

**ECONOMIC ANALYSIS OF NILE CROCODILE FARMING IN TANZANIA:
A CASE STUDY OF KAOLE CROCODILE FARM, BAGAMOYO**

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**A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE
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ABSTRACT

Crocodile products have become popular in the world. In effect, they have attracted the attention of people in many countries including Tanzania. However, the farming practice comprises many activities and time involved before derivation of the commercial products. This study aimed at gaining insight on the economics of Nile crocodile farming in Bagamoyo, Tanzania. The objectives were to determine the reproductive rates of Nile crocodiles, products extracted from the crocodile, costs of inputs, price for various crocodile products, and benefits derived from crocodile farming to the farmer and to the local community. Data were collected using two sampling techniques, purposive sampling in selecting study site and sampling villages while random sampling technique was employed in selecting respondents for determining community benefits. Benefit-Cost Ratio (BCR) was calculated on the crocodile farm after costs and benefits were determined. Crocodile in the farm were 56; males were 35 and females were 21. Only one Crocodile layed 35 eggs in the year of study, hatchery rate was 29% and rate of maturation was 40%. Nile crocodile products extracted were live crocodiles and the skins. The cost of a live crocodile was 20 US\$ from the wild to the farm for purposes of rearing. The skins were exported; Grade 1 sold at 10\$/cm², Grade 2 at 6\$/cm² and Grade 3 at 5\$/cm². The Net Present Value was positive (Tsh8,743,498) whereby BCR was greater than one (1.2) indicating that crocodile farming was profitable to the farmer. Hatchability was low, the reason of which demands investigation. In the study of nearby villages results reveled 27% of the respondent recognizes benefits from crocodile farm while 73% did not recognize. The study recommends that improvement can be achieved by genetic selection of the breeders and eggs should be collected and incubated in a special incubator to enhance hatchability.

DECLARATION

I, BONIFACE ELISAFI NISAGURWE, do hereby declare to the senate of Sokoine University of Agriculture that this dissertation is my own work and have never been submitted for a degree at any other institution.

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DEDICATION

The dissertation is dedicated to my mother EnaelMndika, my brothers Raymond Okick, IssaMwita, JaphetMakundi,Pius Lenox and NisagurweElisafi for their patience during the course of this study.

LIST OF ABBREVIATIONS

BCR	Benefit Cost Ratio; measureratio of the value today of all benefits and the value today of all costs
CFANT	Crocodile Farming Association Northern Territorial; which is the crocodile farming industry in Australia aiming at research, production and trading.
CITES	Convention on International Trade in Endangered Species; it is a multilateral treaty used to protect endangered and animals like crocodile.
IFAW	International Fund for Animal Welfare; which works to rescue individuals, protects entire population and preserve precious habitat of crocodile.
NPV	Net Present Value which is the difference between the present value of cash inflows and the present value of cash out flows in crocodile product
NT	Northern territorial; which is the crocodile farming industry in Australia
SUA	Sokoine University of Agriculture; the college supported the finding.
UNCTAD	United Nations Conference on Trade and Development; which seeks to maximize the trade, investment and development opportunities of developing countries while helping them.
WMA	Wildlife Management Areas in Tanzania that monitor the crocodile farming at Kaole-Bagamoyo

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the study

Crocodiles are large aquatic reptiles that live throughout the tropics in Africa, Asia, the America and Australia. Crocodiles can be in a free range (River) or kept in farms. Production of crocodile products is the mainstay farming industry. Some farmers supplement their income by encouraging on farm tourism.

Crocodile farming was conceptualized an ex-situ conservation strategy in response to the continued threat to crocodiles. Non-permitted hunting and lack of understanding about this animal widely regarded as ferocious were the most likely cause of this decline in crocodile numbers.

Generally reptiles are traded commercially primarily for food, skins as pets and as traditional medicines (Schlaepfer *et al.*, 2005). Turtles on the other hand, are the most heavily exploited reptiles for human consumption (Klemens and Thorbjarnarson, 1995), although crocodilians, snakes, and lizards may also be important in international trade. Exploitation of crocodiles for food is greatest in tropical and sub-tropical regions (Klemens and Thorbjarnarson, 1995), particularly in East and Southeast Asia (van Dijk *et al.*, 2000). Reptile skin trade involves mainly snakes, crocodiles and larger lizards originating in the tropical and sub-tropical regions (Jenkins and Broad, 1994).

This trade involves live reptiles and their products which can be found offered for sale on online auctions, classified websites, pet retailer websites, and in chat rooms

and web fora. For example, in a one-week survey of wildlife trade on the internet, IFAW (2005) recorded 526 turtle products and 2,630 items made from other reptiles, including “handbags, belts, wallets, watchbands, shoes and accessories, as well as taxidermy items and skulls. The rapid growth in availability and usage of the internet has created a new global market place, leading to a boom in online sales of wildlife (both legal and illegal), which is largely unregulated (IFAW, 2005; Engler and Parry-Jones, 2007; IFAW, 2008).

Trade in reptile skins involves the harvest and use of millions of skins every year. Skins are processed and manufactured into a wide variety of products including belts, briefcases, shoes, handbags, wallets, and watchstraps. Fashion trade generally consumes these products. International reptile skin industry is providing benefits to consumers in terms of products, and generating economic benefits that flow down supply chains to all stakeholders involved.

Important aspect of the trade is represented by the leather industry. This mainly involves large snakes, monitors, and crocodiles and generates large income flows. At least 15 of the 24 living species of crocodilians are traded for their skins (Brazaitis, 1987). This includes Nile crocodile whose skin generates large income to the stakeholders involved due to its high value in the world crocodile skin market.

The overall volume of world trade in classic crocodilian and caiman skins has been variable over the ten-year period of 2001 to 2010, with an average of 1,300,000 skins exported annually (Caldwell, 2012).

The importance of crocodiles in indigenous culture is reflected in a complex system of totems and ceremonies which is still evident among most coastal indigenous communities in northern Australia today (Lanhupuy, 1987). Indigenous communities also regard saltwater crocodiles as dangerous animals. The non-indigenous community has a diversity of views on saltwater crocodiles from being reviled and seen as dangerous pests to being admired and recognized as having a significant and rightful place in the natural world. Crocodiles constitute an important natural resource for many sectors including indigenous communities, the tourist industry and the crocodile farming industry.

Tanzania is rich of reptiles species. It has two of the species of crocodiles known, which include;— the Nile crocodile (*Crocodylus niloticus*) and the slender-snouted crocodile (*Crocodylus cataphractus*). The slender snouted crocodile is restricted to Lake Tanganyika and possibly the lower Malagarasi River. The Nile crocodile is classified in Kingdom: Animalia, Phylum: Chordata, Class: Reptilia, Order: Crocodylia, Family: Crocodylidae, Genus and species *Crocodylus niloticus* (Laurenti, 1768), Common names: English: Nile crocodile and Swahili: Mamba.

The slender-snouted crocodile (*Crocodylus cataphractus*) is classified as Kingdom: Animalia, Phylum: Chordata, Class: Reptilia, Order: Crocodylia, Family: Crocodylidae, Genus: *Mecistops* and Species *cataphractus*, hence its scientific name (Mecistops): *Crocodylus (Mecistops) cataphractus*.

1.2 PROBLEM STATEMENT AND JUSTIFICATION OF THE STUDY

1.2.1 PROBLEM STATEMENT

The Nile crocodile is one of the most commercially utilized crocodilians, the skin being acknowledged as one of the “classics”. Up to 160,000 *C. niloticus* skins are produced and traded internationally each year from ranching and captive breeding (IACS 2008). People can derive cash benefits from conserving crocodiles as the main target of conservation through sustainable use (Guggisberg, 1972).

In Tanzania, it is estimated that 12,230 Crocodile skins were exported from 2002 to 2011 but these figures have been taken from the reports of the major importing countries, notably Singapore and Italy for those years (Caldwell, 2013).

The status of trade of Nile crocodile in Kenya reveals that its utilization is based on ranched specimens in accordance with Convention for International Trade on Endangered Species (CITES) Res. Conf. 11.16. The parts utilized include meat for food, sold locally and through outlets authorized and regulated by the management authorities. The crocodile skin that is solely for export markets is used for leather industry (Kyalo, 2008).

Conferences on improving international systems for trade in reptile skins based on sustainable use reveals that in future directions, there appears to be at least three key themes that need to be considered, which are: Firstly, increasing the public profile of the reptile skin industry by fostering more engagement in market-based incentives for the conservation and sustainable use of reptiles and their habitats. Secondly, identifying and prioritizing current and potentially positive and negative issues linked to production and trade of reptile skins, bearing in mind that public support ultimately

hinges on the positives outweighing the negatives. And lastly examining the ways in which collaboration between the private sector, governments and international organizations is of benefit to conservation, trade and the stakeholders involved (UNCTAD, 2012).

The Populations of wild Nile crocodiles can be considered economically and ecologically valuable assets, particularly in the cash poor countries. Crocodile meat and skins command high prices on the international market (Thorbjarnarson, 1999) and wild crocodiles are a valuable component of the photographic tourism industry (Llewellyne, 2007).

Considerable literature exists on Nile crocodiles, their value and conservation status have been a major driving force behind extensive research into the biology, ecology and captive propagation of the species (Blake and Loveridge, 1975; Gans and Pooley, 1976; Graham *et al.*, 1973; Hocutt, Loveridge and Hutton, 1992; Hutton, 1987; Shacks, 2006; Siamudaala, Kunda and Nambota, 2004).

Evidence suggests that the collective value of Nile crocodiles could offset many of the threats facing them and reduce the costs associated with conserving them provided the population is managed and exploited in an ecologically and socially sustainable manner (Adams *et al.*, 2004; Hutton and Leader-Williams, 2003; Ross, 1998). In this way, crocodiles could also be employed as a valuable tool in poverty alleviation programmes and freshwater conservation (Adams *et al.*, 2004; Hutton *et al.*, 2003).

Despite of the widely known studies on economics of crocodile, little is known on performance of Nile crocodile farms in terms of production and economics, crocodile breeding and reproduction rates, growth rates of fingerlings, quantity of skins and meat produced and their values, against costs of housing and watering, management, feeding, and health programmes and other parameters that cause costs and benefits. This study was designed to provide information on the performance of the Nile crocodile farming industry in Tanzania.

1.2.1 Justification of the study

Information on cost-benefit analysis of crocodile farming is important and useful to the Government of Tanzania in enhancing diversified economy in the country and enhancing conservation of various wildlife. To open the mind of entrepreneurs to invest in the crocodiles farming and trade based on sustainable use in wildlife. It is also important in conservation of wild crocodiles as it provides alternative source of crocodiles from the farm by breeding in captivity that could be released in the wild. Nile crocodile farming is the one of the most economical potential to the consumers with classic skins being traded and its product being of high price in many areas of the world. The tail provides ample meat, a source of high quality protein.

1.3 OBJECTIVES

1.3.1 General objective

The main objective of this study was to assess the economics of Nile crocodile farming in Tanzania

1.3.2 Specific objective

The specific objectives of this study were to:

1. Determine the reproductive rates of Nile crocodile on the farm,
2. Determine products extracted from crocodile,
3. Determine costs and price for various crocodile products in Tanzania
4. Determine the costs and benefits of managing crocodiles in farms.
5. Determine benefits that accrue to local communities from the crocodile farms.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Crocodile farming

This means the closed-cycle captive breeding and keeping of crocodiles in captivity intended for producing for sale products such as skins, meat, oil and claws.

Crocodile farm is an area established for breeding and rising of crocodilians in order to produce crocodile as animals and meat, leather, and other goods.

2.2 Necessary cost items involved in reproduction of Nile crocodile

2.2.1 Breeding of the crocodiles

Breeding of crocodiles usually takes place during the dry season (Ross, 1998), though the exact timing varies with location (Webb, 2008).

2.2.2 Mating

Mating occurs in the water where the nest is a hole, up to 50 centimeters deep, dug by the female into a sandy bank, several metres from the water (Alden *et al*, 1996)

2.2.3 Eggs incubation and temperature control by the animal

The female Nile crocodile is an attentive parent, and, after laying up to around 60 eggs, will cover the nest with sand and guard it for the entire incubation period, around 90 days (Modha, 1967). Sex in the Nile crocodile is determined by the temperature at which the eggs are incubated, with females produced below 31 degrees Celsius, and males at above 31 to 34 degrees Celsius (Hutton, 1987).

2.2.4 Hatching and care

When about to hatch, the young (crocodile fingerlings) make a “peeping” noise, which encourages the female to excavate the nest. The female then gathers the hatchlings in her mouth and transports them to the water, where they remain in a group for several months, protected by the female (Modha, 1967). Amazingly, the Nile crocodile’s powerful jaws can be used incredibly gently, and the female can even help hatchlings emerge by carefully rolling and squeezing the eggs in her mouth. However, despite this care and vigilance, nests may be raided by a variety of other animals, and hatchling crocodiles are very vulnerable to predation (Webb, 2008). Young female Nile crocodiles reach sexual maturity at a body size of around 2.6 metres, and males at 2.7 to 3.1 metres (Kofron, 1990), achieved at around 12 to 15 years old (Nature Conservation Act, 1992) in Australia.

2.2.5 Feeds and feeding

Crocodiles are fed on diets of red meat, poultry or poultry by-products such as chickenheads or necks. Fresh meat contains large amounts of water, which in itself is a cost to farmers (Peucker et al., 2005).

To get a more accurate comparison the different diets need to be compared on a dry matter basis. This is where the potential for manufactured feed can be realized along with a better supply and use of nutrients to the animal. Savings will also come via reduced transportation and a reduction in storage costs. A typical juvenile crocodilian consumes about 15–20 percent of its body weight in food every week at a constant temperature around 32° C. However, in outdoor pens, food consumption varies greatly depending on ambient temperature and season. (Nature Conservation Act, 1992)

2.2.6 Housing

A crocodile farm has buildings and management systems that provides basic standards of care for crocodiles, including: incubation and neonatal treatment, maintenance of a high metabolic rate; and elimination of stress, where a type of housing and yard dimensions required by crocodiles vary with the geographic location of the crocodile farm, age of the crocodiles, management practices to be employed, stocking density and the likely occurrence of disease. Pens are constructed to prevent unwanted movement of crocodiles into or out of enclosures. Generally Farm design includes facilities that allow for the isolation and treatment of individual or limited numbers of crocodiles for extended periods and allow treatments to be administered in the water or in food. (Nature Conservation Act, 1992)

2.2.7 Diseases and their control

Crocodile farmers have an effective program in place to prevent infectious disease, and internal and external parasitism. It mostly prevalent among hatchlings and particular attention always paid to all aspects of the management of this age group. Signs of ill-health include separation from other crocodiles, lethargy, refusal to eat, changes in faeces or urine, vomiting, coughing, panting, lameness, and swellings on the body or legs. Viruses, chlamydia (virus-like agents), bacteria, protozoa, fungi and helminth worms have are normally isolated from crocodilians, and some of these infective agents are of significance in farming operations. The farm manager if unable to identify the causes of ill-health and correct the problem does seek prompt advice from a veterinary surgeon preferably with experience in the treatment of crocodiles. (Nature Conservation Act, 1992)

2.3 Trade of crocodile products

Products derived from crocodiles include; skin, meat, teeth, live crocodilians where each item to be used for trade and commerce is labeled at the point of manufacture/processing with an 'Export Permit (manufactured crocodile products)' issued for that product. However, many items of the same type (e.g. teeth) may be packaged together where necessary for reasons of size and practicality (Caldwell, 2012).

2.3.1 Live crocodilians

Live crocodilians are traded for many purposes. Young animals are frequently kept as personal pets; circuses and zoos regularly exhibit such creatures and there are well-established crocodile breeding establishments in Denmark, France, Morocco, Spain and Thailand.

Crocodile farms and ranches import animals to supplement their gene pool and some animals are imported by range States in order to strengthen wild populations. This variety of use, and the limited number of possible purpose codes used in CITES annual reports, means that some conclusions drawn from analysis of CITES data are only tentative (Caldwell, 2012).

2.3.2 Skins

The overall volume of world trade in classic crocodilian and caiman skins has been variable over the ten-year period 2001 to 2010, with an average of 1,300,000 skins exported annually.

Overall the total number of skins entering international trade in 2010 was approximately 1.35 million, a notable increase compared to the low point reached the previous year. Trade in skins of American alligator from the United States of America (here after referred to as the USA), Nile crocodile from South Africa and Zimbabwe, and Brown caiman from Colombia all increased in 2010 compared to 2009, while Yacare exports from Bolivia and Brazil seem to have declined, as do caiman exports from the Bolivarian Republic of Venezuela (Caldwell, 2012).

Exports of *Crocodylus niloticus* appear to have remained steady at between 140,000 and 170,000 skins per year since 2000 with South Africa, Zambia and Zimbabwe being the main suppliers (Caldwell, 2012).

Tanzania annual report represents actual trade; however, major discrepancies between Tanzania's reports and the data provided by importers indicate that Tanzania may not have included all of their crocodile export data in their annual reports between 2002 and 2008. Therefore, the figures in this report have been taken from the reports of the major importing countries, notably Singapore and Italy for those years. According to importer-reported data, skin exports from Tanzania increased from 1,100 in 2006 to 1,784 in 2008, all skins being of wild origin. In 2009, Tanzania reported the commercial export of 1,365 skins, all of wild origin, of which all but one was exported to Singapore (Caldwell, 2012).

2.3.3 Meat

Between 1990 and 2002, the amount of crocodile meat traded globally fluctuated at around 400 tonnes yearly. Exports began an upward trend in 2003, and in 2006 and

2007 peaked at over 900 t. However, the quantity of meat exported decreased to just under 500 t in 2008 and remained around this level in 2009 and 2010 (Caldwell 2012).

Exports of *Crocodylus niloticus* meat, which originate particularly from South Africa and Zimbabwe, increased steadily from less than two tonnes in 1992 to over 475 t in 2007, but then decreased to less than 300 t in 2008 and to below 200 t in both 2009 and 2010. The main destinations for *C. niloticus* meat were Europe, Hong Kong and China (Caldwell, 2012).

Crocodile meat and eggs are thought to have been used as a food source by Aboriginal people for up to 40,000 years (McBryde 1979, Flood 1983). The value of eggs to Indigenous communities was in the protein they provided to people. In the initial phases of the Northern Territory in Australia program of 1970s nests were “bought” from landowners for 12 dozen chicken eggs to compensate for the lost nutritional value.

2.3.4 Teeth

Australia is the world’s foremost importer of crocodile teeth and between 1999 and 2010 imported nearly 425,000. Most of the teeth were of *Crocodylus porosus* from the operations in Malaysia, Papua New Guinea and Singapore, but Australia also imported *C. siamensis* teeth from Thailand and alligator teeth from the USA. Since 2005 trade has gradually increased and amounted to over 47,000 in 2007. In 2008, imports decreased to 19,105 teeth exported from Singapore and Thailand, and in 2009 decreased further to only 5,000 teeth exported from Singapore. In 2009 Australia

reported exporting 24,000 teeth to Indonesia, while Singapore reported exporting 10,000 teeth to Australia in 2010(Caldwell, 2012).

2.4. Prices of various crocodile products

The average price per egg reported to be paid by two farmers for eggs in 2004 was \$20 but one reported on 12 average price of \$8. After taking account of their full cost of collecting eggs from the wild, two farmers reported that average overall cost of wild crocodile eggs delivered to their farm was in effect 150 per cent on the average of the mean price per egg they paid to landholders. In one case, the ‘landed’ cost was estimated to be \$20 per egg and in another case \$50 per egg (Tisdell, Wilson and Nantha October, 2005)

Notably crocodile hatchlings can be sold at \$US2 each to foreign investors, 15 birr (\$US0.75) to Ethiopian investors, and 5 birr (\$US0.25) to farmers for quantities in excess of 100. Crocodile eggs are sold at half those prices. Nile crocodile as a species allowed to be hunted by foreign tourist hunters for a \$US2000 trophy fee.

Table 1. The average price of a crocodile and its products (US\$)

Crocodile and its products	\$/egg	\$/cm Skin	\$/Crocodile	\$/Kg Meat
Average price range in US\$	8 - 20	20 - 35	50 – 350	5 – 7

2.5 Profitability of crocodile farming

The Northern Territorial crocodile farming industry in Australia is capital intensive and its profitability is largely determined by the export price of skins and the

proportion of skins sold as first grade. The crocodile industry experiences high costs of production relative to its competitors in other Australian states and overseas, particularly in the significantly higher costs of labour, food, services and construction. Relative to its international competitors, the industry also faces additional costs associated with a relatively cooler climate for growing and more stringent corporate social responsibilities involving animal welfare and work health and safety(CFANT 2015)

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of the study area

This study was conducted in Kaole crocodile farm in Bagamoyo District in Pwani Region. Bagamoyo-kaole crocodile farm is located 6.22°S , 39.22°E with average temperature of 27°C and elevation of 15m. It is 3 Km from Bagamoyo town to Kaole crocodile farm. Good climatic condition and vast, Social services and infrastructure are at a good standard where, good climatic condition, availability of water makes an area conducive for Nile crocodile farming and better survival. The indigenous main economic activities ranges from small scale farming, small businesses, to local fishing activity for their subsistence. Hereby it is a map of Bagamoyo showing the Kaole where study is located, small tributaries, Indian Ocean and boundaries.

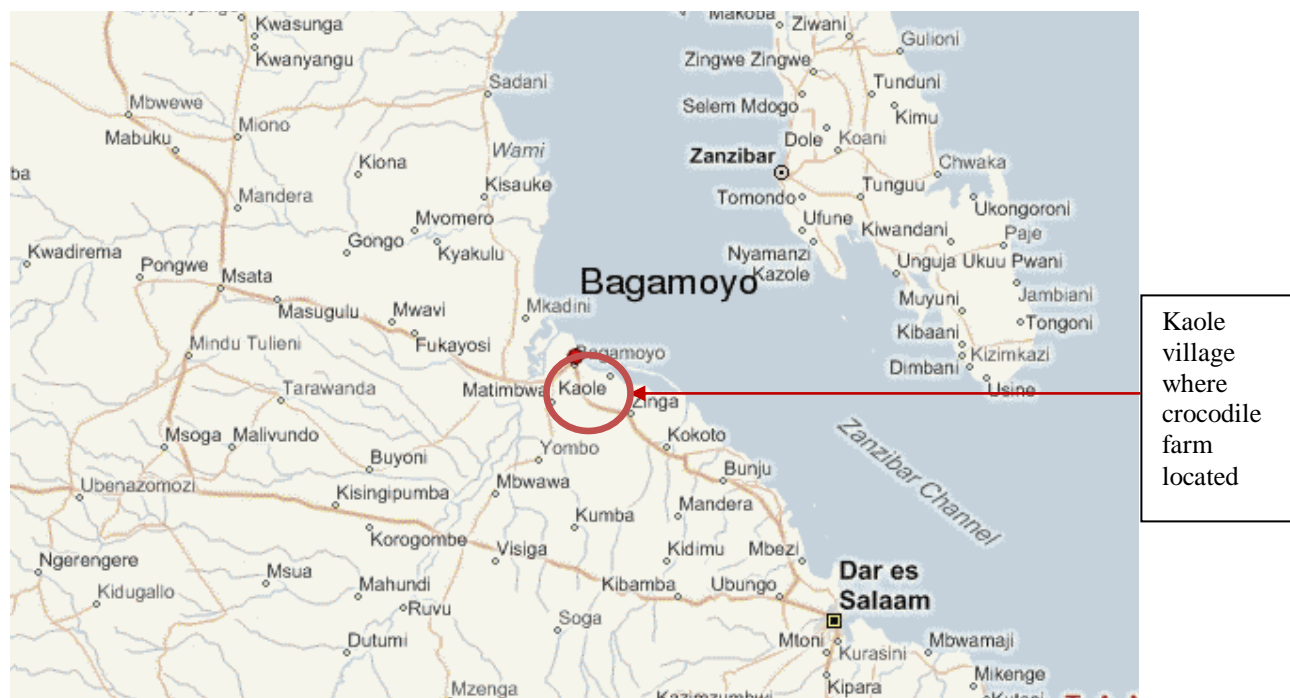


Figure 1.Map of Bagamoyo showing kaole as the study site.

3.2 Study design

Cross sectional design was used to collect information on the farm and surrounding village, where questionnaires were used to collect required data. This design allows large amounts of information to be collected from a large number of people in a short period of time and in a relatively cost effective way (Bailey, 1994).

3.3 Sampling procedure

Purposive sampling was employed in selecting villages for collecting required information. Households were assigned based on random numbers. This gave every household an equal chance of being selected for interview.

3.4 Sample size determination

The sample size selection was based on Babbie (1990) and Creswell (1994) whereby a sample size of at least 5% of a total population is recommended. In this study representative was 18.8% of the respondent were interviewed.

3.5 Data collection and analysis

Collection of information on reproductive rates of crocodiles, products extracted from crocodiles, prices of various crocodile products, cost and benefits of crocodile farming was carried out in Kaole crocodile farm. Lastly gains of local people from the crocodile farm.

3.5.1 Type of data that was collected

Both primary and secondary data were collected. Primary data were collected using questionnaire (farmer and household) and sellers. Secondary information was

obtained from wildlife department and data from published materials including journals and books which were obtained from libraries and websites.

3.5.2 Measuring reproductive rates of crocodile on the crocodile farm

The basic information collected on this objective was based on; the number of crocodiles, breeding time of crocodile in the year, number of eggs layed per crocodile, mode of incubation, hatching rates, housing, growth rates of fingerlings, and time frame for maturation of crocodile. Both questionnaire and interview were used to collect information.

3.5.3 Determination of products extracted from crocodiles

The owner of the crocodile farm was asked to state; live crocodiles marketed, skins produced, meat (Kg),skull, teeth and oil.

Based on this objective descriptive analysis was used to explain products extracted from crocodile.

3.5.4 Determination of price levels for various crocodile products in Tanzania

Based on secondary and primary information, data were collected on price levels of various crocodile products extractedeach year. Mainly published papers and journals, crocodile farmers, local people consuming these products, government officers including wildlife department were source of information on Nile crocodile trade based on price levels of crocodile product.

The information obtained from this objective was analyzed based on descriptive analysis to explain different price levels for various crocodile products in Tanzania.

3.5.5 Determination of benefits to local community from the Crocodile Farm

Information was collected based on economic activities of the local community, benefit local community gains from crocodile farm. Also tour guide were interviewed to give information on tourism activity.

The information obtained from this objective was analyzed based using descriptive analysis. Statistical Package for Social Science (SPSS) computer software was used to analyze and generate descriptive data.

3.5.6 Determination of the costs and benefits of managing crocodiles in farm

3.5.6.1 Costs

3.5.6.1.1 Management

Size of the land (ranch size) of their crocodile and the price used to get/buy the land and annual payments, water system and its source and the cost, housing system and its cost, number of labour working in the crocodile farm and their estimated payment.

3.5.6.1.2 Nutrition

Type of food used to feed crocodile, amount of food they used to feed crocodile, percentage of the mixed food to build diet, the body weight of their crocodile, area of obtaining food and their cost

3.5.6.1.2 Breeding

Water temperature for breeding, its fluctuation and how influence crocodile breeding, breeding time of the year, average number of eggs per crocodile, the percentage of hatching eggs, selection for male and where to get them and their cost

selection for female and where to get them and their cost and factors influencing crocodile breeding.

3.5.6.1.3 Health

Diseases affecting growth rate of crocodile, source of diseases, which disease affects them and medicine used to cure those diseases with their cost.

3.5.6.2. Benefits

3.5.6.2.1 Trade in Skin

Market for skin, price based on size and quality, number of crocodile harvest per year and number of crocodile skin harvest per year

3.5.6.2.2 Trade in other crocodile products

Market for fingerlings if it performed, price Per fingerlings, market for eggs and price Per egg, if he makes food to sell for others, market to sell Animal to make his returns, market for skeleton, meats in kilogram (kg) and their price, trade for skin within and outside the country, market for Teeth and their price per each Teeth and tourism market (number of tourist per year and price of each internal and external tourists).

Based on costs incurred and benefits obtained from crocodile farm data was analyzed using Net Present Value (NPV) as a technique to determine gaining or loss, where cost and cash inflows expected in future years are their present value. This was calculated by using an interest rate equivalent to the discount rate that would have been received on the sums, had the inflows been saved.

Net present value (NPV) represents cash flow of an investment over its lifetime. Thus, it is the difference of the incremental benefits and costs of a project for all periods and the adequate target rate. The investment is profitable if net present value is positive. The NPV is expressed in the following formula. Interest rate used was 10% which is the social interest rate

$$NPV = \sum_{t=1}^n \frac{B_t - C_t}{(1+i)^t} \dots\dots\dots \text{Eqn (1)}$$

Where;

V_n: Value at the end of n years

V₀: Initial value (principal)

NPV: Net present value in Tshs,

n: Project life in year

B_t: Benefits in year (t) in Tshs

C_t: Cost in year (t) in Tshs

i: interest rate in %

CHAPTER FOUR

4.0 RESULTS

4.1 An overview

General the study was based on; Reproductive rates of Nile crocodiles in the crocodile farm includes management of hatching, feeding program, fingerlings care, breeding and diseases control. Products extracted from Nile crocodile in the crocodile farm involves all products extracted from crocodile and being traded, Cost of inputs and price of crocodile product which involves any product extracted and being traded from the crocodile, benefits of local community from crocodile farm and benefit-cost analysis of crocodile enterprises includes all costs involved include Management; Labour and clearness, Health and nutrition. Benefits in the farm were obtained through selling skin and tourism activity.

4.2 Reproductive rate of Nile crocodile in the crocodile farm

4.2.1 Management system.

4.2.1.1 Housing

Crocodile farm was constructed in the ways that provide adequate shade and protection from the other stress. Farm was design that allows isolation and treatment of individual or limited numbers of crocodiles for extended periods. Additionally clean water and over flow pipes used to control water level.

4.2.1.2 Feeds and feeding

Meat, blood and maize flour were mixed together and cooked where crocodiles feed comfortably as their main food sources. Fingerlings were fed every two days where adult were fed every week. Hatchlings are usually fed ground, Chunks' of food seem

to be preferred, but grinding allows any supplements to be mixed into the food effectively.

4.2.1.3 Breeding program

The time frame for Nile crocodile to lay eggs from the day of birth was 12 to 15 years, there after every year the Nile crocodile lays eggs. According to the information from farmer only one crocodile was able to lay eggs with ability to hatch to fingerlings. The rest twenty female only four laid eggs, but eggs had no ability to hatch to fingerlings. Sixteen female crocodiles failed to lay eggs.

4.2.1.4 Reproductive rates

Number of crocodiles were 56 crocodiles of which biggest were two with the approximately age of about 52 years and weight of 250Kg, big (mid-size) were fourty five with approximately age ranged from 12 to 23 years and their weight ranges from 70 to 100 Kg where small size crocodiles were only nine with approximately age of 1 to 5 years and weight of 0.5Kg to 2.5Kg.

Crocodiles on the farm breed between Augusts and December each year and normally laid from 35 to 100 eggs but depend on food and size of crocodile.

The rate of hatchling being 29% and the rate of growth and survival to maturity is about 40%. The age for maturation of crocodile ready for skin allowable for trade is about 3 to 5 years, the allowable length being 2.5 feet and a width of 30 cm.

Generally the reproductive rate is only 7%; four crocodiles survival for each year where crocodiles in the farm are 56.

4.2.1.5 Hatching and care of fingerlings

Young make noise, which encourages the female to excavate the nest. The female then gathers the hatchlings in her mouth and transports them to the water, where they remain in a group for several months, protected by the female. Few months farmer allocate fingerlings to special and clear house for rearing.

Table 2: Reproductive rate of crocodile

Crocodile length	Age of crocodile in years	Mean weight of crocodile (Kg)	Crocodile lay eggs	Number of eggs	Rate of hatching	Maturation
3.8-4.5m	52	225	1 crocodile	35	29%	40%
2.4-2.8 m	12-23	85	4crocodiles	120	-	-
2.0-2.5 f	1-5	1.5	-	-	-	-



Figure 2. Crocodile with age range from 1 to 2 years



Figure 3. Crocodiles aged 3 to 5 years



Figure 4. Nile crocodile aged 12 to 23 years

4.3 Products extracted from Nile crocodile in the Crocodile Farm

Based on both primary and secondary data, the study revealed that products extracted from crocodiles in Tanzania are live crocodiles and skin, being traded outside of the country. First, live crocodiles are taken from conserved area as problem animal by the farmers who wish to establish crocodile farming. This practices an individual is given hunting block/Quator of which it requires the one to extract a given number of crocodiles at a specified period of time of which the payment is made before hunting, only two crocodiles are allowed to be harvested male and female crocodiles for the aim of establishing crocodile farming. The same to the individual practices tourism hunting and other individuals who engage in buying blocks for trade they must possess hunting license from the Ministry of Natural Resource and Tourism. Skins of crocodiles are the main product extracted from Nile crocodile in Tanzania marketed in Italy and Japan.

According to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Tanzania have been given the permission to hunt 1600 crocodiles per year, of which 100 crocodiles for tourism hunting and the rest 1500 is for other trade hunters and farmers. But farmers are given first priority because of their practicing ex-situ conservation which is highly encouraged by the country and CITES for conservation purposes.

4.4 Price levels for various crocodile products

4.4.1 Live crocodile

Live crocodiles are traded in Tanzania. Main two purposes are entertained; for farming to encourage population increase and tourism hunting. Farmers are highly

encouraged for conservation purposes. For farmers starting farming activities, through wildlife department gives license to farmers to hunt crocodiles; a male and female for farming purpose at a price of 20 US\$/crocodile. .For tourism hunting, a tourist purchases a crocodile at 1500 US\$.

4.4.2 Crocodile skins

This study has revealed that, in Tanzania crocodile skins are not internally traded in the country but are exported from the farm and other crocodiles trader to Italy, Japan and Singapore where they sell at high prices. Consequently, in the external market Grade 1 Nile crocodile skin is sold for 10 US\$/cm², Grade 2 Nile crocodile skin is sold for 6US\$/cm², Grade 3 Nile crocodile skin is sold for 5US\$/cm².

Table 3. Prices of Nile crocodile skins

Grade	Price of skin (US\$)/cm ²
Grade 1	10
Grade 2	6
Grade 3	5

Grade 1, Skin should be short-termed preserved, not, hard and dry, and should completely fleshed (no flesh attached to the skin). It full sized (30cm to 51cm, for Saltwater, 35cm to 51cm for freshwater). It should have four legs and four rows of hard horns or scutes. It has no any cut(s) or hole.

Grade 2, the skin should be short-termed preserved, not hard and dry, and it should be completely fleshed (no flesh attached to the skin). It should be full sized (30cm to 51cm, for Saltwater, 35cm to 51cm for freshwater).

Grade 3, 1 cut or hole within the pattern area, 1 cut or hole on belly each cut or hole on head and tail. Two or more legs missing.

4.5 Cost and benefit of crocodile farming

In 1991 was the year farmer started to make construction of houses to prepare for starting business. During 1992 the business was started. Costs involved include Management (Mgt); Labour and clearness, Health, nutrition and transportation of skin to the market. Benefits in the farm were obtained through selling skin and tourism activity. The result from table 6 reveals that Net Present Value was positive (Tshs8,743,498) meaning that the present worth of the benefit was greater than the present worth of the cost. Interest rate used was 10% which is the social interest rate.

Year	Activity (Costs)	Activity (Benefits)	Costs(Tshs)	Benefits(Tshs) ²⁹	Discounted cost	Discounted benefit	NPV
1991	Buying land and construction		32000000		29090909		-29090909
1992	Mgt, Health and Nutrition		1882000		1555372		-1555372
1993	Mgt, Health and Nutrition		1882000		1413974		-1413974
1994	Mgt, Health and Nutrition and transportation of skin	Selling skin	4882000	68,512,500	3334472	46,794,959	43460488
1995	Mgt, Health and Nutrition		1932000		1199620		-1199620
1996	Mgt, Health and Nutrition	Tourism	1932000	1,300,000	1090564	733,816	-356747.5
1997	Mgt, Health and Nutrition	Tourism	1932000	1,300,000	991421	667,106	-324315.9
1998	Mgt, Health and Nutrition	Tourism	2032000	1,400,000	947943	653,110	-294832.7
1999	Mgt, Health and Nutrition	Tourism	2032000	1,300,000	861766	551,327	-310439.5
2000	Mgt, Health and Nutrition	Tourism	2032000	1,300,000	783424	501,206	-282217.7
2001	Mgt, Health and Nutrition	Tourism	2032000	1,500,000	712204	525,741	-186462.8
2002	Mgt, Health and Nutrition	Tourism	2290000	1,300,000	729665	414,220	-315444.5
2003	Mgt, Health and Nutrition	Tourism	2290000	1,800,000	663331	521,396	-141935.5
2004	Mgt, Health and Nutrition	Tourism	2290000	2,350,000	603029	618,828	15799.875
2005	Mgt, Health and Nutrition	Tourism	2290000	3,500,000	548208	837,872	289664.38
2006	Mgt, Health and Nutrition	Tourism	2740000	3,800,000	596304	826,991	230686.88
2007	Mgt, Health and Nutrition	Tourism	2740000	3,000,000	542094	593,534	51439.614
2008	Mgt, Health and Nutrition	Tourism	2950000	3,000,000	530583	539,576	8992.9395
2009	Mgt, Health and Nutrition	Tourism	2740000	3,000,000	448012	490,524	42512.078
2010	Mgt, Health and Nutrition	Tourism	2740000	4,000,000	407284	594,575	187290.97
2011	Mgt, Health and Nutrition	Tourism	5870000	5,300,000	793216	716,192	-77024.43
2012	Mgt, Health and Nutrition	Tourism	5870000	5,800,000	721106	712,507	-8599.218
2013	Mgt, Health and Nutrition	Tourism	5870000	6,000,000	655551	670,069	14518.16
Total			95040000	119,462,500	49220052	57,963,549	8,743,498

Mgt-Management, NPV-Net Present Value

Table 4. Costs and benefits from the crocodile farm

4.6 Benefits to local community from Kaole crocodile farm

4.6.1 Characteristics of respondents in the study area

Table 5. Characteristics of respondent

Parameters	Range/classification	Number	%
Age of respondent (years)	below20	4	4
	21-40	70	74
	41-60	16	17
	61-80	4	4
	Total	94	100
Sex of respondent	Male	48	51
	Female	46	49
	Total	94	100
Education of respondent	Primary education	79	84
	secondary education	11	12
	Tertiary education	1	1
	Informal education	3	3
	Total	94	100
Economic activities	Fishing	75	80
	Business	19	20
	Total	94	100

Age of respondents varies; where below 20 years were 4%, 21-40 were 74%, 41-60 were 17% and 61-80 were 4%,. Respondent by sex were more or less similar where male were 51% and female were 49%, both sex were being involved in selling their product to tourists attending in the crocodile farm.. Education level of surveyed households in the study area; majority (about 84%) as indicated in table 2 had a primary education. The reason of low education level is due to poor economic status. Table 2 80% of the respondent interviewed their main economic activities is fishing where by only 20% business people. Youth from surrounding villages are being employed in the crocodile farm and others selling their local product to tourists.

Bagamoyo is an area near to the Indian Ocean where most of the people depends on fishing as their major Economic activities, few of them depends on business.

Table 4 shows 25 respondents among 94 recognize the benefits to the community derived due to presence of crocodile farm.

Table 6. Respondents aware of the benefits of mamba crocodile farm to local community

Village	Number of people	%
Shaurimoyo	8	24
Madukani	9	30
shuleya secondary	8	26
Total	25	27

Table 5 describes the benefits (opportunities) that the local community gains from crocodile farm, where selling local product is about 4%, Selling foods is about 5%, Selling water and ice cream carries about 7%, Selling dead cow is about 2%, Employment opportunity is about 4% and Tourism activity carries about 11%.

Table 7. Benefits derived from Kaole Crocodile Farm to the local community.

Village	Benefits					
	Selling local products i.e. culture	Selling foods	Selling water and ice cream	Selling dead cows	Employment opportunity	Tourism activity
Shaurimoyo	3	3	6	3	0	9
Madukani	0	10	7	3	3	13
shuleya secondary	10	3	10	0	10	10
Total	4	5	7	2	4	11



Figure 5. Local product offered to tourists at Kaole Crocodile Farm

The above picture describes local products (Ornamental rings, chains and bangle) which local people are selling to the tourist. In the farm local people on surrounding village are allowed by farmer to enter and sell their products. These products are made locally in Tanzania and have greater value to the stakeholders involved as people being employed themselves and receive some cash.

CHAPTER FIVE

5.0 DISCUSSIONS

5.1 Reproductive rates of Nile Crocodiles on the Farm

In the crocodile farm where the investigation was based many incubated eggs do not give rise to the fingerlings. This was reported to be because of environmental factors mainly temperature. Fingerlings also suffered mortalities due to dirty water. Normally water needs to be changed after two days but if water takes long time without replacement it results in to diseases which kills young and adult crocodiles.

Young female crocodiles reached sexual maturity at a body size of around 2.6 meters, while male mature with body length of 2.7 to 3.1 meters, this achieved around 12 to 15 years old. The female Nile crocodile is an attentive parent, after laying up to 60 eggs it cover the nest with sand and guard it for the entire incubation period of around 90 days (Cardeilhac and Larsen, 1981). Figure 2 described crocodiles ranges from 1 to 2 years; these are crocodiles which are not legal allowed to be harvested for skin purposes in natural condition. Figure 3 describe crocodiles aged 3 to 5 years with length of 2.5 feet allowed to be harvested for skin purposes. Figure 4 describe crocodiles aged from 12 to 23 years with length from 2.3 meters to 2.8 meters ; matured ready for reproduction.

For several crocodile species the period between mating and egg laying is known to be 3-6 weeks, but longer periods have been reported. American alligators, during the act of egg laying, become extremely docile and the eggs may actually be caught by hand as the female lays them (Cardeilhac and Larsen, 1981). A similar trance like state during laying has also been reported in the Nile crocodile.

5.2 Products extracted from Nile Crocodile on the Farm

As the crocodile is an endangered species, the production and trade of live crocodiles and any Crocodile product, such as skins, skin products and meat, are controlled and traced by the Convention for International Trade in Endangered Species.

While the Tanzanian experience has been more towards the capture and export of animals from the wild, some attempts have been made to farm wild species for meat and skins (crocodiles, ostrich) or the sale of live animals (tortoises, snakes, birds) with varying degrees of success. It would seem that some of these attempts failed or were suspended (such as the Hambo Crocodile Village) due to policy changes within CITES that temporarily restricted the export of skins.

However, some true game farming is beginning, as evidenced by establishment of several farms such as Kaole Crocodile Farm, where the propagation of commercial species is reducing the need for wild capture). While Tanzania has very few game farmers, it is fortunate to have a considerable number of live animal dealers and with a long-term commitment and who are developing the appropriate technologies specific to breeding Tanzanian species in captivity. With time they could well become true farmers (breeding producers), depending upon future ecological and economic trends (Lungren et al., 2000).

5.3 Costs and price for various crocodile products in Tanzania.

Live crocodile are sold for the purposes of farming activity to farmers. The Prices of crocodile skins vary depending on the grade; Grade one is sold at high price compared to grade two and three because of its high quality.

However, the current market values for Nile crocodile skins (dependent on a whole array of factors; size, number, quality and freight) averaging from USD 2 to 5/cm² of belly width according to grade (Whitaker, 2007). On the other hand, the current prices paid by Ethiopian buyers are abysmally low: from USD 0.35 to 1.70 /cm² of belly width.

The skin is the major driving force causing decline of Nile crocodile in the wild. Ironically, exploitation for skins has proved to be a valuable tool in Nile crocodile conservation that provides an incentive for people to protect the species and its habitat (Ross, 1998). Although listed on Appendix I of the Convention on International Trade in Endangered Species, where most international trade in this species is banned, it has been downgraded to Appendix II in a number of countries, allowing a certain level of commercial utilization and trade, mainly in the form of ranching (Ross, 1998). Appendix I include species threatened with extinction. Trade in specimens of these species is permitted only in exceptional circumstances. Appendix II includes species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival.

5.4 Costs and benefits of Crocodiles farming.

Net Present Value is the sum of all the discounted future cash flows. It is useful tool to determine whether a project or investment will result in a net profit or a loss. A positive Net Present Value indicates profit, while a negative Net Present Value means losses. From the result in Table 6 Net Present Value was positive (Tsh8,743,498) whereby BCR was greater than one (1.2) indicating that crocodile

farming was profitable to the farmer. However the project is profitable but it is very low compared to years of investment, this caused by number of challenges including lack of capital, breeding, survival of embryos during incubation and growth of fingerlings which are very big problems.

Crocodile farming was attempted in Tanzania between 1989 and 1995 (Jenkins et al., 2004). There were 6 crocodile farms, none of which has exported skins since 1995 (Jenkins et al., 2004). Lack of capital, cash flow and expertise, reliability of food supply were principal factors causing low profitability of the Farming system. Against a background of these difficulties, an abundant wild population offered wild harvesting as an attractive alternative form of utilization (Jenkins et al., 2004).

5.5 Benefits local community gains from the Crocodile Farm

It is evident that Kaole crocodile farm is beneficial to the local community, providing employment at a much smaller scale, however the farm is not engaged in commercial viable activities at this time. It can be observed that tourism activity contributes much as an opportunity to the local community in terms of employment where many young people are being employed through Tour guiding, Selling water, ice cream, foods and local product seems also as an opportunity to youth where they are selling their products to the tourist and increasing their income. In addition, other people get employed in the crocodile farm which helps them to run their daily life and also selling dead cows to owner of crocodile farm rather than throwing away thus receive certain cash.

Figure 5 describes local product offered by indigenous community to tourists around Kaole Crocodile Farm where local people gain cash from selling these products.

It is logical that the interests of the local communities are best served when the most activities possible that can be carried out in a harmonious way are engaged in their area. This gives them the best chances for training and employment, markets for their produce, contacts with the outside world, etc. Whether on adjacent private, village or general land, or in a Wildlife Management Area, the same principle applies, in that, compared to running just one wildlife activity such as a game viewing tourism, or safari hunting or cropping, the integration of all three activities under the appropriately-experienced management provides the most opportunity for benefit for the community (Lungren et al., 2000).

6.0 CONCLUSIONS

According to results of this investigation, reproductive (hatching) rates of crocodile are very low. This requires enhancement of hatchability to maximize profits. Crocodile products extracted from crocodile farms are live crocodiles and skin; the skin being the major driving farming activity. The prices of different crocodile products; live crocodile at 20 US\$ for farming purposes and tourism hunting a crocodile is sold at 1500 US\$. Local communities gain from Crocodile Farm through selling local product, foods, water and ice cream, employment opportunity and Tourism activity. The presence of crocodile farm provides chances for communities to earn cash. In the benefit-cost analysis the Net Present Value was Tsh.8,743,498 and benefit cost ratio was 1.2 indicating profitability to the farmer.

7.0 RECOMMENDATIONS

Reproductive rate of crocodile is very low only 7%; fertility and hatchability of Nile crocodile eggs it can be achieved by genetic selection of the breeders, a balanced diet and eggs should be collected and incubated in a special incubator. The specialist should find the reason as to why some other many eggs do not incubated.

-More studies are needed to test whether eggs are embryonated or not in order to help farmer to maximize their profit.

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