor increased dissemination, the prevalence of some of these factors is growing in Southeast Asia because of the particular rapid growth of livestock industries in the region (Hoffmann, 1998). These developments challenge the traditional disease control methods and indicate that new ways need to be found to prevent or control these emerging diseases.

The HPAI crisis in East Asia severely threatens the viability of the small-scale poultry sector in the region, directly through its dramatic spread and high mortality, but also indirectly through the drastic control measures applied, which rely on massive depopulation. In some countries preventive measures may be instituted which severely constrain participation of smallholders in poultry production, forcing them to leave the sector.

Up to date, policy in the poultry sector has concentrated on promoting technical aspects of poultry production. In economic terms, this has meant working to improve production efficiency. Many diseases have been controlled and the production levels have been increased.

These policies have been based on the assumption that improved technical efficiency is in itself a desired outcome without considering the wider effects, such as environmental, ecological and social stability.
Technical issues still dominate policies in the livestock sector. In a survey of Asian livestock policies Riethmuller (2002) found the issues reported to be of greatest importance were those related to production, infrastructure and marketing. Broader issues such as environmental effects, poverty alleviation and international issues were rarely mentioned. These responses suggest a policy focus on short-term issues with an emphasis on the potential for immediate effects rather than on an appreciation of longer-term more complex issues.

Increased investment in livestock production is needed given the rapidly growing demand for animal products and the important contribution of livestock to the incomes and welfare of the rural poor.

Investment, from private, public and international sources however needs to be guided by policies and institutions that promote equitable, sustainable, and environmentally friendly long-term outcomes.

A systems approach, with consultation among all contributing groups is required for the formulation of the above policies if smallholder poultry production development is to overcome the devastation of recent disease events as well as its normal constraints.

Most poor households around the developing world keep small flocks of chickens. These small-scale producers of eggs and poultry meat are often experiencing a very low level of productivity compared to well managed systems; for example, a scavenging hen lays only 30-40 eggs per year, while a well-managed battery hen lays 250-300 eggs annually.

Despite the low productivity the production can be quite profitable with marketable production from virtually no input. The relative low output is primarily caused by lack of management skills and knowledge of how to deal with diseases, feeding and marketing (Permin, et. al., 2000). Still, accounting for the major part of all meat produced in many developing countries, small-scale poultry production, being an
integrated component of nearly all rural, peri-urban and urban households, is of considerable significance to rural as well as national economy and is also an important source of animal protein (FAO, 2004). Predominantly women and children are in charge of poultry husbandry (Gueye, 2000). Generally, poultry scavenge in the vicinity of the house during daytime where they may be given a little grain or leftovers from the household as feed. At nighttime, poultry are kept inside the houses or in simple shelters or left in the trees to roost (Pedersen, 2002). Disease prophylactic measurements are scarce and high mortality rates are common (Pandey, 1992).

Studies in Nicaragua (Kyvsgaard, 1999, c.f. Permin, et al. 2000) and Mali (Wilson et al., 1987) have shown chicken mortality in the range of 30% to 40% within the first three to four months after hatching. In Nigeria,(Matthewman, 1977) and Tanzania (Yongolo et al., 2002) a mortality of more than 80% within one year after hatching was reported, and similar rates has been observed in Zimbabwe (Pedersen, 2002). The constraints for improving productivity are as mentioned multi-factorial. Beside diseases, other important factors are inadequate management systems, lack of supplementary feeding, predators, and inappropriate breeds (Bagust, 1994 and 1999; Pedersen 2002).

In the case of backyard poultry, due to the scavenging habits, feed costs are kept at a low level, which in cash terms often make small-scale production profitable. The long-term profitability is more secure when simple technologies, such as vaccination, anti-parasitic medication, housing and equipment and use of local feedstuffs, are adapted locally. The effect of vaccination, anthelmintics, feed supplementation, housing and management has been studied recently at village level in a number of countries, notably Bangladesh (Network, 2002). The results are highly promising, showing a decrease in bird mortality caused by Newcastle
Disease from 21% to 7% by using vaccination, a significant increase in growth and egg production by using anthelmintics, an the highest net profit for the farmers using only 60 g feed supplementation per day for semi-scavenging birds (Network, 2002). Other simple management procedures such as decreasing the broody period have long been shown to increase in egg production drastically in indigenous birds (e.g. Prasetyo, 1985, c.f. Roberts, 1999). Finally, the two use of improved crossbreeds for smallholders have been shown to have a remarkable positive effect (Sorensen, 1999), although the effect will depend highly on the skills and knowledge of the farmer, as improved breeds may be more vulnerable.

In terms of income generation, keeping small flocks of 5-50 birds under improved management may make a big difference for poor farmers in many countries. “Egg-money” is a well-known term in many countries, signifying the money that is foremost earned by a woman in a poor household, and which she may decide herself on how to be spent (Gueye, 2000). Normally egg-money will be spent on cost relating to the children, i.e. school fees, clothes or food for the children.

Experience from around the world has shown that with relatively simple technical measures, smallholders’ production of meat and egg from indigenous or improved breeds can be improved. However, adoption of new technologies is a slow process for most small-scale farmers (Larsen, 2002). The right approach for technology transfer needs to be developed and tested with and by small farmers (Dilts, 1995).

Unfortunately, the majority of small-scale producers around the world are still today depending on national extension systems. These are in most places either completely lacking or highly dysfunctional due to budgetary limitations and severe reductions in manpower caused by a general reconstruction of many national advisory systems (Hooton, et
al., 2003). This calls for a participatory approach, whereby farmers may themselves develop the necessary “enabling environment” for them to demand the necessary inputs, in particular in terms of veterinary services and training.

Such a demand-driven process will often have a slow start, as it requires training of farmers in more than techniques. Training relating to organizational skills and general empowerment often becomes more important in the initial phase. The Farmer Field School approach encompasses this as farmers are trained in organizational and technical skills in a combined process (Dilts et al., 1995).

How to introduce new technologies for small-scale producers?

In terms of technologies, it is important to acknowledge the need for a step-wise approach, whereby simple technologies are gradually taken over by more sophisticated ones. Improved poultry production system relies primarily on a sustained vaccination schedule against e.g. Newcastle Disease and a few other epidemic diseases such as Fowl Pox. Consequently, training in vaccination and medication will often be an important starting point (Alders et al., 2002). Vaccination campaigns are essential, but not sufficient. Issues relating to housing, feeding and general management are just as vital for the production to be viable (Pedersen, 2002).

Before deciding on any type of intervention, it is imperative to introduce the use of simple cost-benefit calculations making it possible for small-scale farmers to estimate the financial implication of a given activity. A classic project approach has been to give out birds, feed or vaccinations for free without transferring the necessary understanding of the cost-benefits implications to the farmers. In order for the farmer to assess possibilities, it is essential that any proposed intervention be preceded both by a simple cost-benefit analysis and a risk assessment. A
cost-benefit analysis is never a static measure of profitability, it always relates to the context that small-scale producers are acting in. The “Training and Visit” (T&V) system promoted throughout the eighties by the World Bank, FAO (Benor, & Baxtor, 1984; Bagchee, 1994) and many donors, has shown to be largely inefficient in developing sustainable progress, but despite its relative failure, it is still practiced as a role model in some countries (e.g. Bangladesh). “Model Farmers” is another method for transfer of technology promoted by FAO and other and widely adopted in developing countries. However, the expected “snow-ball effect”, whereby neighboring farmers may learn from the model farmers does not always take place with the expected pace. This has made the approach of little impact, if the goals are replicable models to reach out to millions of farmers (Jensen and Dolberg, 2002). Despite its possible limitations, the ‘model farmer’ approach is still promoted in some regions as means of reaching out to many farmers (Gueye, 2003).

In Denmark and other industrialized countries, small-scale poultry producers have since the 1980’es used an experience exchanges system called ERFA-groups. Farmers with the same type of production meet on regularly basis to discuss experience, problems and solutions within their specific context (Skejby, 2002). This kind of self-help groups have been particular successful with poultry producers trying out new methods in developing their enterprises (Danish farmer, pers. Comm.). In Asia, in the late-seventies, a somewhat similar concept called The Farmer Field School (FFS) was developed. This was a participatory training programme designed to help farmers become better in utilizing what is called Integrated Pest Management (IPM) in their rice fields. The immediate objective of the IPM Farmer Field School was to develop the skills and understanding of the farmers on how to observe and analyze their fields, thereby controlling growth and pests by other means than
simple use of pesticides or fertilizers (van de Flirt et al. 1995, Dilts, 2001, Simpson and Owens, 2002). FFS3 activities are primarily based on the ideas formulated by Kolb, (1984) as the principle of experiential learning. In the field, farmers are during each FFS session guided through Kolb’s learning cycle, first by concrete experience in the field, then by observation and reflection followed by generalization and abstract, conceptualization, and finally by trying out new ideas through active experimentation under field conditions.

Farmer Field Schools were implemented as season-long series of weekly or bi-weekly meetings (e.g. 4-5 months from planting to harvesting of a rice crop). Farmers normally gather in groups of 25 and meetings take place either in the village hall or in a nearby extension centers (van der Fliert et al, 1995).

2.8 Poultry Production Systems in the Sudan:

Similar to many African and Asian countries, the Sudan remained dependent on the indigenous local strains as main source of poultry meat and eggs up to the early fifties, when the nucleus of poultry farming industry was started by the Khartoum North Government Unit in cooperation with the USAID Mission at that time.

The unit served as:

-Research unit to probe in the potential and local strains and crosses with foreign breeds.
-Study the adaptability of various foreign breeds to the Sudan conditions.
-Demonstration and extension unit.
-Supply unit mainly for baby chicks and feed.

Sizable data were obtained especially on poultry nutrition and on crossing. The findings indicated poor potentials of local birds and
supported work with foreign breeds and strains especially the Leghorn for egg production.

The findings of the unit geared the momentum and by 1960 there were 10 poultry farms around Khartoum state.

By 1969 a Sudanese-Research Team laid down a plan to modernize the business by increasing production and decreasing costs and by raising the per capita consumption from 29.9 eggs, as was estimated in 1969, to 36 eggs by 1975.

The plan had two options:

- The Government sector to supply chicks and private sector to increase size of production and number of operating units.
- The second option was to build a completely integrated project to meet the country's demand.

Both options were not implemented, as farmers were reluctant to put large investments in the poultry business due to fear of losses and disease hazards.

Another reason was the withdrawal of the Agricultural Bank from financing poultry business and the limited credit resources of farmers.

But in spite of that and with the progress of years more interest developed in the poultry business and by the middle of the seventies there were about 100 layer units of about 5000-20000 birds, there were 26 hatcheries and few feed processing units. The number of imported day-old chicks in 1970-71 was 140135 from European countries and Egypt.

By 1977 there were about 120 layer units with potential capacity of 200000 layers producing about 28 million eggs.

In 1979 the first large size and integrated project-the Sudanese Kuwait Poultry Project, came into being as a four phases project to produce 50 million broilers at full swing.
In 1984 the Arab Sudanese Poultry Company- a subsidiary company of the Arab Authority for Agricultural Development and Investment started production in phase one of the three phases to produce 43.6 million table eggs and 6.3 million broilers by the end of phase three.

By 1987 the Arab Company for Livestock Investment and Development Project to produce 15 million eggs and two million broilers came into business as one phase project.

More other sizable and integrated projects are on the pipeline.

In the area of baby chick production the Animal Production Public Corporation supported by the FAO started in phase one of the two-phased project to produce 2 million unsexed baby chicks.

This period also witnessed an era of large scale feed plants of capacities of 10-30 tons/hours.

A survey in 1983 indicated that out of 150 farm units only 96 were active at that time. These units accommodated 512469 birds of which 284469 were layers giving a daily output of 8645 dozen eggs. (Osama, 1989).

The population was distributed as follow:

<table>
<thead>
<tr>
<th>Size</th>
<th>5-10000</th>
<th>10-15000</th>
<th>15-20000</th>
<th>20-25000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of units</td>
<td>76</td>
<td>11</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

2.9 Demand:

2.9.1 Trends of demand:

In almost all Arab countries growth in demand for red meat is much faster than growth in production leading to decline in self-sufficiency-rates (SSR) which is a healthy indication for the Sudan to increase economic poultry production for local consumption to allow for a margin for red meat export. Production of poultry meat and eggs has in
most cases increased at similar rates as demand and self-sufficiency-rates (SSR) has been obtained in most countries.

Poultry meat can replace a sizable part of red meat for export, Supporting factors include:

- Rapid changes in food habits.
- Urbanization and dependence on industrial food production.
- Rising incomes.
- Population increase.
- Changes in culture and social status.

2.10 Poultry Production Systems in Khartoum State:

There are two poultry production systems in Khartoum state, traditional and commercial type. The traditional type is practiced by individual households for domestic consumption, where as, the commercial type is practiced by individual poultry producers in open-system and by technology using companies in the closed and semi closed-systems.

2.10.1 The Traditional Poultry Production System:

The traditional type was found at the peripheries of the state and it plays an important role in egg production in the state, however, there is no accurate information in these types of production farms. In this type the birds are fully exposed to the natural environment and the producers are reared local breeds (Baladi types) which are adaptable to the Sudan's climatic conditions. The local breed produces, according to the Animal Resources Administration estimates, 6-7 eggs monthly.

The following are the most important breeds (varieties) in the traditional type:
The Large Baladi:
   It is the mostly reared local breed in Khartoum state it was mainly found in the Northern region. It is multi-colored, producing 40-50 eggs per year and weight 1.5 kg.

The Bare-neck:
   It is found in southern Sudan; produce 50-60 eggs per year and weigh less than the large baladi.

The Bitwil:
   It is found in Kordofan state, especially in the Nuba-mountains area. It weight 0.50-0.75 kg, produce 70-80 eggs per year.
   Village chickens can be found in all developing countries and play a vital role in many poor rural households (Alders 2004; Alexander et al. 2004).

2.10.2 The Commercial Poultry Production System:
   Under this type, poultry production is practiced by individual poultry producers in the open-system and semi closed-system and by large companies in the closed system.

2.10.2.1 Poultry Production in the Open-System:
   In this system poultry production is practiced by private producers in farms with open-sided houses, good ventilation, waterproof roof and walls that provide shelter against wind and rain.
   The day-old chicks are housed in brooders or in the same layer houses surrounded by fences under the light until the age of two weeks. The most adaptable breeds to the local environmental conditions are the White leghorn, Hisex, and Bovan which are the commonly used strains of this breed, are reared under good managerial practices. These birds are fed on rations with good nutritive value and vaccinated against the most prevailing poultry diseases (Agricultural Planning Studies, 1992).
2.10.2.2 Poultry Production in the Closed-System:

This type of rearing started in Khartoum state at the mid eighties by the large companies. In this system poultry, flocks are intensively reared in closed houses using air conditioners to alleviate the weather conditions.

2.10.2.3 Poultry Production in the Semi Closed-System:

This type of rearing introduced recently by large companies to decrease relatively the cost of production. In this system, poultry flocks are seasonally intensively reared in closed houses using air conditioners to alleviate the weather conditions just only in the summer.

The Large three poultry companies in Khartoum State are:
1) Arab Sudanese Poultry Company.
2) Arab Company for Animal Resource Development.

The most important company is Arab Sudanese Poultry Company.

Arab Sudanese Poultry Company

It is an agro-industrial project that is located at Taiba Alhassanab, 25 km south of Khartoum. It is a project of Arab Authority for Agricultural Investment and Development (AAAID) which was established in September 1980. It occupies about 5000 feddans and aims at increasing white meat and eggs production and development of poultry industry in Sudan.

The contributors to the capital of this project are:

<table>
<thead>
<tr>
<th>Contributor</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAAID</td>
<td>42.5%</td>
</tr>
<tr>
<td>Unity Bank (Sudan)</td>
<td>20.0%</td>
</tr>
<tr>
<td>Saudi Arabia Government</td>
<td>12.5%</td>
</tr>
<tr>
<td>Kuwaiti Government</td>
<td>12.5%</td>
</tr>
<tr>
<td>Iraq Government</td>
<td>12.5%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
</tr>
</tbody>
</table>
Chapter Three
Materials and Methods

3.1 Data Collection:

This study was conducted in Khartoum State, the capital of Sudan. Khartoum State is composed of three provinces: Khartoum, East Nile and Omdurman. Each one contains small, medium and large farms for egg and broiler production. The Closed system is concentrated in Khartoum, semi-closed in Omdurman and the open-system in East Nile. A questionnaire was prepared in order to obtain information on quantities and costs of inputs related to poultry production, yield and sale prices of the products, besides socio-economic questions such as level of education and experience of poultry producers.

Farm lists were obtained from state Ministry of Agriculture, Animal Resources and Irrigation.

Secondary data were collected from the State Ministry of Agriculture, Animal Resources and Irrigation, the Arab Organization for Agricultural Development and other relevant sources such as previous studies and information published in the internet.

3.2 Sampling Design:

The major differences among poultry farms in Khartoum state are the type of system and the size of poultry flock. A multi-stage stratified random sample was used to increase homogeneity of sampling units. Stratification means dividing the sample into a number of homogenous groups depending on information available from the sampling frame.

In order to increase the degree of precision of the result, poultry farms were stratified based on the size of the flock into three groups:
1-Small farms with less than 5000 birds.
2-Medium farms with 5000-10000 birds.
3-Large farms with more than 10000 birds.
Large and medium group contains feed producing and non-feed producing farms.

3.3 Sample Size:

Generally, it is known that, as sample size increases, the degree of precision of the results increases. But, increasing sample size means increased survey cost. Thus, a compromise between cost and precision must be stated. There were 332 farms in the state. Due to the limited resources and difficulty of transportation among the poultry farms in the three provinces in Khartoum state, the sample was chosen to include 48 poultry farms in the three strata (22 small farms, 12 medium farms and 14 large farms). Random samples were taken from each stratum. The selected sample size (48 farms) represented about 15% of the population.

3.4 Data Analysis:

Statistical computer software known as Statistical Package for Social Scientists (SPSS) was used to analyze the socio-economic data after coding and revision. Then the data was presented in tables, cross-table, charts, diagrams, percentages and means.

The main technique of analysis will be used the chi-square analysis to identify and determine the factors that influence poultry factors of production and marketing. Besides coefficient of variation, analysis will be used to measure the magnitude of variability associated with poultry production among different schemes in Khartoum state and compare it to other countries.

A budget analysis was made for the Feed, Day-old chicks, Vaccines and Drugs, Labor, Electricity and Water, Housing and Equipment, total cost of production, yield, gross returns and net margins. Cost estimates were used to determine the percentage of each item in the total cost of production. The margins for the different farm types were compared to determine the most efficient one.
Chapter Four
Results and Discussion

This Chapter deals with the analysis of survey results of socio-economic characteristics and cost of production in the open, semi-closed and closed-system farms in Khartoum State. Average yields and prices at the time of survey were used in the analysis.

There are certain characteristics of poultry producers that affect their access to the factors of production and accordingly the poultry production. These characteristics are as educational level and occupation. In spite of the positive responses to most of the questions, the respondents were conservative in answering questions regarding their incomes.

Table (4.1) indicates that, 2% of poultry producers had secondary school education and 98% were post-graduates. Therefore, most of them received higher education which means that, the application of improved production techniques is possible. This better educational level of poultry producers in Khartoum state is attributed to that, Khartoum is the capital of the Sudan and its population gets better education and greater awareness and has better wealth status compared to other parts of Sudan.

There was some variation in producers regarding occupation. The outstanding feature is that, business represented 70% of poultry producers, whereas, governmental officials and veterinarians constituted 14% and 16% of producers, respectively. This may be due to less jobs offered for them Table (4.2).

Poultry production in the open-system farms was practiced separately or together with other agricultural activities. Table (4.3) shows that, 56% of poultry farms were producing milk, vegetables and/or fruits, i.e., 56% of farms were mixed farms. Also 28% of farms
were specialized farms and poultry production is the only source of income for these farms. The majority of poultry producers kept dairy cows for milk production besides the original poultry production.

Table (4.4), indicates that, 48.2% of the total number of farms in the State were found in East Nile province, 43.7% in Khartoum and 8.1% in Omdurman province. This may be due to mostly land used for building new extensions to accommodate more people especially the displaced.

Table (4.5) indicates that, 64.2% of total number of farms is small-sized farms, 19.6% are medium and 16.2% are large-sized farms. This may be due to the limited sources of the capitals or practices of other activities with poultry production in the same farms and/or due to high cost of inputs especially day-old chicks and feed cost. Table (4.6) indicates that, 45.8% of the sample unit are small-sized farms, 25% are medium and 29.2% are large-sized farms.
Table (4.1): Distribution of Poultry Producers by Education Level

<table>
<thead>
<tr>
<th>Education Level</th>
<th>Number of Producers</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermediate School</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Higher Secondary School</td>
<td>2</td>
<td>4.17</td>
</tr>
<tr>
<td>Graduate</td>
<td>46</td>
<td>95.83</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>48</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

(Source: Field Survey, 2006)

Table (4.2): Distribution of Poultry Producers by their Occupation

(Source: Field Survey, 2006)

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Number of Producers</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Governmental Officials</td>
<td>1</td>
<td>2.1</td>
</tr>
<tr>
<td>Businessmen</td>
<td>35</td>
<td>72.9</td>
</tr>
<tr>
<td>Veterinarians</td>
<td>12</td>
<td>25</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>48</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Table (4.3): Distribution of Poultry Producing Farms by Activities Other than Poultry Production

<table>
<thead>
<tr>
<th>Other Activities</th>
<th>Number of Producers</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nil</td>
<td>25</td>
<td>52.1</td>
</tr>
<tr>
<td>Milk Production</td>
<td>15</td>
<td>31.3</td>
</tr>
<tr>
<td>Milk, Vegetables and/or Fruits</td>
<td>8</td>
<td>16.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>48</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
Table (4-4): Distribution of the Poultry Farms in Khartoum state

<table>
<thead>
<tr>
<th>Province</th>
<th>Number of Farms</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Nile</td>
<td>160</td>
</tr>
<tr>
<td>Khartoum</td>
<td>145</td>
</tr>
<tr>
<td>Omdurman</td>
<td>27</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>332</strong></td>
</tr>
</tbody>
</table>

(Source: Animal Survey in Khartoum State, June 2006)

Table (4-5): Distribution of the Poultry Farms in the State According to the Size of the Flock

<table>
<thead>
<tr>
<th>Size of the flock</th>
<th>Number of Farms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 5000 birds</td>
<td>213</td>
</tr>
<tr>
<td>5000-10000 birds</td>
<td>65</td>
</tr>
<tr>
<td>More than 10000</td>
<td>54</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>332</strong></td>
</tr>
</tbody>
</table>

(Source: Animal Survey in Khartoum State, June 2006)

Table (4-6): Distribution of Poultry Farms in the Sample Units According to the Flock Size

<table>
<thead>
<tr>
<th>Size of Flock (Farm)</th>
<th>Number of Producers</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small (less than 5000 birds)</td>
<td>22</td>
<td>45.8</td>
</tr>
<tr>
<td>Medium (5000-10000 birds)</td>
<td>12</td>
<td>25</td>
</tr>
<tr>
<td>Large (more than 10000 birds)</td>
<td>14</td>
<td>29.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>48</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

(Source: Derived from Animal Survey in Khartoum State, June 2006).
4.1.1 Socio Economic Characteristics of Producers in the three Locations:

Data showing the effect of location on socio-economic characteristics are presented in Table (4.7). Throughout the data there is no significant different between three locations in the education level, land status, labor type or labor experience, but there is significant difference in the farm history.

4.1.2 Economic Values in the three Locations:

The economic values data are presented in Table (4.8). Throughout the data there is no significant different between three locations in the capital source, but there is significant difference in the budget analysis, marketing chain, delivery and flock size.

4.1.3 Production Techniques in the three Locations:

The production techniques data are presented in Table (4.9). Throughout the data there is no significant difference between three locations in the records presents, flock type, chick source and feed source, but there is significant difference in the farm system.

4.1.4 Socio-economic characteristics of the producers of the two types:

The socio-economic characteristics data are presented in table (4.10). Throughout the data, there is no significant difference between the two types in the education level, farm history, land status and labor experience. However, there is a significant difference in the labor type.

4.1.5 Economic values of the two types:

The economic values data are presented in table (4.11) throughout the data there is no significant difference between the two types in capital source, budget analysis, market chain, delivery and flock size.
4.1.6 Production techniques of the two Types:

The production techniques data are presented in table (4.12). Throughout the data there is no significant difference the two types in the production techniques.
Table (4.7): Socio-Economic Characteristics of Producers in the three Locations

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Options</th>
<th>East Nile%</th>
<th>Khartoum%</th>
<th>Omdurman%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education level</td>
<td>1.Intermediate</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2.Secondary</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>3.University</td>
<td>30.4</td>
<td>34.8</td>
<td>34.8</td>
</tr>
<tr>
<td>Farm history</td>
<td>1.2years</td>
<td>22.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>22.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>55.6&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>2.4years</td>
<td>24.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>37.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>37.9&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>3.more than 5years</td>
<td>70.0&lt;sup&gt;c&lt;/sup&gt;</td>
<td>30.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Land Status</td>
<td>1.Owned</td>
<td>33.3</td>
<td>41.7</td>
<td>25.0</td>
</tr>
<tr>
<td></td>
<td>2.Rent</td>
<td>29.0</td>
<td>29.0</td>
<td>41.9</td>
</tr>
<tr>
<td></td>
<td>3.Sharing</td>
<td>60.0</td>
<td>40.0</td>
<td>0</td>
</tr>
<tr>
<td>Labor type</td>
<td>1.Permanent</td>
<td>47.8</td>
<td>30.4</td>
<td>21.7</td>
</tr>
<tr>
<td></td>
<td>2.seasonal</td>
<td>21.1</td>
<td>26.3</td>
<td>52.6</td>
</tr>
<tr>
<td></td>
<td>3.1/and 2</td>
<td>16.7</td>
<td>66.7</td>
<td>16.7</td>
</tr>
<tr>
<td>Labor experience</td>
<td>1.trained</td>
<td>52.9</td>
<td>29.4</td>
<td>17.6</td>
</tr>
<tr>
<td></td>
<td>2.untrained</td>
<td>25.0</td>
<td>37.5</td>
<td>37.5</td>
</tr>
<tr>
<td></td>
<td>3.1/and 2</td>
<td>14.3</td>
<td>28.6</td>
<td>57.1</td>
</tr>
</tbody>
</table>

Mean values in the same row having different superscripts, differ significantly (P < 0.05).
Table (4.8): Economic Values in the three Locations

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Options</th>
<th>East Nile%</th>
<th>Khartoum%</th>
<th>Omdurman%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Capital source</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. government</td>
<td>50.0</td>
<td>50.0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2. sharing</td>
<td>50.0</td>
<td>0</td>
<td>50.0</td>
<td></td>
</tr>
<tr>
<td>3. private</td>
<td>31.0</td>
<td>33.3</td>
<td>35.7</td>
<td></td>
</tr>
<tr>
<td><strong>Budget analysis</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. found</td>
<td>21.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>43.2&lt;sup&gt;c&lt;/sup&gt;</td>
<td>35.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>2. not found</td>
<td>72.7&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td>27.3&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Market chain</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. whole seller</td>
<td>54.2&lt;sup&gt;c&lt;/sup&gt;</td>
<td>20.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>25.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>2. retailer</td>
<td>60.0&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td>40.0&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>3. various</td>
<td>0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>57.9&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
<td>42.1&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Delivery</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. farm gate</td>
<td>82.4&lt;sup&gt;c&lt;/sup&gt;</td>
<td>11.8&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>2. buyer place</td>
<td>28.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>28.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>42.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>3. various</td>
<td>0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>50.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>50.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

Mean values in the same row having different superscripts, differ significantly (P < 0.05).
Table (4.9): Production Techniques in the three Locations

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Options</th>
<th>East Nile%</th>
<th>Khartoum%</th>
<th>Omdurman%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>System</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. closed</td>
<td>0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>100.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>2. semi closed</td>
<td>0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>100.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>3. open</td>
<td>41.0&lt;sup&gt;c&lt;/sup&gt;</td>
<td>28.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>30.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td><strong>Records</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. keeps records</td>
<td>34.1</td>
<td>36.4</td>
<td>29.5</td>
<td></td>
</tr>
<tr>
<td>2. no records</td>
<td>25.0</td>
<td>0</td>
<td>75.0</td>
<td></td>
</tr>
<tr>
<td><strong>Flock type</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. layer</td>
<td>42.3</td>
<td>30.8</td>
<td>26.9</td>
<td></td>
</tr>
<tr>
<td>2. broiler</td>
<td>22.7</td>
<td>36.4</td>
<td>40.9</td>
<td></td>
</tr>
<tr>
<td><strong>Chick source</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. local companies</td>
<td>34.8</td>
<td>30.4</td>
<td>34.8</td>
<td></td>
</tr>
<tr>
<td>2. on farm</td>
<td>0</td>
<td>100.0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Feed source</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. on farm</td>
<td>36.8</td>
<td>31.6</td>
<td>31.6</td>
<td></td>
</tr>
<tr>
<td>2. from market</td>
<td>31.0</td>
<td>34.5</td>
<td>34.5</td>
<td></td>
</tr>
</tbody>
</table>

Mean values in the same row having different superscripts, differ significantly (P < 0.05).
Table (4.10): Socio-economic characteristics of the producers of the two types

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Options</th>
<th>Boiler%</th>
<th>Layer%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. intermediate</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2. secondary</td>
<td>0</td>
<td>100.0</td>
</tr>
<tr>
<td></td>
<td>3. university</td>
<td>47.8</td>
<td>52.2</td>
</tr>
<tr>
<td>Farm history</td>
<td>1. 2years</td>
<td>55.6</td>
<td>44.4</td>
</tr>
<tr>
<td></td>
<td>2. 4years</td>
<td>51.7</td>
<td>48.3</td>
</tr>
<tr>
<td></td>
<td>3. more than 5</td>
<td>20.0</td>
<td>80.0</td>
</tr>
<tr>
<td>Land status</td>
<td>1. owned</td>
<td>33.3</td>
<td>66.7</td>
</tr>
<tr>
<td></td>
<td>2. rent</td>
<td>54.8</td>
<td>45.2</td>
</tr>
<tr>
<td></td>
<td>3. sharing</td>
<td>20.0</td>
<td>80.0</td>
</tr>
<tr>
<td>Labor type</td>
<td>1. permanent</td>
<td>26.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>73.9&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>2. seasonal</td>
<td>73.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>26.3&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>3. 1/and2</td>
<td>33.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>66.7&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Labor experience</td>
<td>1. trained</td>
<td>41.2</td>
<td>58.8</td>
</tr>
<tr>
<td></td>
<td>2. untrained</td>
<td>50.0</td>
<td>50.0</td>
</tr>
<tr>
<td></td>
<td>3. 1/and2</td>
<td>42.9</td>
<td>57.1</td>
</tr>
</tbody>
</table>

Mean values in the same row having different superscripts, differ significantly (P < 0.05).
### Table (4.11): Economic values of the two types

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Options</th>
<th>Boiler%</th>
<th>Layer%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Capital source</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. government</td>
<td>25.0</td>
<td>75.0</td>
<td></td>
</tr>
<tr>
<td>2. sharing</td>
<td>0</td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td>3. private</td>
<td>50.0</td>
<td>50.0</td>
<td></td>
</tr>
<tr>
<td><strong>Budget analysis</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. found</td>
<td>45.9</td>
<td>54.1</td>
<td></td>
</tr>
<tr>
<td>2. not found</td>
<td>45.5</td>
<td>54.5</td>
<td></td>
</tr>
<tr>
<td><strong>Market chain</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. whole saler</td>
<td>33.3</td>
<td>6607</td>
<td></td>
</tr>
<tr>
<td>2. retailer</td>
<td>40.0</td>
<td>60.0</td>
<td></td>
</tr>
<tr>
<td>3. various</td>
<td>63.2</td>
<td>36.8</td>
<td></td>
</tr>
<tr>
<td><strong>Delivery</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. farm gate</td>
<td>35.3</td>
<td>64.7</td>
<td></td>
</tr>
<tr>
<td>2. buyer place</td>
<td>28.6</td>
<td>71.4</td>
<td></td>
</tr>
<tr>
<td>3. various</td>
<td>58.3</td>
<td>41.7</td>
<td></td>
</tr>
</tbody>
</table>

a, b

Mean values in the same row having different superscripts, differ significantly (P < 0.05).
Table (4.12): Production techniques of the two Types

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Options%</th>
<th>Boiler%</th>
<th>Layer%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>System</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. closed</td>
<td>40.0</td>
<td>60.0</td>
<td></td>
</tr>
<tr>
<td>2. semi closed</td>
<td>25.0</td>
<td>75.0</td>
<td></td>
</tr>
<tr>
<td>3. opened</td>
<td>48.7</td>
<td>51.3</td>
<td></td>
</tr>
<tr>
<td><strong>Records</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. keeps records</td>
<td>45.5</td>
<td>54.5</td>
<td></td>
</tr>
<tr>
<td>2. no records</td>
<td>50.0</td>
<td>50.0</td>
<td></td>
</tr>
<tr>
<td><strong>Chick source</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. local companies</td>
<td>45.7</td>
<td>54.3</td>
<td></td>
</tr>
<tr>
<td>2. on farm</td>
<td>50.0</td>
<td>50.0</td>
<td></td>
</tr>
<tr>
<td><strong>Feed source</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. on farm</td>
<td>31.6</td>
<td>68.4</td>
<td></td>
</tr>
<tr>
<td>2. from market</td>
<td>55.2</td>
<td>44.8</td>
<td></td>
</tr>
</tbody>
</table>

a, b
Mean values in the same row having different superscripts, differ significantly \((P < 0.05)\).
4.1.7 Variation of Broiler Production Costs per bird between the three Locations:

Analysis of cost per bird of the broiler production in the three locations indicates that, there is no significant difference in average cost per bird the three locations, but there is a significant difference in the net profit per bird. As mentioned companies used closed-system concentrated in Khartoum province and it may be to this with high prices of their products in the market which consumers prefer it and that refer to as good process of its products, Table (4.13).

4.1.8 Variation of Egg Production Costs per bird between the three Locations:

Table (4.14) indicates that, there is no significant difference between the three locations in rearing average cost per bird of the egg production, net profit per bird at 4.5 months, production average cost per bird, but there is a significant difference in the net profit per bird at the end of the production cycle. As mentioned companies used closed-system concentrated in Khartoum province and it may be to this with high prices of their products in the market which consumers prefer it and that refer to as good process of its products.
Table (4.13): Variation in the Broiler Production Costs per bird between the three Locations:

<table>
<thead>
<tr>
<th>Parameters</th>
<th>East Nile</th>
<th>Omdurman</th>
<th>Khartoum</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Revenue</td>
<td>8.394 SDG</td>
<td>9.344 SDG</td>
<td>9.116 SDG</td>
<td>0.62</td>
</tr>
<tr>
<td>Average Cost per kilogram</td>
<td>6.555 SDG</td>
<td>7.278 SDG</td>
<td>6.150 SDG</td>
<td>0.33</td>
</tr>
<tr>
<td>Average Net Profit per kilogram</td>
<td>1.839 SDG(^a)</td>
<td>2.066 SDG(^b)</td>
<td>2.966 SDG(^c)</td>
<td>0.34</td>
</tr>
</tbody>
</table>

(Source: Field Survey, 2006)

\(a, b\)

Mean values in the same row having different superscripts, differ significantly \((P < 0.05)\).
Table (4.14): Variation in the Egg Production Costs per bird between the three Locations

<table>
<thead>
<tr>
<th>Parameters</th>
<th>East Nile</th>
<th>Omdurman</th>
<th>Khartoum</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Revenue per bird at 4.5 months of age</td>
<td>14.664 SDG</td>
<td>15.428 SDG</td>
<td>16.125 SDG</td>
<td></td>
</tr>
<tr>
<td>Rearing Average Cost Per bird (4.5 months)</td>
<td>9.296 SDG</td>
<td>10.571 SDG</td>
<td>10.375 SDG</td>
<td>1.6</td>
</tr>
<tr>
<td>Net Profit Average per Bird (4.5 months)</td>
<td>5.368 SDG</td>
<td>4.857 SDG</td>
<td>5.750 SDG</td>
<td>0.3</td>
</tr>
<tr>
<td>Total Revenue per bird at the end of the Production Cycle</td>
<td>88.383 SDG</td>
<td>89.450 SDG</td>
<td>94.400 SDG</td>
<td></td>
</tr>
<tr>
<td>Production Average Cost Per bird (14 months)</td>
<td>51.615 SDG</td>
<td>44.881 SDG</td>
<td>46.121 SDG</td>
<td>2.1</td>
</tr>
<tr>
<td>Net Profit Average per bird at the end of Production Cycle (14 months)</td>
<td>36.768 SDG</td>
<td>44.569 SDG</td>
<td>48.279 SDG</td>
<td>3.4</td>
</tr>
</tbody>
</table>

(Source: Field Survey, 2006)

a, b

Mean values in the same row having different superscripts, differ significantly (P < 0.05).
4.2 Analysis of the Cost Structure of Egg Production in the Open and Closed-System Farms:

The main cost items are feed, day-old chicks, labor, vaccines and drugs, electricity and water and housing and equipment costs.

4.2.1 Feed cost:

Feed cost is an important cost item and according to the survey results, it constituted about 70.3% and 67.5% of the total cost of egg production in the feed-producing and non-feed producing farms in the open-system farms, respectively, Table (4.17). Whereas in the closed-system farms it was found to amount to 73% and 44% of the total cost of egg and broiler production, respectively. The life span of the laying hen consists of two periods, rearing and production periods. Different feed intake estimated as, (51.8g/bird/day) and (85g/bird/day), respectively in the open-system for egg production. In the closed-system farms, consumption of feed in the rearing and production periods is (51g/bird/day) and (8.804g/bird/day), respectively, whereas for broiler production, consumption of feed is (60.07g/bird/day).
Table (4.15): Feed Rations for Layers as formulated by Ellis, 1981

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum</td>
<td>55.1</td>
</tr>
<tr>
<td>Wheat Bran</td>
<td>15.0</td>
</tr>
<tr>
<td>Cotton Seed Meal</td>
<td>3.0</td>
</tr>
<tr>
<td>Groundnut Meal</td>
<td>10.0</td>
</tr>
<tr>
<td>Sesame Meal</td>
<td>5.0</td>
</tr>
<tr>
<td>Oyster Shell</td>
<td>9.0</td>
</tr>
<tr>
<td>Salt</td>
<td>0.4</td>
</tr>
<tr>
<td>Vitamins and Minerals</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Table (4.16): Examples of Locally-produced Feed for Layers in Khartoum state

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Example (1) %</th>
<th>Example (2) %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum</td>
<td>58</td>
<td>67</td>
</tr>
<tr>
<td>Wheat Bran</td>
<td>13</td>
<td>6</td>
</tr>
<tr>
<td>Groundnut Cake</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>Concentrates</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Shells</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Salt</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

(Source: Field Survey, 2006)
4.2.2 Day-Old Chicks:

In Sudan, the production of day-old chicks was restricted to Khartoum State, but after wards, the government and some other companies, to cover different parts of the country, have constructed several production centers. For healthy and high yielding flocks, it is essential to purchase high quality breeds, i.e. high production with low mortality rate and highly adaptable to the local environmental conditions (Nesheim, 1979).

Survey results revealed that, the cost of chicks in the open-system farms constituted about 5% for egg production Table (4.17), whereas, it constituted about 40.2% of the total cost of broiler production table (4.19).

4.2.3 Labor:

Labor tasks in poultry production are feeding, watering, cleaning and egg collection of the flocks. In the open-system farms, labor has a major role in vaccination of chicks. In spite of the incentives given to workers, such as food, medical care, there are different complaints of poultry producers regarding the dishonesty and poor performance of workers (Field survey, June 2006). Labor cost, according to the survey constituted about 6.6% of the total cost in the open-system farms Table (4.17), however, in the closed system farms, it constituted about 0.8% of the total cost of egg production Table (4.18).

4.2.4 Vaccines and Drugs:

The importance of vaccines and drugs of vital importance, where chicks are susceptible to various diseases leading to increased mortality rate. both in layers and broilers whereas broilers are kept for more shorter time. There are different viral, bacterial and fungal diseases, as well as, parasites that affect poultry production, but the viral diseases are the most important ones (Hofstad, 1984). The most important viral
diseases are Newcastle, Fowl Pox, Mareks, Gumboro disease. There are different external and internal Parasites that affect poultry production. The most important external parasites are Lice and Mites, whereas, worms are the major internal parasites.

Survey results showed that, on average, the cost of vaccines and drugs in the open-system farms constituted about 1.57% Table (4.17). But in closed system farms, it was found to be 2.4% of total cost of production Table (4.18). This may be due to the a highly spread of the diseases when it cause the flock in the closed-system farms, thus vaccine program conducted carefully, whereas in the most open-system farms conducted the program after the occurrence of the disease.

Hygiene is important for feed safety, and since in many alternative system, the birds are not separated from their dropping, care needs to taken them to avoid soiling of the eggs and of other birds. The death rate in the floor systems is generally, although not necessary, higher than in the caged layers (Appleby et al., 1992). Higher mortality rate will lead to increased total cost per head, especially if death occurred at the end of rearing period or at the beginning of the production period (Elbashir, 1995). Mortality rate for layers according to the survey results was found to range between 15% to 20% and 5% to 7% in the open and closed system farms, respectively. The reason behind this variation is that, chicks in the open-system are exposed to hard environmental conditions, whereas, in the closed-system and semi-closed system there is a controlled environment.

4.2.5 Electricity and Water:

The majority of poultry farms in Khartoum State obtain their supply of electricity and water from the Nile and wells (Field survey, June 2006). The share of electricity and water in the total cost of egg production in open-system was found to be 3.23% Table (4.17). In the
closed system farm, it constituted about 0.7% of the total cost of egg production table (4.18). This may be due to the stability of electricity and water in the closed-system farms.

4.2.6 Housing and Equipment:

These include the depreciation of houses, mills, drinkers, feeders and laying nests. This survey revealed that, in the open-system farms, the feeders and drinkers are locally-made and the price for each was 3SDG, whereas, the price per laying nest was 5SDG. The life span of both the steel feeder and drinker is 5 years, but that of laying nest is 4 years. The optimal number of birds per a square meter is 5-6 birds, (Jull, 1982), but according to the survey, it was found to be about 10 birds per square meter.

Depreciation is the loss of value due to use and time. The commonly used method for calculating depreciation is the straight-line, where annual depreciation is computed by dividing the original cost of asset, less the salvage value, by the expected years of life (Castle et. al, 1972) according to the following equation:

\[ AD = \frac{I-S}{L} \]

Where,

\( AD \) = Annual Depreciation.
\( I \) = Initial Cost of the Asset.
\( S \) = Salvage Value.
\( L \) = Expected Life Span.

In the open-system farms, depreciation was found to be 20%. However, in the closed system farms, it was found to be only 9% and 11% for egg and broiler production, respectively. Based on the survey results, the cost of housing and equipment in the open-system farms was about 17.63% of the total cost of egg production Table (4.17), but in the
closed-system farms, it constituted about 8.3% of the total cost of egg production Table (4.18). This may be due to the less losses of housing and equipment in the closed-system and that refer to the material that used to make of and proper utilization of the equipment.
Table (4.17): Cost Items for Egg Production in the Open-System Farms

<table>
<thead>
<tr>
<th>Cost Items%</th>
<th>Farm Size</th>
<th>Feed</th>
<th>Chicks</th>
<th>Labor</th>
<th>Vacc/Dru</th>
<th>Elec/Wat</th>
<th>Hou/Equip</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>48.2</td>
<td>4</td>
<td>7.7</td>
<td>1</td>
<td>2</td>
<td>37.1</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>70.3</td>
<td>5.6</td>
<td>8.3</td>
<td>2.9</td>
<td>2.7</td>
<td>10.2</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Large</td>
<td>84.1</td>
<td>5.3</td>
<td>3.9</td>
<td>0.8</td>
<td>0.5</td>
<td>5.4</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

(Source: Field Survey, 2006).
Table (4.18): Cost Items for Egg Production in the Closed System Farms

<table>
<thead>
<tr>
<th>Cost Items</th>
<th>Total%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed</td>
<td>72.9</td>
</tr>
<tr>
<td>Chicks</td>
<td>14.8</td>
</tr>
<tr>
<td>Labor</td>
<td>0.8</td>
</tr>
<tr>
<td>Vaccines and Drugs</td>
<td>2.4</td>
</tr>
<tr>
<td>Electricity and Water</td>
<td>0.7</td>
</tr>
<tr>
<td>Housing and Equipment</td>
<td>8.3</td>
</tr>
</tbody>
</table>

(Source: Field Survey, 2006)
4.3 Analysis of the Cost Structure of Broiler Production in the Closed System Farms:

Commercial broiler production in the Sudan started in 1987 by the private sector. Before that, it was practiced on a very limited scale by both governmental units and private sector. Vertical integration is the main feature of this industry in Sudan, where all processes were done by the same firm. Percapita-consumption of poultry meat is low due to the high prices of poultry meat and the low production level, where broiler was not used commercially till 1978 (Baaboud, 1981). The broiler business requires a relatively large investment in short-term capital and considerable element of risk (Nesheim, 1979). The cost items in broiler production are feed, day-old chicks, labor, vaccines and drugs, electricity and water and housing and equipment.

4.3.1 Feed:

The main economic problem is the relationship between total feed intake and meat output, i.e. the feed conversion. The efficiency of feed conversion depends upon the quality of feed, poultry management, environment and genetic ability of bird to convert feed into meat. Feed conversion ability is usually expressed as a ratio of pounds of feed required to produce one pound of poultry meat. A low ratio will result in a significant reduction in costs (Baaboud, 1981). Baaboud, (1981), found that the cost of feed represented about 39% of the total broiler production cost. Survey results indicated that, the feed cost constituted about 42.7% of the total cost of broiler production Table (4.19). This difference between the two percentages may be due to the time of rearing winter or summer, or due to modified feed ingredient costs.
4.3.2 Day-Old Chicks:

It is an important cost item, especially in case of imported chicks. Some poultry farms produce their own day-old chicks, while others imported them from abroad, mainly from the Netherland (Field Survey, 2006). A survey done by Baaboud in 1981 showed that the share of this cost was about 37% in the total cost of broiler production. According to the field survey, Nov. 2006, the cost of this item represented about 40.2% of the total cost of broiler production Table (4.19). This difference may be due to insufficient supply of day-old chicks at the time of this study which it conducted after the spread of Avian Influenza disease.

4.3.3 Labor:

Highly skilled labor is required in boiler production and their major role is to operate the different processes, which are mechanically done (Field Survey, 2006). The cost of labor according to the field survey, constituted about 6.3% of the total cost of broiler production Table (4.19).

4.3.4 Vaccines and Drugs:

Vaccines are very important in broiler production. The large poultry companies in Khartoum State imported vaccinated chicks; locally produced chicks are more susceptible to various diseases and with high mortality rate (field survey, 2006). Mortality according to this survey was found to be 5% among imported chicks and 10% among locally produced once.

The cost of vaccines and drugs, depend on this survey, was found to be 1.9% of the total cost of broiler production Table (4.19).

4.3.5 Electricity and Water:

The closed system farms depend on the National Electricity Corporation an National Water Corporation besides their own generators
for supply of electricity and water. Survey results showed that, electricity and water contributed about 1.6% of the total cost of broiler production Table (4.19).

**4.3.6 Housing and Equipment:**

The primary purpose of housing poultry is to provide comfort for the fowls at all time and in all seasons. Unless the growing stock is kept comfortable day and night throughout the growing season, it will not attain optimum growth. Properly equipping the houses is necessary for efficient management of the growing and adult stock (Jull, 1982).

The closed system farms used different equipment such as automatic feeders and drinkers, nests and mills. According to survey done by Baaboud (1981), the cost of this item constituted about 9% of the total cost of broiler production, whereas, in this survey this cost item contributed about 7.2% of the total cost of broiler production in the closed system farms Table (4.19). These reduced percentage may be due to encouragement to producers by freeing them from the inputs tasks.
<table>
<thead>
<tr>
<th>Cost Items</th>
<th>LS/ Bird</th>
<th>% Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed</td>
<td>2.200</td>
<td>42.7</td>
</tr>
<tr>
<td>Chicks</td>
<td>2.500</td>
<td>40.2</td>
</tr>
<tr>
<td>Labor</td>
<td>0.400</td>
<td>6.4</td>
</tr>
<tr>
<td>Vaccines and Drugs</td>
<td>.0120</td>
<td>1.9</td>
</tr>
<tr>
<td>Electricity and Water</td>
<td>0.100</td>
<td>1.6</td>
</tr>
<tr>
<td>Housing and Equipment</td>
<td>0.450</td>
<td>7.2</td>
</tr>
</tbody>
</table>

(Source: Field Survey, 2006)
4. 4 The Total Cost of Production:

On average, in the open-system, the total cost of egg production per bird was found to be 53.44SDG. In closed system, the total cost of egg production was found to be 48.907SDG. The broiler production was found to be 6.250SDG in the closed-system.

On average, the cost of the other items (other than feed cost) in the open-system was found to be 30.0% of the total cost of production of eggs. In the closed-system, the cost of the other items for egg production per bird was 27% and that for broiler production it was 64.6% of the total of broiler production in the closed-system.
Table (4.20): Comparison between Feed Cost and Other Cost Items in the Open and Closed-System Farms

<table>
<thead>
<tr>
<th>Item</th>
<th>Egg Open-System%</th>
<th>Egg Closed-System%</th>
<th>Broiler Closed-System%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed Cost</td>
<td>70</td>
<td>73</td>
<td>42.2</td>
</tr>
<tr>
<td>Other Items</td>
<td>30</td>
<td>27</td>
<td>57.8</td>
</tr>
<tr>
<td>Total Cost</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

(Source: Field Survey, 2006)
4.5 Gross Margin analysis:

4.5.1 Yields:

In the open-system, the laying period for egg production starts at the age of 20 weeks with 10% productivity. Maximum productivity which 70% is reached at age of 22 weeks and the lowest productivity is 30% in a flock of 44 weeks.

In the closed-system farms the laying period egg production starts at the age of 16 weeks with a productivity of 20% and maximum productivity, which is, 90% is reached at 28 weeks.

The variation between the open – system and closed – system farms with respect to productivity is attributed to adverse environmental conditions the open-system farms are exposed to, whereas in the closed-system environment is completely controlled, Table (4.21).

4.5.2 Prices:

Farm-gate price were used in this study and the time of survey, the average prices per egg table was found to be 8SDG in the open-system and 9SDG in the closed system farms.

4.5.3 Gross Returns:

Gross returns are obtained by multiplying yields in table by prices per egg table. The average gross returns of the egg production in the open-system farms were found to be 85SDG/ bird. In the closed-system farms, the average gross returns of egg production and broiler about 115 SDG/ bird and 10 SDG/ bird, respectively Table (4.22).

4.5.4 Net Margins:

Net margins were obtained by subtracting the total cost of production from the gross returns. For egg production in the open-system farms, net margins were found to be SDG 36.66/ bird. In the closed-
In the feed-producing farms, the feed is a major cost item, followed by housing and equipment cost, labor, chicks, vaccines and drugs and electricity and water cost. The same sequence is observed in the non-feed producing farms with the exception of vaccines and drugs cost which is replaced with electricity and water cost.

With respect to the egg yield, feed-producing farms are more yielding than the non-feed producing farms; this may be due to that, produced feed contains all the necessary ingredients with required amount contrary to the purchased feed that may lack the required amount of the high price ingredients. The lower prices in the feed-producing farms may indicate lower cost of egg production (more efficient) than the non-feed producing farms, and hence the net margins are greater in the feed-producing farms. The total cost of production in the closed-system farms is lower (more efficient) than that in the open-system farms. This is due to the economic of scale, where the closed-system farms operate with large scale of production than the open-system farms. In the closed-system farms, the net margins per bird from the broiler production are 65.00/1.5 month, but for egg production they are 67.093/18 month, this indicates that, the net margins from egg production are greater than that from the broiler production, although the broiler production cycle is shorter than that of egg production.

Logically, egg production is more profitable than broiler production due to the following reasons:

1) Egg more profitable.
2) Demand for egg is greater than that for broiler.
3) Demand for egg is inelastic.
4) Marketing of broiler is risky (more perishable).
Table (4.21): Average Yields among Different Systems

<table>
<thead>
<tr>
<th>System</th>
<th>Beginning of Production and %</th>
<th>Time of Maximum of Productivity and %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open-system</td>
<td>20 Weeks 10%</td>
<td>22 Weeks 70%</td>
</tr>
<tr>
<td>Closed-system</td>
<td>20%</td>
<td>90%</td>
</tr>
</tbody>
</table>

(Source: Field Survey, 2006)
Table (4.22): Gross Returns and Net Margins

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Open-System</th>
<th>Closed-System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Returns per bird of Egg Production</td>
<td>85 SDG</td>
<td>115 SDG</td>
</tr>
<tr>
<td>Net Margin of Egg Production per bird</td>
<td>36.66 SDG</td>
<td>67.09 SDG</td>
</tr>
<tr>
<td>Gross Returns per bird of broiler Production</td>
<td>8.00 SDG</td>
<td>10.00 SDG</td>
</tr>
<tr>
<td>Net Margin of broiler Production per bird</td>
<td>2.50</td>
<td>4.50 SDG</td>
</tr>
</tbody>
</table>

(Source: Field Survey, 2006)
Chapter Five
Summary, Conclusion and Recommendations

Summary:

Poultry production in Khartoum state is practiced in traditional and commercial systems. The traditional poultry production system is practiced in the backyards of dwellings, whereas the commercial system is practiced under the open, semi and closed-system.

In the Traditional system, poultry production is practiced by individual households for domestic consumption, where the birds were fully exposed to the natural environment.

In the Commercial system, poultry production is practiced by individual poultry producers in the open-system, as well as, by large companies in the semi and closed-system.

In the open-system, poultry is kept in farms with good ventilation and water-proof roofs, the birds are fed on good nutritive rations and vaccinated against the most common diseases. In the closed-system, poultry production is practiced by large technology-using companies under controlled environment. In the semi closed-system, poultry production is practiced by technology-using medium companies under seasonally controlled environment.

Poultry farms in Khartoum state were stratified into three strata based on the size of flock. A sample sizes of 48 farms were chosen using stratified random sampling method. The data were collected using interviewing method of data collection through a structured questionnaire. The study revealed that, poultry producers in the open-system are well educated and with good living standards. About 37.5% of poultry producers prepared their feed in their own farms, 58.4% bought it from the market and 4.16% owned and bought it from the market. The analysis of cost of production in the open-system revealed
that, feed cost is the main cost item for poultry production, where it constituted about 70% of the total cost of production, followed by housing and equipment cost 17.63%, labor cost 6.6%, chicks cost 5%, vaccines and drugs 3.23% and electricity and water cost 1.57% of the total cost of production. For egg production in the closed-system farms, feed cost constituted about 73% of the total cost of egg production, followed by the chicks cost 14.8%, housing and equipment cost 8.3%, vaccines and drugs cost 2.4%, labor cost 0.8% and electricity and water 0.7%. For broiler production in the closed-system, feed cost constituted about 44% of the total cost of broiler production, followed by chicks cost 40.22%, housing and equipment cost 8.3%, electricity and water cost 6%, vaccines and drugs cost 1% and labor cost 0.7%. 
Conclusions:

1. Feed cost is the main cost item for egg and broiler production in Khartoum state. In the open-system, it constituted about 70.3% of the total cost of egg production, whereas, in the closed and semi closed-system, it constituted about 73% and 44% of the total cost of egg and broiler production, respectively.

2. Many other factors were found to affect the cost of poultry production. Some of them are not significant different from zero.

3. In the open-system, the total cost of egg production in the feed producing farms was found to be 41.96/bird, whereas, in the non-feed producing farms, it was found to be 45.18/bird, meaning that, the feed-producing farms are more efficient in egg production than the non-feed producing farms.

4. Comparison of the cost of production among the different farms sizes indicated that, the large size farms are more efficient in production (less cost of production/bird). Followed by the medium and small size farms, respectively.

5. Mortality rate was greater in the open-system farms where birds are more exposed to the natural environment and leading to an increased cost of production than in the closed-system farms.

6. Variation in yield in the open-system farms is attributed mainly to variation in the number of birds, poultry diseases and feed source (whether produced or purchased).

7. Production in the open-system farms was hindered by a number of constraints, the most important ones are:
   a. Limited access of producers to credit sources.
   b. Limited supply of good quality feed, as well as, day-old chicks.
   c. Outbreak of poultry diseases.
Recommendations for Improving Poultry Industry:

1. Sustained growth of production is dependent upon the introduction of new techniques and technology that can be adopted by producers especially smallholdings e.g. cage system introduction.

2. There is a pressing need to utilize effective tools and techniques available to pursue farming system research and extension strategy. The major areas in this approach include:
   a. Control of infectious diseases.
   b. Expanding feed supply by having various ration formulations using different local raw materials in the different parts of the country.
   c. Improving management system to increase flock output.
   d. Reduce dependence on imported sophisticated inputs at least for sometimes.

3. Government needs to formulate integrated feed/livestock policy, which fully covers economics and social considerations to overcome by:
   a. Improving production, storage, transportation and marketing to ensure quantity and price stability.
   b. Investment in and dissemination of new technologies through on-farm trials and demonstration through persistent extension work.

4. High temperature and humidity can be economically overcome largely by appropriate housing system and management.

5. Proper assessment of production costs and good pricing and marketing system on quantity control which affects mainly large-scale projects.
6. Proper training program for staff and on farm manpower development for effective production.
7. Proper extension work to motivate producers to operate with knowledge of techniques and skills that prove to be profitable.
8. Regulation of law that can be control and organize the business in totality.
9. To facilitate financing and credit facilities for the business specially the infrastructure and initial inputs.
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