THE ROLE OF BUTTERFLY FARMING IN FOREST CONSERVATION AND COMMUNITY DEVELOPMENT IN KENYA

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ABSTRACT

Butterfly farming is the breeding of butterfly pupae for sale to butterfly houses, exhibitors and natural museums. In Kenya, butterfly farming projects are located adjacent to natural forests where the utilization of the rich butterfly resources in these forests is made possible. The farming of butterflies in Kenya begun in 1993 as a local community initiative to directly generate income to the community so as to enhance conservation of forest resources which were otherwise threatened from over exploitation.

Remarkable developments have been recorded by the butterfly farming rural community in Kenya. Over 700 rural households derive their livelihoods from the forest through butterfly farming. Improvements in food security, primary health care and education have been recorded. The average annual per capita income of a dedicated and organized butterfly farmer has risen from US$ 20 to US$ 735.5 between 1993 and 1997. Butterfly farming has improved the local eco-tourism and conservation education, and has led to better involvement of the local community in managing and conserving forest resources.

However, despite all these positive developments butterfly farming in Kenya has a number of challenges to meet to develop its full potential. These are mainly those challenges that are related to pupae production such as access to the proper farming facilities and farming technology by all the farmers, and those related to access to regular markets and improved prices of the pupae.
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INTRODUCTION

This masters thesis was carried out from the first of September to the thirtieth of November 2001 in Kenya’s Coastal and Western Provinces. The study area covered communities living adjacent to Arabuko-Sokoke Forest at a radius of three kilometres from the edge of the forest, the Kipepeo Butterfly Farm and Shimba Hills communities (who sell their pupae through the Kipepeo Butterfly Farm at the Coast) and Isecheno community (living) at the periphery of Kakamega Forest in Western Province. For a long time, these communities have been depending greatly on the forests for their livelihoods. These forests are rich in flora, fauna, and mineral deposits. They are ranked as priority areas for conservation in Kenya by the International Union for the Conservation of Endangered Species because they are important habitats for endemic, threatened and rare species of birds, mammals, insects and plants. However with the increase in the human population adjacent to these forests, the demand for materials from the forest to satisfy the population’s needs has been higher than the rate at which natural replenishment takes place thus threatening the survival of the forests.

To enhance conservation of the forests while at the same time enabling the adjacent communities to derive their livelihoods from the forests, a butterfly farming enterprise was started which makes use of the rich butterfly resources found in the forests. Initial funding of the enterprise came from the United Nations Development Programme (UNDP) Global Environment Facility (GEF) through the Non Governmental Organisation Small Grants Programme. The rural community adjacent to these forests are licensed to collect butterflies from the forest and rear them to produce pupae which they sell to butterfly houses, exhibitors, and museums in Europe and America. By so doing, they have been actively involved in conservation of the forests while at the same time directly generating an income out of it.

The purpose of this study was to investigate how the rural (butterfly) farming community has developed on the basis of butterfly farming, the challenges facing butterfly farming in Kenya and to some extent, how butterfly farming has impacted on forest conservation in Kenya. The thesis consists of a main body organised in nine sections and appendices at
the end. The first section is an introduction. Section two provides the background information which comprises a detailed review of literature in forest conservation and management; butterflies, their collection, farming and trading; and development of rural areas. Section three outlines the study rationale, aims and objectives while the fourth section describes the location of the study area. The fifth part presents the methods of data collection and analysis while section six gives the analysis of the research findings. Sections seven and eight discuss the results and draws conclusions respectively while section nine lists the literature cited.

BACKGROUND

Forest conservation and management
All over the globe, forests are being degraded and lost at a rate unprecedented in human history (ITTO, 2000). Large parts of formerly untouched boreal forests have become the object of timber exploitation. Old-growth forests in temperate zones, most of them in industrialised countries, continue to disappear or are being degraded. Tropical rainforests are diminishing at a rate of around 15 million hectares a year of which, estimates show that, 100 acres of the global rain forest cover is destroyed per minute (ITTO 2000, Hurst 1990). For example, the Guineo-Congolian rainforest that once spanned West, East and Central Africa now exists as relatively small islands of habitat surrounded by savannah and human settlement (Brend 1999). This high loss of natural forests is as a result of the ever-increasing human demand for land, food, timber, energy and minerals.

Forest destruction inevitably means the loss of a large part of the earth’s terrestrial biodiversity and is a major contributor to the current growth and concentration of atmospheric greenhouse gases. It also endangers the livelihoods of many people, since forests provide shelter, employment, and health services, especially for the poorer segment of the world’s population. This is especially so because, of the one billion people living in or near forested areas in developing countries, thirty to fifty percent are estimated to be poor and highly dependent on forest products (ITTO, 2000). Conservation
of the natural forests involves the use of the resources in these forests in such a way that it provides the greatest benefit for the highest number of people for the longest period of time. This ensures resource utilisation by all on a sustainable basis.

Natural forests are important as they provide multiple goods, values and environmental services (Young and Giese, 1990). At the global scale, they play a significant role in the functioning of the atmosphere and biosphere through photosynthesis, evapotranspiration, decomposition, succession and other natural processes (Houghton et al, 1990). At local and regional scales, the ecological processes and biological diversity of natural forests provide the foundations for stable human communities and opportunities for sustainable development (Salati and Vose, 1984, Houghton et al, 1990, Young and Giese, 1990). Local and global climate patterns are influenced by the interaction of forests and the atmosphere. Forests are thought to influence the convection of currents, wind, precipitation patterns and rainfall regime because of their ability to reflect solar heat back into space and to receive and release large volumes of water (Houghton et al, 1990, Salati and Vose, 1984). With this realisation of the increased forest loss coupled with the crucial role natural forests play in supporting human life, there is a need to develop and adapt a holistic approach to natural forest conservation and utilisation of the forest resources locally, nationally and globally. Natural forests should not be conserved *per se* but because those living adjacent to these forests are able to derive their source of livelihood from them in a sustainable way (Simeox and Calvert, 1982).

*Kenyan Forests, Management and Conservation*

In Kenya forests (cover) comprise two percent of the total land area (Wass, 1995) categorised as, Coastal forests (82,500 ha), Dry forest (210,000 ha), Montane forest (748,500 ha), and Western rainforest (49,000 ha). Plantation forests are estimated to
cover 160,000 ha\(^1\) appendix 1 gives details of the individual forests. Wass (1995) observes that these forests are a habitat to forty percent of Kenya’s large mammals, thirty-five percent of butterfly species, thirty percent of bird species including twenty seven forest dependent and twenty six forest generalised and seventy percent of all threatened bird species (occur in these forests). Further, these forests contribute fifty percent of all the woody plant species found in the country.

Kenya’s natural forests are jointly managed by the Forest Department (FD) and the Kenya Wildlife Service (KWS) under protection status of either County Council Trust land (CC) or Forest Reserve (FR) as outlined in a memorandum of understanding between the two institutions that became operational from 5 December 1991 and valid for twenty-five years (KIFCON, 1994). The management is aimed at conservation of Kenya’s biological diversity by preserving selected examples of the different forest communities including forest woodlands, mangroves, population of endemic and threatened species of plants and animals and important areas for maintaining the genetic diversity of plants and animals. These forests include Arabuko-Sokoke, Shimba Hills, Mt. Kenya, Kakamega, Aberdares, Mangrove forests at Malindi/Watamu area, the Chyulu Hills among others. Wass (1995) observes that some forests are of top priority for biodiversity conservation. These include, Mau Forest Complex, Mathews Range, Tana River, Marsabit, Mount Kenya, Aberdares, Taita Hills, Shimba Hills, Kakamega, and Arabuko-Sokoke.

Of these, Arabuko-Soke was ranked top most priority area for biodiversity conservation in Kenya by the International Union of Convention on Endangered Species. This forest contains the greatest area of natural complete forest cover at the Kenyan Coast (Stattlerfield et al, 1998, Larsen, 1996, Fanshawe, 1992). It has an amazing (large) wealth of biodiversity ranging from microscopic plants such as algae to woody plants, insects, birds and mammals (among others) thus making it a world class reserve (Fanshawe 1992, Bibby 1992, Bennis, 1993). Twenty percent of Kenya’s bird species and about three hundred and five of the butterfly species have been recorded in this forest. Four of the

\(^1\) [http://www.mec.go.ke/biodiversity.htm (12/14/00 4:27 pm)]
butterfly species are endemic\textsuperscript{2} to this forest (Stattlerfield et al, 1998, KIFCON 1995). Fifteen rare and endemic bird species are restricted to the Kenyan coast; six of them, considered globally threatened,\textsuperscript{3} have their habitat restricted to the Arabuko-Sokoke Forest. The forest is also a home for three rare and endemic mammals\textsuperscript{4} (Larsen, 1996, Fanshawe, 1992).

**Butterflies and Butterfly Collection, Farming and Trading**

Butterflies are insects belonging to the class \textit{insector} and order \textit{lepidoptera}, they are further subdivided into five families namely, \textit{Papilionidae}, \textit{Pieridae}, \textit{Lycaenidae}, \textit{Nymphalidae} and \textit{Hesperidae} (Larsen, 1991, Larsen, 1996). Larsen (1991) further classifies them into twenty subfamilies and hundred and eighty genera. Butterflies are generally very colorful winged insects with an overlay of tiny scales which are arranged much as the tiles of a roof with each scale having a single colour pattern (Morris et al 1991, Ayiemba 1995, Emmel and Carraway 1990, Emmel and Emmel 1990, Larsen 1996). The aesthetic nature and positive appeal of butterflies are almost universal amongst humans (Parsons, 1992). New (1991) advances that the positive attitude towards butterflies is due to the fact that they are relatively large, often very pretty and rarely harmful. Perhaps this could explain the increasing enthusiasm in butterfly studies and associated research. According to Larsen (1993), butterfly communities are specific to ecological zones and as such less than one percent of them are ubiquitous. Most of them have their habitats restricted to the lowland forest zone while the less specialized savannah species thrive in agricultural lands and disturbed forest zones.

\textit{Life cycle}

In general, butterflies have a short life span averaging four weeks (Larsen 1996, Larsen 1993, Courtney, 1984, Singer 1984). Their life cycle consists of four stages, each stage lasting between one to four weeks (Larsen 1996). Like other living creatures, the life of a butterfly begins when gametes of mature male and female get fertilized after a mating

\textsuperscript{2} Acrae matuapa, Charaxes blanda kanga, Balliechila latrimagnata and Baliochila stygia.

\textsuperscript{3} Otus ireneae, Turdus fischari, Anthus sokokensis, Anthroptes pallidigaster, Sheppardia gunning and Ploceus golandi.

\textsuperscript{4} Cephalophus adersi, Bhynchocyon chysopygus and Deogale omnivora crassicauda.
process. Larsen (1996) observes that there is often competition for females and as such the most fit male gets the chance to mate with the available females. The other males are eliminated in a fight which determines the fit male to serve the females in that territory. The fertilized female gamete (the egg) is then laid on the right food plant which must be in the correct growth condition. Such a plant must have young shoots. This is vital because it determines the survival of the larvae once the egg hatches.

The larva is essentially a feeding stage. Thus an abundant supply of fresh and tender leaves of the correct food plant is essential as preferences differ among species and habitats (Larsen, 1996, Courtney, 1984, Singer, 1984). In its preparation to pupate, the larva wanders searching for the right position of the plant to pupate. This is important as the pupa stage is essentially an immobile stage and hence needs to be camouflaged for protection against enemies in order to survive to adulthood. For some species, the pupa stage is the stage of diapause characterised by a season of environmental stress and hostility (Larsen, 1996, Larsen, 1993, Emmel and Garraway, 1990, Emmel and Emmel, 1990). As opposed to the larva which is essentially an eating machine, the pupa is a biological factory where the simple tissues of a larva are rearranged to form an adult butterfly (Larsen, 1996). Larsen states that just before the pupa hatch; all features of an adult butterfly are clearly visible. At this point the pupa case splits at the head and the thorax to release the adult butterfly which crawls out often perching on the empty pupa case with the tiny wings hanging out limply. After a slight pause, the adult butterfly begins to pump its wings ready to brave the still lie wait, to mate and to restart the lifecycle once again.

Diversity and Distribution of Kenyan Butterflies
Worldwide, there are approximately 18,000 species of butterflies of which 3,600 occur in the African continent, further 870 of these species are said to occur in Kenya (Larsen, 1991, Larsen, 1993). In Kenya, these species thrive in different ecological conditions. Coastal forests contain a large proportion of species that are endemic and most species hardly penetrate inland. Few species are able to survive outside the forest. The forests include Tana River, Arabuko-Sokoke, and Shimba Hills. In these forests the dry seasons
are not pronounced as they are twenty kilometers further inland (Larsen, 1996). A large number of Savannah species are common in the Eastern and Northern Savannah regions while in the extreme North and parts of the Rift Valley the desert and sub-desert species thrive (Map 1). The area East of Lake Turkana supports the Sudan Savannah species while towards the southern end of the Rift Valley the Masaai Savannah species thrives. Butterflies in these zones contain some endemic species. The Rift Valley creates a barrier between the butterflies of the Western and Central forests. This area is also highly elevated to support the species from the Sudan and the Masaai Savannahs, and neither does it evolve species of its own (Larsen, 1993). Larsen observes that the semi-montane central highlands’ forest vegetation, strongly limit the number of equatorial forest species that can occur in the forest. In the isolated Eastern and Northern forests, there is a degree of endemicity in the species of butterflies while in the Western Forest, which is the remnant of the equatorial rain forest, butterflies are mainly characteristic of the forest and Savannah vegetation areas. South of Kavirondo, forest butterflies can be found in the small forest relics and some savannah species from the Zambesi have their ranges stretching into the zone.

Importance and usefulness of butterflies

Butterflies for a long time have been the subject of interest to both amateurs and professionals (Brinckerhoff and Sabido, 2000, Santiapillai, 1999, Larsen, 1996, Morris et al 1991). According to Brinckerhoff and Sabido (2000), interest in lepidoptera became a serious vocation for many people in western countries during the Victorian era roughly between 1860 and 1910. This period was characterised by collection, identification and cataloguing of lepidoptera from all over the world by members of the English aristocracy. As such, the Victorian era formed a foundation for the evolution of interest and studies in lepidoptera and more specifically in butterflies. Studies have shown that butterflies have continued to play a major role in many areas of scientific research (Persons, 1992, Larsen 1996, Morris et al, 1999). Larsen (1996) points out five areas of scientific discoveries that have resulted from butterfly research. These are; (1) the discovery of the heredity characteristic of the Rhesus factor in human blood. This was based on information gained

5 http://www.earlhamm.edu/-biol/kakamega/ecology.htm (12/18/00 12:41 pm)
from the genetic study of polymorphic Swallow Tails. (2) Much of the early information on chemical communication among insects came from studies on butterflies and moths and some of the data proved valuable in devising pest control strategies based on trapping of the male insects using synthesised pheromones.

(3) Butterflies have been used in population dynamics. They have yielded some of the most interesting results including the fact that local population are often not permanent but regularly go extinct followed by spontaneous re-introduction. (4) Butterflies have been used in studying evolution of plants by co-evolution of insects. As such plants have evolved new and more toxic deterrents and butterfly larvae have become increasingly adopted at overcoming them. (5) Butterflies have been found to be vital geographical and ecological indicators; they form communities which are specific to each of the geographical sub-regions and to different types of ecological conditions. Further studies have shown that butterflies are a valuable resource in the lepidoptera trading industry (Parsons 1992, Morris et al, 1991). This trade deals with both live and dead stock of butterflies. According to Pyle and Hughes (1978) and Pyle (1981), the trade in butterfly dead stock consists of low quantity/high value also termed as the specialist trade and the high quantity/low value also known as the decorative trade. Parsons (1992) estimates the annual trade in butterfly stock to be in the range of US$ 100 million. Butterflies are also vital in plant pollination, monitoring environmental effects when using chemicals to control pests, and in identifying key areas for conservation (Morris et al, 1991). On the other hand butterflies have extensively been used in the social life such as weddings and fundraising. Brinckerhoff and Sabido (2000) observe that people of means have been purchasing butterflies for release at weddings and other special occasions such as raising funds for street children. In the handcraft industry, butterfly wings have over a long time been used in decorations (Parsons, 1992). Butterflies have also been instrumental in the conservation of tropical forests, development and promotion of rural economies through eco-tourism and butterfly farming (Young, 1986, BOSTID, 1983, Parsons, 1992, Santiapillai, 1999).
**Collection and Trading of Butterflies**

The origin of the butterfly collection and trading can be traced to the maritime exploratory expeditions from Europe to various parts of the world. As early as the seventeenth century, impressive butterfly specimens had reached Europe from the Dutch colonies (Parsons, 1992). Parsons notes that this period was the beginning of collection of more spectacular butterfly species such as the swallow tails from what has now become one of the leading regions in the butterfly farming and trading industry in the world, the Indo-Australian Region. Historical events like exploration coupled with the spread of Christianity, colonialism, discovery and improvement of communication by sea and postal services played a significant role in the development of the Lepidotera industry. For example the settlement of Europeans in countries such as Papua New Guinea was crucial to some home based Lepidopterists. Persons (1992) observes that missionary Rev. Diamond Jenness based at Bwaidogo Mission on Goodenough Island in Papua New Guinea in the period 1911-1912, was asked to collect butterflies and other insects for Professor, E. B. Poylton of Oxford University. Other world events like the first and second world wars contributed to the development, collection and sale of butterflies. For example, Wyatt (1955) points out that during the period of world war two, Ornithoptera become highly priced for their market value resulting from increasing demand from Australian and American servicemen who were fighting in New Guinea. In Taiwan, butterfly collection began in 1880 while in Malaysia, demand for butterflies emerged in the 1950s (Unno, 1974, Jackman and Regan, 1987).

With the increase in interest and demand for butterflies across the world, more and more people have been involved in the collection and exhibition of butterflies. The trade in butterfly has developed from the collection and sale of dried butterfly specimen (dead stock) to including sale of live butterflies (livestock) as explained by Pyle and Hughes (1978), Pyle (1981), Collins and Morris (1985), and Morris (1986). The increase in demand of livestock has resulted in the development of techniques in raising the butterfly pupa under a controlled environment to boost production for sale. This production in a controlled environment has come to be known as butterfly farming (BOSTID, 1983, Parsons, 1992).
**Butterfly farming**

Butterfly farming is the breeding of butterfly pupae for sale. The practice capitalises on the life cycle of the butterflies which is relatively short. The length of the life cycle from time of oviposition of the egg to emergence of the adult varies according to the species. In some species, it can be between 22 to 81 days while in others, it can be 63 to 78 days like the Homerus Swallowtail (Emmel and Garraway, 1990). The end product for sale is pupa, which is immobile thus making it possible to transport it over long distances. The farming of butterflies is dependent on the native vegetation, which the butterflies feed on in their various stages of their life cycle. In order to attain good results, a butterfly farmer has to maintain a garden of native plants in and around the farm that constantly supply food to the larvae. This new practice of utilising undomesticated insects is not expensive nor does it involve any sophisticated technology. All a butterfly farmer needs is a means of transport to go to the forest to collect the butterflies for breeding and perhaps an irrigation mechanism in cases where there is insufficient rain to sustain the vegetation.

If properly implemented, butterfly farming can be beneficial for conserving tropical forests. With an appropriate legislative framework that cut out middle men, butterfly farming can be effective in utilising this highly sustainable resource and the funds can be directed back into habitat protection (Parsons, 1992). Further, Parsons continues to argue that the practice can provide rural economies with much needed income which in turn reduces the needs of people living in or adjacent to tropical forests to exploit them in unsustainable ways. The farming of butterflies is being done in a number of countries globally and notable examples include Costa Rica, Papua New Guinea, Kenya, Thailand, Taiwan, Central and South America among others (Young, 1986). The current world’s leading producers of butterfly pupae are; Malaysia, Philippines, Thailand, Taiwan, Kenya, Madagascar, United States, El Salvador and Costa Rica.⁶

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How a Butterfly farm works.

The daily operation of any one given butterfly farm has many components. They can be broadly divided into three major ones, notably, the entomological facets of breeding the butterflies, the horticultural duties of propagating the appropriate food plants and the accounting and the other paper work (ibid). The entomological and horticultural components further depend on a number of factors such as the species type being bred, the number of species, and the location of the farm and the level of establishment of the farm. For example, Gagne and Gressitt (1982) cited by Parsons (1992:21-22) state that, “some species in the genus *Ornithoptera* which have more specialised ecological requirements can only be effectively farmed if the farm is located in close proximity to areas of prime habitat containing healthy world populations”. The number of species being cultivated is important when it comes to organisation of the farm and this (organisation) too depicts how established a farm is. For example, Parsons (1992) observes that in order to locate all the early stages of the butterfly, the farmer needs to adopt the “idealised” model (appendix 2) of organising a butterfly farm as outlined by Pyle and Hughes (1978) cited by Parsons (1992). The model makes it easier for the farmer to accurately assess the amount of stock present within the farm area. For less established farms, the food plants are treated in a way similar to planting normal food crops and often in a rather randomised fashion. Such farmers utilise small areas adjacent to the village buildings. In such a set up, the farmers do not concern themselves with the overall appearance of the butterfly gardens nor do they see the necessity of maintaining them in any form of neatness. In such cases, farmers maintain colonies of different butterfly species by varying the food plant species with a combination of flowering and leafy plants (BOSTID, 1983). Such a combination generates an enriched butterfly habitat garden that is capable of supporting breeding populations that if well managed can be self-reproducing. The farmer must do routine collection of the ova and secure them in locations where predators such as ants, spiders, wasps, parasitic wasps and lizards cannot get to them. In a case where the butterfly garden is a caged flight area, the ova can be secured in small plastic and predator free boxes. The ova is checked on a daily basis to ensure that the larvae are removed placed in potted food plants and returned in the cage. On the other hand, if the farmer adopts the “idealised” model, then the wider spacing of
the food plants will ensure that there is less concentration of predators and parasitoids of the ova. High standards of cleanliness must be maintained in flight caged enclosures to ensure high survival rates of the pupae.

Butterfly Farming in Kenya
The history of butterfly farming in Kenya can be traced back to 1993 when the Arabuko-Sokoke Kipepeo Project was established (Ashley, 1999). This project was and still is organised as community based conservation as well as an income generating endeavour. The initial funding source was the United Nations Development Programme Global Environmental Facility (GEF) through the Non Governmental Organisation Small Grants Programme (Maundu, 1993). The project whose aims were to raise the economic status of the people living adjacent to the Arabuko-Sokoke Forest and enable them realise the benefits of conservation has also led to the starting of other butterfly farming initiatives at Shimba Hills and Kakamega Forest.

Currently there are four butterfly farming projects in Kenya namely, Kipepeo Butterfly Farm, The Mida Butterfly Farm, Shimba Hills Butterfly Community Development and Kakamega Butterfly Community Development. Butterfly farming is one of the ways rural people are getting empowered to secure sustainable livelihoods. In this way they are at the same time able to conserve the environment and actively involved in the development of rural areas (KIFCON, 1992).

Development of Rural Areas
To day, there are over 1.3 billion people who are compelled to live on less than a dollar a day (World Bank, 1996, FAO/WHO, 1992). The World Bank has noted that more and more people go hungry and at risk of micro-nutrient deficiency, and the number of underweight children below five years is on the increase. Further, studies have shown that, poverty is more prevalent in rural areas than in cities and that the deep poverty in rural areas is a major contributor to urban poverty (Narayan et al, 1999, World Bank, 1996, FAO/WHO, 1992). Rural people make up about seventy percent of the population in South Asia, Africa and East Asia and the Pacific, about fifty percent in Middle East
and about thirty percent in Europe and Central Asia, Latin America and the Caribbean. On many
continents, rural poverty is pervasive and persistent; access to basic human needs such as food, shelter; education, potable water; health care and sanitation are far less available in rural areas compared to cities. The problems of malnutrition, low life expectancies and high infant-mortality are more severe in rural areas (World Bank, 1996).

Rural development is that development which meets the needs of the present without compromising the future generation’s ability to meet their own needs (World Commission of Environment and Development, cited by KIFCON, 1992). Such development lies in the hands of many actors who collectively struggle to contribute positively and significantly to the social, economic, political, spiritual and cultural well being of rural inhabitants and rural areas as a whole. Havnevik and Malmer (1999) advance that “important actors influencing the process of rural development are the rural farmers and entrepreneurs and their families, local and central government, interested organisations and researchers”. Rural development differs from place to place depending on the local needs. The goal of development is not growth but the well being of poor people (Chambers, 1993). Chambers further observes that poor people define their well being in different ways. Many are likely to want good livelihoods rather than simply employment where livelihoods mean adequate assets, food and cash for physical and social well-being, and security against impoverishment. In the developed world, development of rural area needs has over time moved through different phases. In the nineteenth century, the shift was from subsistence to commercial-based household. This was characterised by the agrarian revolution with new technologies and farming systems. This resulted in self-food sufficiency at household and national levels. This was followed by industrialisation and production of cheap food which resulted in massive rural-urban migration of agricultural labour force. The result is a change in the demographic profile of the rural population. This development is as well evident in the Nordic countries (Havnevik and Malmer, 1999).
In the developing world, rural development involves access and provision of the basic human needs. This is being hampered by poor institutional set ups which seem to be gender discriminative and lack of empowerment especially to the socially marginalised groups like the women and the girl child. For example most African cultures do not have room for property ownership and/or inheritance by the females, yet it’s the females (household mother and the girls) who do most of the domestic work including farming (Hilhorst, 2000, Jiggins, 1998, Mellor, 1995). Studies have shown that females contribute significantly to the total agriculture production in developing countries (Jiggins, 1998, Boserup, 1998, Bryceson, 1995) and that “women’s work sustains man’s power” (Jiggins, 1998) yet they do not own any land nor do they have access to credit facilities. Further, women and girls spend long hours of the day fetching fuel wood, water and food. Furthermore the education of the girl child is not taken seriously. Instead girls are encouraged and sometimes forcefully married at very young ages. In such cases girls are seen as a source of wealth (bride price) to the family and as such little attention is paid to their education needs compared to the boy child. However, Jiggins (1998) observes that social investments in females like in education can lead to reduced family size, higher family income, better family nutrition, and improved quality of life thus leading to development. HIV/AIDS is another important problem when it comes to rural development in developing countries. This epidemic which is heavily affecting the young and productive labour force is now turning out to be the most important threat to development of rural areas.

Globalisation\(^7\) coupled with the International Monetary Fund (IMF) and the World Bank imposed structural adjustment programmes in the developing nations too have their impact on the rural dwellers and rural areas as a whole. The impact of globalisation is not uniform (Narula and Dunning, 1999 and Long, 1996). A vast number of developing countries continue to experience divergences in their income levels and consumption patterns away from their counterparts in the industrialised countries. Further,

\(^7\)“Globalisation refers to the increasing integration of the world economy and to the decreasing capacity of national state governments to follow policies which diverge from the interests of international capital” (Raikes and Gibbon, 2000:51).
globalisation has so far brought relatively few economic gains to the least developed countries such as those of Sub-Saharan Africa. It has been characterised by restructuring of firms and states, an increase in global competition for markets for goods, closure or sale of locally owned factories to multinationals and the disintegrating of the welfare state (Mingione, 1991). The net result is lack of and/or reduction in employment opportunities for many people (both rural and urban dwellers), diminishing in the provision of state funded welfare services such as clean potable water, medicare, education among others. This is most felt in the rural areas.

Challenges of Rural Development
The World Bank projects world population to increase to eight billion by the 2025 much of which is expected to occur in developing countries (World Bank, 1996) and with a significant rise in the rural sector. Thus given moderate income growth, food needs in developing countries will nearly double. This poses a great challenge to the agricultural sector. Considering the fact that land and water are increasingly becoming scarce, environmentalists predict that future increase in food supply will only be realised from an increase in biological yields rather than area expansion and increased cultivation and irrigation of marginal and fragile environments. The World Bank predicts that this will only be achieved if “international and domestic policies, institutional frameworks, and public expenditure patterns are conducive to cost-effective and sustainable agricultural production; otherwise the required technologies will not be developed and adopted, the supportive infrastructure will not be built and maintained, land and water will not be located to their highest-valued uses and farmers will not have the incentives to maintain and improve the natural resources on which their livelihood depend” (World Bank, 1996:3).

With the continuous population increase comes an increase in demand and utilisation of natural resources. Proper management utilisation and conservation of natural resources to minimise degrading the environment is another challenging task in development. Most natural resources ranging from terrestrial to aquatic occur in the rural areas. Considering the rise in poverty levels in these areas, there is danger of environmental degradation as
the rural people struggle to survive on these resources. This may result in destruction of the ecological system which plays a fundamental role in supporting life on earth. Ecosystems produce renewable resources (such as food, fibre and timber) and ecological services such as carbon and water cycles. Further ecosystem disturbance will interfere with species interaction in a food web and their relations to water flow and biogeochemical cycling which is complex, non-linear, and contain lags and discontinuities, thresholds and limits (Folke et al, 1997). To be able to raise agricultural productivity while at the same time minimising environmental damage, society needs to identify and make proper and productive use of untapped opportunities. This may include improving household health and nutrition by working with women, tapping unused local knowledge, giving smallholders access to services, knowledge and technology, better management of common-property resources and giving rural people a voice through empowerment (Agarwal, 1992, Batliwala, 1994, Dollar et al, 1995, Leach, 1997). This is yet another challenge if meaningful rural economic growth and development is to occur (World Bank, 1996).

Rural Development in Kenya

Rural Kenya is a home for eighty percent of the Kenyan population while at the same time providing employment opportunities (directly and indirectly) for seventy percent of the population, (Republic of Kenya, 1995). Because of this, the Kenyan Government in 1983 started a strategy aimed at development of the rural areas. The strategy which came to be known as District Focus for Rural Development (DFRD) harnesses and mobilises resources to ensure their maximum utilisation for the development of rural areas (Republic of Kenya, 1995). This involved directing and increasing the share of the total resources available in the nation towards the rural areas by, improving agriculture production through activities such as livestock development, water and minor irrigation projects, afforestation, credit and marketing services; development of cottage and small scale industries; development of the social service programmes especially education, health services, sanitation and family planning; development of training programmes at the Youth Polytechnics and Youth Development Centres. Development of minor roads and housing and development and provision of extension services and utilising and
assisting voluntary agencies engaged in development work were also prioritised (Republic of Kenya, 1974, 1979, 1984). Development of the rural areas is aimed at improving the welfare of the rural communities because the bulk of the poor people in Kenya reside in the rural areas and average incomes are much lower in the rural areas than in the urban areas.

To enhance development of rural areas in Kenya, the performance of key sectors of the economy in rural areas needs to be strengthened. This includes agricultural sector, education and health. In Kenya the agricultural sector is the major sources of employment. Estimates show that the sector is a means of livelihood to six million people (Levin, 1994). Strengthening the agricultural sector involves a number of issues such as empowering the farmers by improving their access to information on issues like timely acquisition of required farm inputs at affordable prices, timely planting, management and control of agricultural pests and diseases, timely harvesting and improved storage capacity to minimise losses. Price stabilisation of farm produce is important for strengthening the farmers’ market power. In the past years there has been a decline in prices of major agricultural crops such as coffee, tea, and maize thus significantly affecting their production in subsequent seasons (Republic of Kenya, 1997 and Levin, 1994). Development of rural infrastructure will significantly contribute to agricultural development. Access to good roads and other communication facilities will improve the efficiency and delivery of agricultural produce to markets thus reducing losses especially of perishable products.

Agricultural development can further be enhanced by increasing the total arable land. This will involve increase in total land under crop cultivation (both permanent and seasonal crops) and pastures by increasing land under irrigation. 1993 estimates showed that only 1% of Kenya’s arable land is under permanent crop, 37% under permanent pastures and 660 km square was under irrigation. Improvement of land under crop and pastures will cater for the agricultural needs of the rural nomadic communities. This

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could result in increase in production of beef and dairy products from the rural nomadic communities.

The forest adjacent dwellers in Kenya are resource constrained and are therefore most often poor communities (KIFCON, 1992). To meet their needs sustainably would be to achieve rural development. But as in other parts of the world a common pattern to rural areas is the crisis of livelihoods generated by increasing rural populations and by weak rights and access to natural resources. Sustainable rural development for forest adjacent dwellers calls for strategies which will reinforce the need to off-set the pressures posed on the forest resource both from the commercial, rich and poor people within and around the forests. More important is the potential within the scope of this study to recognise the ability of resource poor forest adjacent dwellers in utilising the forest resources (in this case butterflies) to improve their welfare.

**STUDY RATIONALE, AIMS AND OBJECTIVES**

**Study Rationale**
The livelihood of communities living in and around conservation areas such as forests, have for a long time been sustainably supported by extraction of resources from the forest to meet their daily requirements. Items like thatching grass and building poles, medicinal plants, fruits and vegetables, fish and game meat have been sourced from the forest. However with the increasing human population the capacity of the forests to support the requirements of the population is diminishing (ITTO, 2000). Consequently, forests are increasingly becoming protected areas prohibiting any human activities. However barring local people from using the resources in their environment in the name of conservation will even make the conservation efforts of the government and other agencies even more difficult (KIFCON, 1995). This is because people have evolved over time as custodians of these resources and thus they command a capacity to conserve them in an enabling environment. Therefore in the new situation there is a need by the state to cultivate an enabling environment where the local people are able to directly benefit from these
resources while at the same time cooperate with the state in conserving them (Simeox and Calvert, 1982).

This can be attempted for example by initiating community-based income generating projects that will provide for the local community a chance to sustainably utilise the forest based resources while at the same time ensuring their existence for future generation (Lecup and Nicholson, 2000). Activities like bee keeping, production of silk from silk warm and butterfly farming constitute some examples. To ensure the relevance of such activities to the requirements and needs of the local people and conservation, information is needed on how much income is generated on yearly basis, how the local people use the income, and the impacts on the forest resources. In Kenya, butterfly farming as a forest-community based activity has been started at Arabuko-Sokoke, Shimba Hills and Kakamega Forests as a way to make rural people living adjacent to these forests benefit from them in a sustainable way (Maundu and Sojah, 1997).

**Aims and Objectives**

This study aimed at finding out the various income sources of the rural people in the butterfly farming areas, trends in involvement in butterfly farming by the rural people in Kenya living around natural forest areas, the income they earn from butterfly farming and how they use it, any developments activities that have resulted from farming of butterflies, the challenges facing butterfly farming in Kenya and the impact of butterfly farming on forest conservation.

**Specific objectives**

. How has the rural butterfly farming community in Kenya developed?

. What are the challenges facing butterfly farming in Kenya?

. What is the contribution of butterfly farming to forest conservation in Kenya?
LOCATION OF THE STUDY

Study area
This study was carried out in Kenya, Coast province, Kilifi/Malindi districts and Kakamega district in Western province. The study area covered communities living adjacent to Arabuko-Sokoke Forest at a radius of three kilometres from the edge of the forest where butterfly farming is currently taking place, the Kipepeo Butterfly Farm and Shimba Hills communities who sell their pupae through the Kipepeo Butterfly Farm at the Coast (map 2) and Isecheno community at Kakamega Forest. Arabuko-Sokoke Forest is situated 80 km north of Mombasa, Kenya’s second largest city and lies 35 km North of Kilifi town and 17 km South West of Malindi town (Maundu, 1993). Kipepeo Butterfly Farm is situated at the Gede Ruins approximately 1.5 km from the Arabuko-Sokoke Forest at the Gede Village in Malindi District (map 3). Isecheno is located at Kakamega Forest approximately 15 km from Kakamega town (map 4).

Accessibility
Arabuko-Sokoke Forest and the Kipepeo Butterfly Farm are both accessible by air, road and sea while Isecheno is accessible by road and air. The principal means of reaching the study area at the Coast is by the Mombasa-Malindi highway. Access by air is via Malindi airport while by sea is via Chanoni and Leopard points at Malindi beach and through the turtle bay at Watamu beach. The access to Isecheno by road is from Kakamega town through Shinyaru while by air it is via chartered flights from Nairobi to Kakamega air strip.

Climate
The study area at Arabuko-Sokoke falls into a zone whose average annual rainfall ranges from slightly below 600 to just above 1000 mm (Moomaw, 1960, Mogaka, 1991). The rainfall pattern is bimodal with a period of long rains from April to June and short rains from October to December. The area experiences a dry spell from July to September and January to March. The rainfall pattern is closely associated with the inter-tropical convergence zone. The average annual temperatures are 25 degrees Celsius (Mogaka,
1991). At Isecheno, the area is wet with an average annual rainfall of 2080 mm, the temperatures are fairly constant throughout the year with a mean daily minimum of 11 degrees Celsius and mean daily maximum of 26 degrees Celsius\(^9\).

**Socio-economy and the welfare situation of the community**

The welfare of the rural community in Kenya is determined by employment levels, income earnings and distribution, morbidity rates, nutrition status, disease incidences, food availability and nutrition levels (Republic of Kenya, 1997b). Despite that rural areas in Kenya are reported to be providing employment opportunities to seventy percent of the Kenyan population, the 1997/2001 National Development Plan indicates a limitation in employment opportunities, low income levels, and a high incidence of poverty (Republic of Kenya, 1997a). This is attributed to the increase in rural population from 19.43 million in 1990 to 24.36 million in the year 2000 as opposed to urban population of 4.09 million in 1990 and 7.44 million in the year 2000, decline in agricultural production as a result of poor weather conditions (such as the recent el-nino rains), expensive agricultural inputs, high losses of perishable produce resulting from inability to deliver them to the market on time due to poor road conditions, lack of proper and adequate storage facilities and low market prices (Republic of Kenya, 2000a).

The 1997-2001 Development Plans of Malindi/Kilifi and Kakamega Districts projected the population in the districts to be 865,562 persons by the year 2001 with the area around Arabuko-Sokoke Forest having a population density of 268 persons per square km and a mean household size of 13 persons (Maundu *et al*, 1997). The main income sources in the district were agriculture, livestock keeping, tourism, fisheries, wage employment and informal sector activities (Republic of Kenya 1997b) and sale of butterfly pupae from 1993 (Mogaka, 1991, Maundu, 1993, Maundu *et al*, 1997). The spatial distribution of income in the districts depended on urbanisation and the resource profile and distribution in the area. There were more income generating activities in the urban areas as compared to the rural areas where people depended mainly on small scale farming activities. The mean annual per capita income of the community adjacent to the Arabuko-Sokoke Forest

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\(^9\) [http://www.earlham.edu/bio/kakamega/ecotourism.htm](http://www.earlham.edu/bio/kakamega/ecotourism.htm) (12/18/00 1:01 p.m).
was 1,470 Kenya shillings (US$ 20) (Mogaka, 1991). The infant mortality rate (IMR) in the said period was at 100/1000. There was an improvement compared to the period 1992-1996 which recorded 147/1000 (Republic of Kenya, 1994). However this infant mortality rate was considered high and was due to the high levels of malnutrition, lack of awareness about infant care among the mothers and traditional and cultural beliefs. There was a high disease incidence especially in the rural areas prompting people to spend most of their income on medical bills. This significantly reduced the income available for food and other basic needs especially in rural households. Chronic malnutrition was consistent in the districts. Nutrition surveys conducted in 1982 showed that fifty-three percent of school going children were malnourished; forty-nine percent had stunted growth, while 6.8 percent were wasted children.

METHODOLOGY

In research endeavours, external agents are often assumed to have access to resources of some kind or even at times represent some threat to people’s internal organisation and system of operation upon which the research is done. As such, if the researcher has to get access to non biased data he/she should “behave appropriately” and hand over control to the people (Scoones and Thompson, 1994:108). To achieve this, the researcher has to view the respondents as equal partners and not view them as objects to be researched on. Participatory approach in data collection could be of help in meeting this objective. In such a research set up, research is done “with the people” and not “on the people”. In consideration of the above, Participatory Rural Appraisal (PRA) methodology was used in primary data collection. Advocates of the PRA approach argue that the production of knowledge and the generation of potential solutions in order for them to be realistic and sustainable should be carried out by those whose livelihood strategies form the subject for research. The methodology combines research with action, offering opportunities for mobilising local people for collective action (op. cit, 108).
PRA offers a creative approach to information sharing and a challenge to prevailing biases and preconceptions about rural people’s knowledge, and further it recognises that rural people should have control over its use (ibid, 109). The methodology gives the local people a chance to present their ideas in a form they can discuss, modify and extend. They become creative analysts and performers, rather than reactive respondents. The PRA tools were used with their limitations in mind. Some of the limitations included; language barrier, manipulation of respondents, respondents’ degree of participation, cultural and religious beliefs which rebar certain members of the society from free associating with outsiders and gender discrimination implying that men and women can not freely discuss issues in an open forum. In a case where a researcher is carrying out research in an area where she/he is not familiar with the local language of the people there can be a barrier to free communication exchange of ideas and free flow of information this can be a source of errors in the data. In the present study, a research assistant coming from the local tribe and who could fluently speak and understand the local native language aided in translations in some cases were respondents could not speak Kiswahili or English. The respondents were given ample time to discuss and analyse the issues being researched and the use of leading questions by the researcher was avoided. Instead free discussions were encouraged. The respondents freely used familiar objects of their choice like sticks, small stones and leaves to draw and present information on the ground rather than using paper and pen to increase their participation. In cases were cultural and religious beliefs barred some members from participation, possible alternatives were sorted out. For example, during the research at the Coast I came across a butterfly farming household with a believed women of the Muslim culture who was not allowed to see or even talk to any male during her period of moaning yet she was the one who could provide the information needed. In this case I tried to find out from her daughters when she would be allowed to talk to men. I then came back and discussed with her. In cases where men and women were traditionally not allowed to mix, exchange ideas and discuss issues in open fora, different sessions of men and women were held separately. The following PRA tools were used:
Matrix scoring
This tool shows different perceptions about advantages and disadvantages of a particular issue among different social groups in a community (Pretty et al, 1995:251). In this study, the rural people identified their income sources, their uses and allocated scores on a matrix where the maximum and minimum scores where set to be 8 and 1 respectively.

Time line and chronologies
This is a tool that helps one to look at activities over time. In this study, the tool was used to investigate the trend of involvement of the rural people in butterfly farming over time. Information was obtained from the Kipepeo Butterfly Farming project records from the beginning of the project up to the period of the current research.

Interviewing
The key informants during the interviews were the butterfly farmers, representatives of Kipepeo Butterfly Farm, representatives of the Forest Department and the representative of Kenya Forest Research Institute (KEFRI). A list of all the butterfly farmers was obtained from Kipepeo Butterfly Farm. Systematic sampling was done where the group representatives were selected for interviewing first. Later, random sampling was done to select the other farmers who were not group representatives to be interviewed from each of the 25 groups. Five farmers were then randomly selected from each group. Care was taken to ensure that all the 25 groups were fairly represented. The interview was semi-structured and aimed at gathering data on the following nine key variables.

Number of butterfly species grown
Each farmer interviewed provided data on the total number of butterfly species he/she farms. This also included the commonly grown species, how available the species are in the forest and the location of their habitats in the forest. Also the farmer was asked to give reasons why he/she preferred farming particular species to others. This information showed the farmers’ knowledge about butterfly diversity, how they utilized the butterfly diversity in the forest, and if the regular collection of preferred species had any impact on the availability of these preferred species in the forest.
**Number of species sold so far**

From the sales records of the farmers, the total number of each species sold was obtained. This helped to find out market supply of each species, the preferred butterfly species in the market, and how the farmers responded to the market requirements of these species.

**Employment opportunity**

The farmers discussed their opinions as to how they so far view butterfly farming as a new and alternative source of employment in the rural areas. The farmers identified the common economic activities that they are involved in and compared the income they earn from the economic activity with that earned from butterfly farming. A ranking exercise was then done to determine which of the economic activities provided more income to them. The information obtained could show whether or not butterfly farming was taken as a new and alternative employment opportunity in the rural areas.

**Market incentives**

The farmers discussed how they market the pupae. The standards required for pupae to be marketed were brought out. The prices offered to different pupae species locally and internationally were discussed. Terms of payment for pupae delivered were discussed. A separate interview session was held with representatives of the management of Kipepeo Butterfly Farm to cross-check the information obtained from the farmers.

**Sustainable livelihoods**

Based on the financial returns they got, the farmers gave their views whether or not butterfly farming could sustain their livelihoods. Discussions were done comparing with the other economic activities the farmers were involved in.

**Disease and pest occurrence**

The farmers identified the diseases and pests common in the different stages of the life cycle of a butterfly. They explained how they tried to handle disease and pest problems.
The farmers discussed their different opinions regarding the extent and losses of pupae resulting from diseases and pests. The most frequently affected species were identified. The economic loss resulting from the loss of different species was explained. The farmers also explained how the diseases and pest problems challenged the development of butterfly farming in the rural areas. Information on any farmers who might have dropped butterfly farming or reduced the number of species farmed or even reduced stocks of a specific species due to disease and pest problem was also obtained.

Forest encroachment
Discussions with representatives from the Forest Department and Kenya Forestry Research Institute were done to establish incidences of the butterfly farming and non-butterfly farming rural community living at the periphery of the forest extending their agricultural land into the forest land. Past cases of forest encroachment before butterfly farming was introduced in the area were discussed. Any cases of forest encroachment in the nine years of butterfly farming in the area were also discussed.

Conservation of biological diversity
The current status of threatened, endemic and rare species of animals and plants in the forest was discussed with the representatives of the Forest Department. Information was obtained as to whether the conservation status of these species was improving and whether there was any link between conservation and butterfly farming.

Habitat conservation
Discussions were done with the farmers, representatives of the Forest Department and the management of Kipepeo Butterfly Farm on the impacts of collection of butterflies and their food plants on the conservation of the habits that support the butterflies and their food plants. The farmers expressed their views regarding the effects to different forest habitats resulting from their (farmers) regular presence in the forest.
Stakeholder analysis
Stakeholder analysis is a holistic approach or procedure for gaining an understanding of a system, and assessing the impact of changes to the system, by means of identifying the key actors or stakeholders and assessing their respective interests in the system (Grimble and Wellard, 1996:175). The approach has potential where interventions are likely to involve conflicts and trade-offs, such as the cases of common property resources (Farrington, 1996:2). In this study, the stakeholders in the butterfly farming and trading industry were identified and described based on their different roles and interaction modes. To identify who had a stake in butterfly farming and trading, a number of group sessions were held in which discussions were done between the researcher and the members of the different groups. The following groups were represented: the local community, the Forest Department and Kenya Wildlife services, local environment conservation groups, and Kipepeo Butterfly Farm. The analysis was then done by interviewing the stakeholders who had been identified.

Transect and group walks.
Transects refer to systematic walks through an area. This allows one to associate a set of natural conditions such as climate and soils and agricultural activities such as farming and other activities used to exploit the natural resource base. This tool is used alongside with other tools such as aerial photographs, survey maps and Geographical Information Systems (GIS) maps. In this study, transect walks were mainly conducted through the forest to establish any incidences of forest destruction such as logging and charcoal burning.

Data Analysis
The data collected was computed and analyzed by help of Excel. Charts were developed by the help of Excel Chart Wizard where comparisons, patterns and trends in the data were analyzed.
RESULTS

Contribution of Butterfly farming to rural development

Source of employment and income to the community

The community in the study area had five different income sources namely; butterfly farming, bee keeping, subsistence crop farming (agriculture) wage labor and others (income from the informal sector, and financial gifts from relatives working in the urban areas). Butterfly farming was found to be the major income source (figure 1).

![Image of income sources](image)

Figure 1, Income sources of the rural people in the study area

Source: this thesis

During the study period, there were a total of 700 registered and unregistered small scale butterfly farmers at Arabuko-Sokoke and Shimba Hills and two independent large scale farmers at Mida and Kakamega areas. The small scale farmers were all indigenous Africans people natives of the study area while the two independent large scale farmers were settlers of European origin. The unregistered farmers sold their butterfly pupae using the names of the registered ones. The small scale farmers sold their butterfly pupae
through the Kipepeo Butterfly Farm. This was because each individual farmer produced a small number of pupae on weekly basis and since orders from the international markets and shipment of the pupae was done on weekly basis; each individual small scale farmer could not afford to meet the shipment costs for each of them to sell the pupae they produced directly to international market. The large scale farmers exported their pupae directly to buyers abroad. This was because their pupae production on weekly basis was of a big scale to meet the costs of direct shipment. More females than males were involved in butterfly farming at the small scale level.

Figure 2, Trend in registration of small scale butterfly farmers
Source: This thesis

Figure 2 shows the annual trend in registration and involvement in butterfly farming since 1993 when butterfly farming begun (data source Kipepeo Butterfly Farm). Statistics obtained from Kipepeo Butterfly Farm showed that by 1997, a total of US$ 98,837 had been earned from the export of 64,949 pupae to overseas market by the small scale butterfly farmers. Pupae production and sales statistics of the independent large scale producers were not available. Figure 3 gives the yearly number of pupa sold and the corresponding income earned by the small scale farmer.
Promotion and Development of area eco-tourism

By 1997, a total of US$ 2518.0776 (KShs 143,820) had been earned from ecotourists visiting the butterfly exhibits at the Kipepeo Butterfly Farm from gate collection and 197.49628 (KSh 11,280) was donated. A total of 383 Kenyan adult resident ecotourists and 142 children, 1300 non Kenyan resident adults and 95 children had visited the butterfly exhibits at the Kipepeo Butterfly Farm (data source Kipepeo Butterfly Farm). Figures 4, 5a and 5b give the average monthly breakdown.

Figure 3, Exports of pupae and their respective yearly earnings
Source: This thesis
Figure 4, The monthly trend of ecotourists visiting the Butterfly Exhibitions
Source: This thesis

Figure 5a, Comparison of year round earnings from gate collections and donations from ecotourism
Source: This thesis
Figure 5 b, Year round earnings from donations
Source: This thesis

*Improvement of the local community welfare situation*

On how the income earned was spent by the people in the study area, eight different income expenditures (uses) were identified for the income from butterfly farming and other sources (figure 6) with food, medicare and school fees being the highest expenses across all the income sources. The use of income from butterfly farming was spread over all the uses while uses from the income accrued from subsistence crop farming (agriculture) was food, medicare, school fees and other incidental expenditures. Income from bee keeping was used in medicare, the bulk of it in food and the remaining in other uses like traveling and leisure. Other sources of income to the families interviewed were identified as money received from family members mainly children working in cities and that got from fishing and small wage labor within their villages. Figure 6 gives the percentages of individual uses from each source.
Figure 6, How the people in the study area spent their income

Source: This thesis

Challenges of Butterfly farming in Kenya

The study revealed that the main challenges faced by butterfly farmers in Kenya are; marketing of produce, very low prices of some species of butterflies, diseases and pests attacking the larvae before it pupates and the seasonality of species of high value.

Marketing of their produce

There was seasonality of the international markets where some buyers could not buy the pupae on a regular basis. A total of twelve markets were available with only 50% being regular. The regular markets were, Stratford-upon-Avon Butterfly Farm (UK), Butterfly Pavilion and Insect Centre (USA), The Academy of Natural Sciences Philadelphia (USA), Day Butterfly Centre (USA), Florida Cypress Gardens (USA) and Cockerell Butterfly Centre (USA).

Pupae prices

There came out a big price difference between the pupae prices at the international markets and the prices given by the local buying agency. At the international market, the
buyers gave a quotation of the most expensive pupa at US$2.5 while the same species went at US$0.87 at the buying agency level. The lowest pupa price internationally was quoted to be US$ 1.00 with a local agency price of US$ 0.13. According to the local buying agency, the differences between the local and international prices meet the costs of packaging and shipment to overseas markets. The local prices according to the farmers were low in comparison with the international prices. The farmers therefore wished increase of the local prices. However most of the farmers interviewed seemed not to be aware of the costs involved in shipment of the pupae to overseas market. Figure 7 shows comparison between the two price levels.

![Figure 7: Comparison between international and local pupae prices](image)

Source: This thesis

**Diseases and Pests**

The farmers expressed concern about some pests that attacked the larvae, these mainly being ants, spiders, wasps, parasitic wasps and lizards. There seemed to be a relationship between the degree of occurrence of the pests and diseases to the total number of species
a farmer bred at a time and whether or not the farmer had proper breeding facilities. Those farmers who had good butterfly flight cages made from nets of good quality and planted the food plants the butterflies fed on at the different stages of their life cycle in these cages experienced less problems of predation. This was because the cages kept away predators like lizards, birds and parasitic wasps. The farmers who made their butterfly cages from improvised materials like old manila sacks suffered more losses from predation. This was because with time, the manila sacks could develop large holes as a result of heat from the sun. These holes could let in predators more easily. Secondly, it was more difficult to plant the butterfly food plants in cages made from sacks as the sacks did not allow in sufficient light to enable normal growth of plants.

![Graph showing disease and pest occurrence](image)

**Figure 8, Disease and pest occurrence**

*Source: This thesis*

### Species Seasonality

The farmers rear a total of 45 different species of butterflies from 23 different Genera (appendix 3). However the farmers expressed concern over the increasing scarcity of some species in the forest especially those which fetched good international prices. During the study, the farmers grouped the availability of the butterfly species that were of
commercial value to them in six different groups (figure 9). The first group was that of those species which are now not found at all in the forest. This group comprised of species of very high value in the international market. According to the farmers these group of species were available in the forest in large numbers when they begun to farm them. But as they continued to catch them in large numbers from the forest, their numbers have since then been reducing until they are now not found at all in the forest. The second group was of those butterfly species which are now rare to come by in the forest. This group comprise of butterfly species which command a high commercial value in the market. According to the farmers, the current rate of utilisation of this group of butterfly species has greatly reduced their numbers in the forest until now they can rarely find them in the forest. The third group comprised of those butterfly species which are not easily found. This category comprised of those species whose market price is medium. Their current utilisation has increased due to the unavailability of species of the first two groups. This has made them to increasingly become not easily available in the forest. The fourth group comprised of those butterfly species whose numbers in the forest are reducing. This group comprised of those butterfly species of medium price in the market. According to the farmers interviewed, the availability of this group of species in the forest is slowly reducing. The fifth group consists of those butterfly species which are half year seasonal. Species in this group are found in the forest in large numbers from April to September the other months they are out of season. This group of butterflies are those of low market value. The sixth group comprise of those which are found in the forest in large numbers the whole year. This group comprise of species of the lowest price in the market. Their breeding for sale in the past has been rarely done because of their low price. However this is now changing as species in other categories are becoming scarce in the forest. Breeding of butterfly species in the sixth group is now increasing despite their low value in the market.
Figure 9, The relationship between species availability and utilization

Source: This thesis

**Impact of Butterfly Farming to Forest Development and Conservation**

100 percent of all the farmers confidently confirmed that there has been increased improvement in conserving the forest in the last nine years of butterfly farming. The improvement has been in these areas; hunting and collection of animal trophies is very low, pit sawing has been eradicated completely, mining of sand glass has been totally stopped, the local people have established wood lots as an alternative source of building materials. The Forest Department (FD) also expressed similar views concerning the impact of butterfly farming on forest conservation. The management of FD said that in addition to the government deploying forest guards, the butterfly farmers are an additional force thus boosting the forest severance. During the transect walks in the forest, no incidents of illegal logging and charcoal burning was noticed.
DISCUSSION

How the butterfly farming rural community has developed.

Although butterfly farming is still a young and upcoming way of utilizing non-tree forest products for the conservation of the natural forests and the development of the rural communities adjacent to these forests in Kenya, remarkable developments have been recorded by the currently participating communities. From the study, a discussion of the development so far achieved by the rural people involved in butterfly farming is done in the light of:

- The livelihoods of the people
- Conservation education
- Development of area eco-tourism
- Involvement of local community in management of the forest

The livelihood of the people

According to Chambers (1993), peoples´ livelihoods mean accessibility to adequate assets, food and cash for physical and social well-being and security against impoverishment. The livelihoods have to be sustainable in a way for the people to realize the benefits that is to say; a way of thinking about the objectives, scope and priorities for development has to be developed, in order to enhance progress in poverty elimination. In this way, the poor people will be helped to achieve lasting improvements against the indicators of poverty that they define. “The premise is that the effectiveness of development activity can be improved through: systematic – but manageable – analysis of poverty and its causes; taking a wider and better informed view of the opportunities for development activity, their likely impact and ‘fit’ with livelihood priorities and placing people and the priorities they define firmly at the centre of analysis and objective-setting” (Ashley and Carney, 1999:6).

The livelihood of the butterfly farming community in Kenya has for the last eight years shown remarkable achievements. The people have an assured and steady income from the export of pupa (figure 3) and from the commission from the gate collection at the
exhibition of butterflies at the visitors’ centre (figure 5a and 5b). By 1997 an average farmer earned an annual income of US$ 737.5\textsuperscript{10} which is far above the mean annual per capital income of the residents of the area which was US$ 20 (KSh 1470) as observed by Mogaka (1991) before butterfly farming was introduced. This is in line with studies carried out on other similar butterfly farming enterprises in the world. For example, in Papua New Guinea in 1981, it was estimated that a “diligent butterfly farmer could earn an annual income of about US$ 1200 in a rural set-up where the mean annual per capita income is US$ 50” (BOSTID, 1983:3).

The improved income level for the butterfly farmers has helped them meet the financial requirements of their basic necessities namely; food, shelter, medicare and school fees. Improvement in food situation is in two dimensions; firstly the money earned is directly used to purchase industrially produced food stuffs such as sugar, salt and cooking fat. Secondly, some farmers have used part of the income from butterfly farming to hire and/or purchase suitable land elsewhere and purchase farm inputs such as fertilizers, seeds and pesticides for improved agricultural production. This they do because crop raiding by wild animals on farms adjacent to the forest is rampant and significantly reduces the annual agricultural production of the households with farms adjacent to the forest (Muoria, 2001). In some cases farmers have abandoned their farms near the forest edge (Maundu, 1993). This has led to greatly improved subsistence agriculture production among the butterfly farmers placing agricultural production as their third income source (figure 1). This has also improved the nutrition status of the farming community justifying the use of butterflies as a forest resource also for developing and improving subsistence agricultural food production. The World Bank notes that “the overwhelming challenge in Africa is to increase agricultural growth. Far more than in any other region, a prosperous agriculture is the engine without which poverty cannot be reduced, natural resources cannot be managed sustainably and food security cannot be assured” (World, 1992:20).

\textsuperscript{10} Computed from total export of pupae by 1997 which was US$ 98,837 divided by the total number of butterfly farmers by 1997 which was 134.
Closely related to improved food availability is school attendance and education of the children. This is because a well fed child is in a fit state to learn. Improvement in school attendance among the children (of the butterfly farming households) especially the girls is another remarkable achievement. The farmers spent a substantial amount of their income in paying school fees and purchasing other school related items like; uniforms, books and writing materials (figure 6). This is vital in ensuring that the children especially the girls get basic education at an early stage in life to improve on their literacy status considering the fact that “two out of every three children not attending primary school are girls, and that half of all women in developing countries are unable to read or write” (World Food Programme, 2000:14). Investment in education, especially of the girls, “is one of the wisest and most profitable investments a country can make, it is the key to empowerment and gives the girl the knowledge and tools she needs to improve her own life and that of her family and society as a whole. Girls’ education contributes significantly to improving the income, health and nutrition of families and can bring reductions in infant and maternal mortality rates” (ibid, 13).

The improvement of primary health care services to the farming households is also another key issue. A major difference in primary health care status was noted between the farming and non-farming households with farming households showing a better understanding of the importance of good primary health care. This is in line with the goal of the World Health Organisation (WHO) in achieving universal primary health care by all by the twenty first century. WHO outlines the basic principles in primary health care as “education in methods of preventing illness, promotion of healthy nutrition, availability of safe water and sanitation, access to maternal and child health and family planning services, immunization against major infectious diseases, prevention and control of local endemic diseases, appropriate treatment of common diseases and injuries and provision of essential medication” (McMurray and Smith, 2001:35, Staudt, 1991:246). The study revealed that the farmers were organised into twenty five different groups and that these groups formed a good platform for several other functions. One of these other functions was that farmers time and again were able to get lectures from resource persons on primary health care especially on the importance of good nutrition for good health,
timely and proper immunization of children, proper and timely treatment of local endemic diseases especially malaria, and the ways to and implications of contracting HIV/AIDS. Part of the money they earned was used in improving the household primary health care situation especially in the treatment of malaria. Alongside the financial benefits accruing from butterfly farming, the local people are now slowly realising their various potentials. A number of income generating activities have been started by different butterfly farming groups including, bee keeping, goat farming, zero grazing units for dairy cattle, poultry farming and small village kiosks and shops.

Development of local Conservation Education

“Since most conservation objectives and decisions will have to be realised through the political or democratic process, a major educational exercise will be needed to help those charged with carrying out more specific conservation practices” (Newbound, 1974:437) Conservation is “the process through which natural resources are managed to allow partial or total exploitation, for individual, community or commercial use, without in any way jeopardising the long-term viability of the resource base or inflicting undue or excessive environmental damage. It is held to encompass full consideration of the varying requirements of the local human population, together with those of wildlife species or habitat to be conserved, including an appreciation of the ability of each to adapt to any change” (Andy, 1991:60-61). For the local community to be able to conserve a given resource they need to have access to information and knowledge in conservation and about the resource to be conserved. Acquisition of such information may involve training and education which can take different approaches. Gaining local support to involve the local community to utilize forest products like butterflies in order to conserve the forest resource can be termed as a metadisciplinary approach in conservation. This approach involves training a trainee to become an expert with a solid grounding in a given area of expertise and with a general knowledge of a problem area. The trainee thus becomes a specialist in terms of his/her expert knowledge and a generalist in terms of a set of problems to which he/she becomes committed (Westoby, 1987).
Butterfly farmers can be termed as trained specialists in butterfly farming as they have a solid grounding in this subject. They have general knowledge in broad issues of the forest including flora and faunal composition and they have thus become more enlightened on the issues involving conserving the forest which they now depend on. Bearing in mind that butterfly farmers are ordinary people drawn from rural communities adjacent to forests, and have managed to acquire this training and education, it can be argued that introduction of butterfly farming in these areas has helped local community dwellers to improve their conservation knowledge. The economic utilization of butterflies is a tactic being used by forest planners, administrators, and natural scientists operating within voluntary or governmental frameworks to impart conservation education to the local people adjacent to the forests (Warren and Goldsmith, 1974). Apart from the farmers, exhibitions at the Butterfly Centre have contributed greatly in developing local conservation education. At this centre, domestic and foreign tourists access information on how local people can directly benefit from forests resources by for example involving themselves in projects like butterfly farming and bee keeping, how they (the tourists) can be involved in conservation work and how their visit to the exhibitions is vital to conserving the forest.

**Development in local Eco-tourism**

Eco-tourism is a concept which aims at utilising the desire for man to be closer to nature and at the same time enhance conservation, development and control over the negative impacts of visitors to the ecology, culture and aesthetics of a place. According to Oteket (1995), eco-tourism involves “responsible travel to natural areas which covers the environment and improves the welfare of the local people” (Oteket, 1995:5). However, it is worth mentioning that eco-tourism is not a new phenomenon. Young (1986) observes that it has been in practice for a considerable time as exemplified by safari tours of Africa, mountain climbing in the Rockies, and hiking to the top of the Peruvian Andes. “But what is new is the heightened awareness of host governments of a new industry capable in some way of generating millions of dollars in annual revenue” (Young, 1986:362). Eco-tourism can take different dimensions, for example European exploration and adventures to new places in steamships in the last century. More recently, is the mass
media appeal to natural wonders as exemplified by the recent wave of digital and print media appeal to go and see tropical wonders vast lands. This has resulted in substantial investments in off beat destination sports for the naturalists visiting natural attraction sites especially in the tropics. The investments include fully equipped research stations for university and natural museums conducting field research studies and county hotels and lodges for holiday makers. The most current dimension of eco-tourism, especially in the tropical countries, is the generation, exhibition and export of plants and animals to foreign markets. This involves establishment of snake parks close to or within natural environments, bee farming, butterfly farming and exhibitions, siliculture, and establishment of tree houses (observation points) within rainforests (BOSTID, 1983, Young, 1986, Parsons, 1992, Santiapillai, 1999).

Within the present study, eco-tourism activities in the study area included butterfly farming and exhibitions at the visitors centre. The visitors’ centre had a display of live butterfly species in flight cages complete with their respective food plants. It also had a laboratory facility where entomological work related to butterfly pests and diseases is being conducted, and a section where packaging and dispatch of pupae to foreign markets is done. There are also separate displays of well labelled and mounted butterflies, and the life cycle of a butterfly. Included here was also the whole process of butterfly farming where the visitors were systematically taken through all the stages to produce desirable butterfly pupae for the international market. Other eco-tourism activities included forest walks and bird watching. This involved taking the visitors through guided walks in the forest to appreciate the forest environment. To facilitate the appreciation, ‘tree houses’ have been constructed at strategic points. They serve as platforms where tourists are able to view the different tropical rain forest canopy layers, a more secure place to observe certain animals especially those difficult to come cross by in a thick forest.

The immediate gain associated with eco-tourism for tropical nations is creation of new employment opportunities for local naturalists, teachers and tour operators, revenue accruing to state from gate charges for use of national parks, game reserves, and other natural attraction sites and increased use of local hotels and lodges (Oteket, 1995,
Gordon, 1995 Parsons, 1992 and Young, 1986). Within the present study, butterfly farming has directly contributed to development of the local eco-tourism and the rural community in a number of ways. The revenue generated from gate collections and donations (figure 5a and 5b) is channelled to the local community for use in areas as maintenance and/or upgrading of rural access roads and supporting genuinely needy students in local primary and secondary schools village and/or youth polytechnics to meet their fee requirements. Job opportunities have also been created to the rural community through involving local tour guides who may serve tourists or as field assistants to students and researchers conducting research and other studies in these forests. Research work in these places has also lead to an increase in the use of local hotel and lodging facilities.

Involvement of the local community in managing forests

In the past, the community adjacent to these forests was mainly barred from extracting any resources from the forest by the then Forest Department (KIFCON, 1994). The move to bar people came as a result of increased human encroachment on forest land, too much extraction of timber, firewood and animal trophies from the forest at a rate incompatible to natural replenishment. This resulted in the establishment of nature reserves within these forests thus totally banning cutting, grazing, and removal of forest produce or disturbance of flora, hunting, fishing and disturbance of fauna. This prohibition was thought to protect the forest biodiversity for future use. This for a long time created big enmity between the locals and the FD thus making conservation work more difficult. Despite this move, illegal extraction of forest products continued and slowly the forests were diminishing. This prompted the FD to look for ways to incorporate the local community in managing the forests. This resulted in the birth of projects like butterfly farming among others.

The farming of butterflies is one of the ways the local community is being involved in utilising and conserving the forest resource. The economic benefits locals get from the project have made them feel to some extent that the forest belongs to them and not to the FD. Thus they are now actively involved in conservation work. The farming of butterflies
has helped to link development and conservation and led to the winning of local support for the conservation of the forests. This has helped to demonstrate that the forests can provide new and unexpected income sources and that it is of greater value as intact wildlife than as land cleared for agriculture.

**Challenges of Butterfly farming in Kenya**

Just like any other upcoming economic activity, butterfly farming being at an embryo stage in Kenya has challenges to meet to develop its full potential. Discussion of the challenges is done in two dimensions namely; production and marketing.

*Production challenges*

In any economic production venture, the realisation of the goals of production will depend on the degree of efficiency in the production. The level of efficiency will depend on different factors, such as the technology in use, the environmental conditions under which production work is being done and the inputs. The technology in use will also be affected by the availability of the right instrumentation to facilitate its use, the timing and the technological know how of the personnel involved in production. The timing depends on the availability of the inputs while environmental conditions are determined by the physical location of the production work.

Efficiency in butterfly farming requires the right combination and set up of all these factors. To be able to produce pupae which meet the market standards, the farmer needs to fully understand the concept of the life cycle of a butterfly, the environmental conditions favourable for the metamorphosis of larvae to pupae and finally to an adult butterfly. Further, the farmer will need to have the right instruments to be able to achieve this also; there should be a good supply of adult butterflies from their natural habitat to lay the required eggs to start the life cycle. As indicated by the results, the farmers seemed to be challenged by the diseases and pests attacking the butterflies before reaching the pupae stage. An analysis of the relationship between availability of proper farming facilities and the number of species type farmed on a scatter graph showed a positive correlation (figure 8). Farmers who had all the required facilities were able to
farm many different species at a time with very low incidences of diseases and pests (see figure 8). The production level for this category of farmers was very high. Likewise farmers who had minimal facilities experienced frequent incidences of diseases and pests and thus recorded low production turn out. This is in line with observations made by Parsons (1992) who argues that adopting the idealized model of a butterfly farm which has all the required facilities and set in the proper environment will contribute greatly to the reduction of the concentration of parasitoids and predators of pupae, and will give the farmer an enabling environment to regularly assess the stocks in the farm. This in the long run increases production. The production level was also affected by the proximity of the farm relative to the forest. Farmers who had access to most of the facilities and had their farms located close to the forest, produced more pupae of species of high value than those whose farms were farther away from the forest edge. For example, Shimba Hill farmers had their production right on the forest. These farmers produced more valuable species than those located far away. This is in line with findings put forward by Gagne and Gressitt (1982) that proximity of habitats containing healthy wild populations will be necessary for the success of butterfly farming. Parsons (1992) also argues that successful farming of butterfly species which have more specialised ecological conditions will not be achieved in absence of adjacent areas of prime habitats.

The seasonality of some butterfly species also affected the production levels. One species *Amauris niavius* was reported not to be found by most farmers interviewed, while seven species were reported to have become rare in the forest including *Charaxes cithaeron, Charaxes protoclea, Charaxes varanes, Charaxes violetta, Charaxes jahlusa, Euxanthe wakefieldi, Euphaedra nephron*. This was a challenge to the farmers as it could imply that continuous extraction of species from the forest without returning any back may lead to depletion of the wild stocks. This will beat the very conservation purpose the farmers are committed to. Those species reported being reducing in number commanded higher prices than those which are still in plenty. Perhaps this could be one reason why their extraction was much higher than others. The reduction of some species could also depend on other factors like the climate, habitat condition and not necessarily the extraction
levels. However more detailed research and continuous monitoring are needed to be able to come to concrete conclusions.

*Market challenges*

The availability of markets for goods produced in any enterprise is crucial to the realisation of the long term goals of the enterprise. Market availability in turn depends on how well the product being marketed is advertised, the quality of the product, the price of that product relative to the prices of similar products in the market and the tests of the targeted consumer. The long term goal of butterfly farming is to conserve the forests while at the same time enabling the local community to earn a living directly from the forest. For this to be achieved, the farmers should be in a position to sell the pupae they produce at the right time at a reasonable price. For this to be achieved proper marketing of Kenyan butterflies to the targeted consumers should be done. Low local market price was one of the factors affecting production (see figure7). This represents a challenge to the local buying agency to try to cut down on overhead costs so that higher prices can be paid to the farmers. Also a problem of seasonality in markets was reported. This also challenges the local buying agency to find alternative markets so that all year markets for pupae of all species are available.

**Impact of Butterfly Farming to Forest Conservation**

Though still at its embryo stage, butterfly farming has so far shown a positive indication towards the conservation of the forest biodiversity. If properly carried out and the challenges facing it are handled carefully, tangible result will be seen in the long run. Conservation of the forest resource can be seen in three dimensions of which two are inter-twined namely conservation of the different forest habitats and flora and fauna species within these habitats and reduction in forest encroachment. The major aim of conservation is to enhance, perpetuate and improve the survival of what is being conserved (Morris *et al*, 1991). In any conservation effort, habitat loss is crucial. If the habitat is destroyed or altered in any way so that it no longer favours the ecological requirements of the fauna species therein, the fauna species must either change in order to
adapt to the new habitat conditions migrate to new habitats with similar ecological conditions as the mother habitat or simply go extinct.

Butterfly farming seems to be on the right track in conserving forest habitats. The farmers through their involvement, are now more familiar with the ecological requirements of different animal species, the different forest habits that support their survival and thus any form of utilisation of these habitats be it leisure or in physical material forms. This includes careful collection of butterflies to stock their farms or butterfly food plants so that minimum negative impacts to the flora and flora occur. Also through commercial utilisation of butterflies the local community is increasingly getting informed about those forest habits that are supporting endemic, rear or endangered species. This has helped in the protection of these species by avoiding any form of human activity in or around these habitats. Also it is important to mention that through their continuous involvement in collection of stocks from the wild, the farmers are able to detect reduction in numbers of a given species. Such information will enable close monitoring of the said species to find out what factors that are causing the diminishing in numbers so that the right action can be taken in time.

Forest encroachment has been a big threat to the survival of the whole forest ecosystem in Kenya. Communities living at the forest edge have slowly been expanding their farms to the forest land. This in the past has resulted in conversion of large tracts of forested areas to agricultural farmlands. The result is continuous shrinking of the entire forest ecosystem and reduction in species diversity. More species become threatened while others are in danger of becoming extinct. Butterfly farming has so far provided to the rural community a means of harnessing the forest resource while at the same time ensuring that the forest remains intact. If maintained, this will contribute greatly to the conservation of the entire forest ecosystem.
CONCLUSION

The aim of this study was to find out how butterfly farming has contributed to the development of rural communities in Kenya, challenges facing butterfly farming and to some extent how butterfly farming has impacted on forest conservation. To a large extent positive results have been achieved. Community development in terms of creation of employment opportunities and a source of income are central. Income from peasant farming is now being supplemented by income from butterfly farming. It has also contributed to the development of peasant farming in the area. The living standards of the farming community have been improved. Central to this is improved food security, primary health care and basic education to the children.

The need to have these forests retaining wildlife intact is now becoming clear to the community as its value is being realised. The community has thus joined in conserving the forest rather than destroying it as in the past. Butterfly farming is increasingly promoting conservation education to surrounding schools. It provides an opportunity for one to learn more about insects and specific butterflies.

Also it’s worth mentioning that it is a big step in popularising Kenyan butterflies, through research and scientific work, educational tours, ecotourism, and the sale of pupae abroad. To the country, it is a source of foreign exchange. Butterfly farming is now a living example and has created a challenge to the stakeholders in the forestry sector to initiate similar forest based income generating projects in other local communities. The management charged with running this enterprise is also challenged to see to it that it is sustained by improving the production conditions, ensuring availability of markets and through diseases and pest control.

The utilisation of butterflies is a constructive way of saving threatened tropical forests and at the same time providing a form of livelihood to the people living adjacent to these forests. To achieve this long term goal, the following should be taken into consideration; before commencement of production, the local people should be carefully trained on the
specific issues central to butterfly farming such as design and installation of the proper facilities including flight cages. This will minimise losses from predation. Well constructed cages should be in a position to keep predators like lizards and birds out. Farmers should be taught when to collect eggs, and how to properly keep them in order to generate the required pupae. Acquisition of proper farming facilities is vital to realise these objectives. To ensure that the conservation goal is achieved, the collection of butterflies should be designed so that it first conserves the butterfly population in the wild. This can be achieved by regular releases of unsold pupae to the wild to become adult butterflies and controlled collections of or banning of species occurring in low numbers in the wild. Also continuous research and monitoring should be done in order to detect those species whose numbers are declining and to establish the facts behind the decline. For the rural people to get substantial economic benefits, the production of pupae must be raised. Farmers should be able to sell all their produce at reasonable prices. To achieve this, proper marketing of Kenyan butterflies should be done. The local people should also be trained as to how they directly can sell their pupae to the international markets. To achieve this, the community should be organised into some form of cooperative led by sound management. This will also give them better opportunities to acquire grants and loan facilities from local and international institutions to improve on their farms. The locals should also be encouraged to diversify their income sources by investing wisely the money they get from butterfly farming into other income generating activities.

Detailed research is recommended to be undertaken in the following areas; on forest habitat conservation in order to establish the impact of butterfly farming on the conservation of the forest resource; on butterfly species diversity which will help to establish the impact of collection of butterflies on the abundance of the butterfly resource in the forest; on other possible ways of generating income from the forest without in any way destroying it; and possible alternative markets of butterfly pupae which will reduce overdependence on current markets and thus enhance the possibility for increased sales.
REFERENCES


APPENDIX 1

Natural Forests Jointly Managed by Kenya Wildlife Service and Forest Department

PHASE I

<table>
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<tr>
<th>Forest Name</th>
<th>Area in Hectares</th>
<th>Protection status</th>
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<td></td>
<td>Indigenous forest reserve</td>
<td>Adjacent Nat. Park or RSV</td>
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<tr>
<td>Aberdares</td>
<td>159,638</td>
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<td>Shimba Hills</td>
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<td>Mpunguti</td>
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<td>Tana River Delta</td>
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Key
FR – Forest Reserve
CC – County Council Trust Land
* - Protection Status refers to the forest area identified for joint management
** - A small portion of Kilifi County Council Forest adjacent to gazetted Arabuko-Sokoke Forest covering 6sq km was gazetted as a national park vide legal notice No. 426 of 5/9/1990
### PHASE II

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<td>Adjacent Park or NAT. Park</td>
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<td>Mt. Elgon</td>
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<td>16,923</td>
</tr>
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<td>Mt. Kulai</td>
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<td>Marsabit</td>
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</tr>
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<td>Bojoge Forest</td>
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</tr>
<tr>
<td>Chylu Hills</td>
<td>10,000</td>
<td></td>
</tr>
<tr>
<td>Loita Hills</td>
<td>4,722.3</td>
<td></td>
</tr>
<tr>
<td>Ngare Ndere</td>
<td>8,701.3</td>
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</tr>
<tr>
<td>Nyambene</td>
<td>4,139.9</td>
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<tr>
<td>Ngayaa Forest</td>
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</tr>
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<td>Mkogondo Forest</td>
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<td>Cherangani Forest</td>
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<td>Tindereti Forest</td>
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</tr>
<tr>
<td>Leroghi Range</td>
<td>16,211.3</td>
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<td>47,100</td>
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Source: Forest Department, Gede Forest Station
APPENDIX 2

An Idealized model of a butterfly farm

Source: Parsons. 1992
# APPENDIX 3

Butterfly species commonly farmed, their market prices and availability

<table>
<thead>
<tr>
<th>Genus</th>
<th>Species</th>
<th>International market Price US$</th>
<th>Local market price US$</th>
<th>Species availability in the forest</th>
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<tr>
<td>Papilio</td>
<td><em>Papilio constantinus</em></td>
<td>2.00</td>
<td>0.87</td>
<td>Not found easily</td>
</tr>
<tr>
<td></td>
<td><em>Papilio dardanus</em></td>
<td>2.50</td>
<td>0.87</td>
<td>Reducing</td>
</tr>
<tr>
<td></td>
<td><em>Papilio demodocus</em></td>
<td>1.75</td>
<td>0.53</td>
<td>Reducing</td>
</tr>
<tr>
<td></td>
<td><em>Papilio nireus</em></td>
<td>2.00</td>
<td>0.87</td>
<td>Reducing</td>
</tr>
<tr>
<td>Graphium</td>
<td><em>Graphium antheus</em></td>
<td>2.00</td>
<td>0.87</td>
<td>Half year seasonal</td>
</tr>
<tr>
<td></td>
<td><em>Graphium porthaon</em></td>
<td>2.00</td>
<td>0.87</td>
<td>Half year seasonal</td>
</tr>
<tr>
<td></td>
<td><em>Graphium colonna</em></td>
<td>2.00</td>
<td>0.87</td>
<td>Reducing</td>
</tr>
<tr>
<td></td>
<td><em>Graphium philo noe</em></td>
<td>2.00</td>
<td>0.87</td>
<td>Reducing</td>
</tr>
<tr>
<td>Charaxes</td>
<td><em>Charaxes brutus</em></td>
<td>2.30</td>
<td>0.87</td>
<td>Reducing drastically</td>
</tr>
<tr>
<td></td>
<td><em>Charaxes castor</em></td>
<td>2.50</td>
<td>0.87</td>
<td>Heavy reduced</td>
</tr>
<tr>
<td></td>
<td><em>Charaxes cithaeron</em></td>
<td>2.50</td>
<td>0.87</td>
<td>Rare</td>
</tr>
<tr>
<td></td>
<td><em>Charaxes proto clea</em></td>
<td>2.50</td>
<td>0.87</td>
<td>Rare</td>
</tr>
<tr>
<td></td>
<td><em>Charaxes varanes</em></td>
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<td>0.87</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td><em>Charaxes violetta</em></td>
<td>2.50</td>
<td>0.87</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td><em>Charaxes jahlusa</em></td>
<td>2.50</td>
<td>0.87</td>
<td>Low</td>
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<td>0.87</td>
<td>Rare</td>
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<tr>
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<td>0.53</td>
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<tr>
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<td>0.40</td>
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<tr>
<td>Genus</td>
<td>Common Name</td>
<td>Count</td>
<td>Frequency</td>
<td>Availability</td>
</tr>
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<td>---------</td>
<td>------------------------</td>
<td>-------</td>
<td>-----------</td>
<td>-------------------</td>
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<td>High in 6 months</td>
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<td>0.13</td>
<td>Constantly high</td>
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<td>Junonia</td>
<td>Junonia oenone</td>
<td>1.50</td>
<td>0.40</td>
<td>High</td>
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<td></td>
<td>Junonia natalica</td>
<td>1.50</td>
<td>0.40</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Junonia orithya</td>
<td>1.50</td>
<td>0.40</td>
<td>High</td>
</tr>
<tr>
<td>Pharanta</td>
<td>Pharanta pharantha</td>
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<td>0.13</td>
<td>Plenty</td>
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<tr>
<td>Bebearia</td>
<td>Bebearia chiremhilda</td>
<td>1.50</td>
<td>0.40</td>
<td>Plenty</td>
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<tr>
<td>Byblia</td>
<td>Byblia illithya</td>
<td>1.00</td>
<td>0.13</td>
<td>Plenty</td>
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<tr>
<td>Melanitis</td>
<td>Melanitis leda</td>
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<td>0.13</td>
<td>Plenty</td>
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<tr>
<td>Pseudacraea</td>
<td>Pseudacraea lucretia</td>
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<td>0.40</td>
<td>Plenty</td>
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<tr>
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<td>Tilumula petriverana</td>
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<td>0.53</td>
<td>High</td>
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<tr>
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<td>Danaus chrysippus</td>
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<td>0.13</td>
<td>High</td>
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<td>0.13</td>
<td>Plenty year round</td>
</tr>
<tr>
<td></td>
<td>Acraea eponina</td>
<td>1.00</td>
<td>0.13</td>
<td>Plenty year round</td>
</tr>
<tr>
<td></td>
<td>Acraea anemosa</td>
<td>1.00</td>
<td>0.13</td>
<td>Plenty year round</td>
</tr>
<tr>
<td></td>
<td>Acraea egina</td>
<td>1.00</td>
<td>0.13</td>
<td>Plenty year round</td>
</tr>
<tr>
<td>Colotis</td>
<td>Colotis euippe</td>
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<td>0.13</td>
<td>Plenty year round</td>
</tr>
<tr>
<td>Genus</td>
<td>Species</td>
<td>Male Frequency</td>
<td>Female Frequency</td>
<td>Abundance</td>
</tr>
<tr>
<td>-----------</td>
<td>--------------------------</td>
<td>----------------</td>
<td>------------------</td>
<td>-------------------</td>
</tr>
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<td>Belenois</td>
<td>Colotis ione</td>
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<td>0.13</td>
<td>Plenty year round</td>
</tr>
<tr>
<td></td>
<td>Colotis danae</td>
<td>1.00</td>
<td>0.13</td>
<td>Plenty year round</td>
</tr>
<tr>
<td></td>
<td>Belenois creone</td>
<td>1.00</td>
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</tr>
<tr>
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<td>Belenois thysa</td>
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<td>0.13</td>
<td>Plenty year round</td>
</tr>
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</tr>
<tr>
<td>Coeliades</td>
<td>Coeliades forestans</td>
<td>1.00</td>
<td>0.13</td>
<td>Plenty year round</td>
</tr>
</tbody>
</table>

Source: Kipepeo Butterfly Farm and Author’s field notes
Map 1 Distribution of Kenyan Butterflies

Source: Larsen, 1996
Map 2 Gazetted Forest areas of Kenya showing location of Arabuko-Sokoke, Shimba Hills and Kakamega Forests

Source: KIFCON, 1994
Map 3 Arabuko-Sokoke Forest

Source: KIFCON, 1994
Map 4 Kakamega Forest

Source: KIFCON, 1994