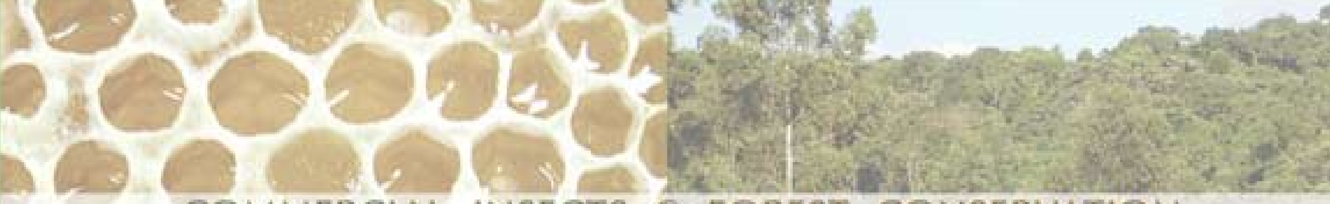

COMMERCIAL INSECTS & FOREST CONSERVATION

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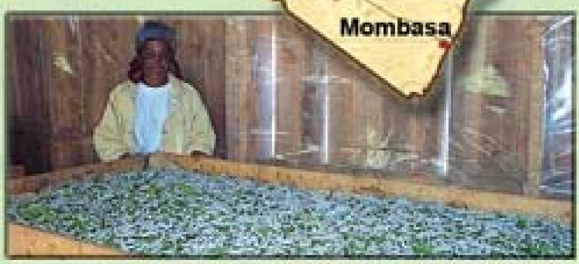

Compiled by Suresh K. Raina, Esther N. Kioko, Ian Gordon and Charles Nyandiga

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Lead Scientists:
Elliud Muli, Everlyn Nguku and
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—S.K. Raina, Programme Leader, Commercial Insects Programme, *icipe*

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Contents

Acronyms and Abbreviations

ASFMT	Arabuko-Sokoke Forest Management Team
CBD	Convention on Biological Diversity
CBO	community based organisation
CC	community conservation
CDF	Constituencies Development Fund
CFA	Community Forest Association
CIP	Commercial Insects Programme
CVA	canonical variate analysis
DFO	District Forest Officer
DLPO	District Livestock Production Officer
EMCA	Environmental Management and Coordination Act
FA	Forest Associations
FD	Forest Department
GEF	Global Environment Facility
HPLC	high performance liquid chromatography
HMF	hydromethylfurfural
ICD	Integrated Conservation and Development
icipe	International Centre of Insect Physiology and Ecology
ICS	internal control system
IFAD	International Fund for Agricultural Development
IMO	Institute of Marketecology
KEEP	Kakamega Environmental Education Programme
KEFRI	Kenya Forestry Research Institute
KFS	Kenya Foresty Service
KOAN	The Kenya Organic Agriculture Network
KWS	Kenya Wildlife Service
M&E	monitoring and evaluation
METT	management effectiveness tracking tool
MSP	medium sized project
NEMA	National Environment Management Authority
NGO	non-governmental organisation
NMK	National Museums of Kenya
PA	protected area
PCA	principal components analysis
PFM	participatory forest management
PFO	Provincial Forestry Officer
PSC/TPR	Project Steering Committee/Tripartite Project Review
PRSP	Poverty Reduction Strategic Plan
SAT	sericulture and apiculture technologies
ToTs	Training of trainers
TRA	Threat Reduction Assessment
UNDP	United Nations Development Programme
USAID	United States Agency for International Development

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Foreword

The aim of this project was to strengthen the protection of three different forest reserves in Kenya by improving incentives to adjacent communities for them to collaborate in forest management. Such incentives are most effective when they are based on sustainable use of forest biodiversity, since this gives local communities a direct stake in forest conservation without threatening the resource base. Commercial insects (like bees and silkmoths) are ideal for this purpose. They give quick rewards, use renewable resources (nectar, pollen and leaves), and are technically relatively simple and easily adopted. In the case of bees, there are also positive synergies resulting from their pollination activities in both the forests and adjacent farmland.

The project activities were designed to link bee keeping and silk production to Participatory Forest Management (PFM) initiatives in Kenya. PFM has become widely accepted as an effective mechanism for forest conservation, but it suffers from a lack of incentives for community involvement. This problem is exacerbated when conservation requires reduced extraction of forest products such as timber, poles and fuelwood. Commercial insect enterprises can compensate for this foregone resource use and provide an incentive for local communities to engage in forest management. They are particularly suitable for use in buffer zones around protected forests.

In this context, the project provided (i) support for conservation of forest-protected areas through improved buffer zone management by local communities; and (ii) improved livelihoods of forest adjacent communities through the commercial use of insect resources, linked to forest habitats.

These strategies were used to strengthen the community forest associations, and forest managers in the target sites. All these efforts were coordinated at the project steering committee and tripartite review meetings by the multiple stakeholders.

The project has demonstrated the effectiveness of this approach to development and forest conservation. We look forward to the mainstreaming of commercial insect activities throughout the forest sector in Africa.

Christian Borgemeister
Director General
icipe

Section 1

Introduction

Purpose and Scope of This Book

This project has developed incentives for community participation in forest conservation through the use of commercial insects in Kenya. The activities to accomplish this goal were undertaken from 2004 to 2008 with the support of UNDP-GEF, co-financed by IFAD and several other donors. The community is now managing the insect based enterprises and running the silk and honey marketplaces developed during the course of this project. The fundamental approach was based on close integration of investments into productive rural infrastructure, forest resources and human and institutional capital, in a way that reduces pressure on three forests, their biodiversity and resources.

This book highlights achievements, impact and key lessons learned from the project in three forest sites (Kakamega, Arabuko-Sokoke and Mwingi) which demonstrate that the biodiversity of Kenya's forest protected area system can be maintained through collaborative management systems using incentives based on income from commercial insects. The book also incorporates technical studies that were undertaken in the course of the project implementation.

Why Is This Project Important?

Forest Conservation—Crisis, What Crisis!

Kenya's loss of forest cover and associated biodiversity has led to serious environmental deterioration, the consequence of which is the marked decrease in food production and rural poverty found across these previously rich and abundant lands. Closed canopy forests, today, cover less than 1.8% and woodland less than 15% of the total land area, and every year these forests further decrease in size and regeneration capacity. The forests in Kenya are under increasing pressure from encroachment, burning and overuse and, until early 2003, from 'legal' excision. Thousands of people live within five kilometers of forest boundaries and benefit from a whole range of forest resources.

Improving forest resource management, that includes a strong biodiversity conservation component, requires a strategic mix of law enforcement and local capacity building with community participation based on incentives through the diversification of livelihood options. All of this needs to operate within a supportive enabling environment at local, District and Central level requiring an investment into policy support and institutional strengthening and awareness raising so as to allow informed decision-making.

Kenya has just overhauled her forest sector, with improved management capacity, and a new Forest Bill / Policy are before Parliament. Many forests are prioritised for conservation. Renewed donor support to a sector that has been greatly under-funded in the past years looks probable.

In the past two years, *icipe*, the main project proponent for this MSP, has pioneered a set of rural community livelihood support mechanisms that are based on the sustainable use of natural forest products. This has been done on pilot basis (including some Mwingi and Kakamega sub-villages) using 'commercial insects' (honey and wild silkmoths) and plant based medicinal products. This input, with funding from IFAD, MacArthur Foundation and the GEF Small Grants Programme has been extremely successful. However, one of the barriers to forest conservation is the lack of linkage between the forest managers and the rural development sector—including civil society and the private sector. There is a need for strong collaboration between the conservationists and the developers to achieve synergies of purpose around forest resources. This requires introducing proven development initiatives to act as the incentive for forest conservation by local communities.

What This Project Planned to Achieve and How

Designed to Create Lasting Impact

This project was designed to strengthen the management of national protected area system of forest reserve through presenting and developing tangible incentives for community collaboration in forest management.

The project's fundamental approach was based on close integration of investments into productive rural infrastructure, forest resources and human and institutional capital, in a way that reduces pressure on the three forests and their biodiversity and resources. Based around three different globally significant forest areas, this project has developed the methodology and mechanisms to scale up existing conservation compatible livelihood activities in forest adjacent villages. The project was orientated to provide communities the incentive and the ability to produce attractive and sustainable incomes as a direct result of activities that are essentially supportive to forest conservation, as well as to the commercial enterprises themselves. Experience at Arabuko-Sokoke has shown that even small numbers of farmers benefiting from commercial insects can have significant impacts on forest conservation: demonstrated by 150 butterfly farmers protesting against the excision of 2500 ha of forest (Gordon and Ayiemba, 2003).

The design and implementation of this project had to be pragmatic and fast in its impact to capture and maintain the interest of the communities and to secure the future of these rapidly dwindling resources. With IFAD co-financing the income support activities and GEF bringing linkages to forest conservation institutions to work with the developing community forest conservation, the project demonstrated in three forest sites—Kakamega, Arabuko-Sokoke and Mwingi—that biodiversity of these forest protected areas can be maintained through the tangible incentives from commercial insect enterprise together with community-driven collaborative management systems.

Linking Insect to Enterprise

Insects are the origin of two internationally important and established products, honey and silk. Apiculture and sericulture were central to the development and empowerment of local community owned enterprises. The action research on efficient pro-poor mechanisms linking the communities with markets to their profits, conducted through the partnership with IFAD, validated this choice.

Selected on-farm and in-forest enterprises, beekeeping and silk production, were developed to stimulate the resident communities to undertake positive and incentive led management of the forest buffer zones. The project focused its activities through Village Forest Associations and used the participatory forest management system and methodologies to develop the conservation approaches. To ensure the economic success of the enterprise and maximise the returns to the participating communities, the project developed and fully equipped market centres for silk/honey products at all three sites. On-going training and guidance was given to ensure the correct value addition of these products and compliance to quality and certification standards was achieved, and to provide a facility to enable sound market linkage for sale of these commodities.

The awareness creation amongst the communities about the importance of pollination to the productivity and health of agricultural crops was demonstrated through experimenting with various crops—tomatoes, cucumbers, sunflower and passion fruits. These were planted at varying distances from the bee hives and records made on seed set and fruit size.

Linking Insect to Conservation

Whilst insects are one of the critical natural resources of forest ecosystems, general understanding of their activity and their interaction with the wider biodiversity is poor. Besides serving as efficient pollinators and crop protection elements, insects are good indicators of beneficial resource management of an ecosystem. The project has supported conservation and sustainable use of biodiversity within and outside the protected forests by improving forest management through involvement of local communities who depend upon them for their livelihoods.

This project has also helped to increase the awareness of communities and national institutions of the ecological and economic importance of insects and their forest habitats. This was achieved through highlighting and demonstrating the direct links between commercial insect and forest conservation. For example, the close dependence of wild nectar sources in the forests enhances honey production for better income. This has reinforced the positive attitudes to forest conservation within the local communities.

Three approaches were taken, which broadly mirror the three pillars of the CBD: conservation of biodiversity, livelihood improvement and fairness in trade/benefit sharing. The first was focused on training of local people in the methods and benefits of conserving biodiversity. The second approach was to train communities in the sustainable use of forest resources; the third approach was to ensure that products, benefits and costs of conservation are shared equitably.

The activities of this project were fully linked to the management plan of the Forest Department. Stakeholder workshops were conducted to allow the communities to examine and take part in informing the management planning processes.

Influencing Policy

One of the United Nations' millennium development goals commits governments to "ensure environmental stability" by 2015, integrating the principles of sustainable development into country policies and programmes. The development plans and policies of national governments are crucial aspects and have the potential to make an enormous contribution to mainstreaming biodiversity considerations into government departments and sectors of the economy. This project has provided information that can be used to influence policy that encourages sectors of society and government on the importance of integrating biodiversity conservation and economic development focusing on commercial insects.

The new forest policies and legislation, as well as the environment policy and legislation, promote local community conservation of the natural forest cover, through participatory management processes. The Protected Area system of forest management has been developed to accord with Kenya's global and national commitment to biodiversity conservation, as expressed within Kenya's National Biodiversity Strategy and Action Plan. A major part of the selected project areas is in the Protected Area (PA) system of forest management.

The project contributed to the GEF global interest and to Kenya Government national priorities by conserving threatened biodiversity resources in and outside the targeted forests. The strategies used were to strengthen the community forest associations, and legally recognised local management institutions of forest resources within the country. All these efforts were coordinated at the project steering committee and tripartite review meetings by the stakeholders shown in this section. In addition, the individual protected area sites, identified as national priorities in the Kenya Biodiversity Strategy and Action Plan, are regionally/globally significant in protecting the biodiversity in Kenyan forests.

This project responded well to the *UN-COP guidance under the CBD*[1] by promoting capacity building of local communities, generating off-farm employment and creating local business capacity.

Through dissemination of best practices into the policy development and implementation process, it assisted Government and the larger conservation and development community in Kenya to address the interface between the conservation of bio-diverse rich forests and the livelihoods of forest adjacent

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[1] *New guidance from COP 7 (Malaysia 2004) on Protected Areas and on Sustainable Use. www.iisd.ca/biodiv/COP7/feb12.html.*

communities. The project demonstrated innovative forest conservation practices that reduce pressures on forests and their productive natural resource base and their biodiversity in the project areas. The partners can now use these results and lessons to influence policies and programmes that address all forest protected areas in Kenya (and beyond).

Project Partners

Building Collaboration

The new forest policies and legislation, as well as the environment policy and legislation, promote local community conservation of the natural forest cover, through participatory management processes. The Protected Area system of forest management has been developed to accord with Kenya's global and national commitment to biodiversity conservation, as expressed within Kenya's National Biodiversity Strategy and Action Plan. A major part of the selected project areas is in the Protected Area (PA) system of forest management.

This complex project involved a range of activities from operations at local community level where community groups are involved in silk and honey production through to the research activities of *icipe*, the policy formulation processes of government up to the establishment of national and international market linkages. This spread of focus areas and the variety of stakeholders involved in the project has necessitated the development of effective coordination mechanisms to make all these elements work together effectively.

Overall, project coordination rested with *icipe*. At the national level *icipe* worked in collaboration with primary stakeholders such as the KFS, NEMA, NK, key GoK ministries, IFAD and UNDP-GEF. A Project Steering Committee was responsible for overall project management and supervision including approval of annual workplans. To achieve intended results, the project established strong operational ties with an ongoing IFAD project for product development. The project linked with the expertise and commitment of existing Forest Department and other Government services, local NGOs and local groups to implement activities for which they have comparative advantage. By selecting the District Community Development Plan as the basis of all planning, activities and investments, the project avoided possible duplication resulting in it establishing transparent relationships with other development partners, as well as leveraging additional commitment from other donors. *icipe* was in contact with several organisations involved in biodiversity conservation, and linkages with these institutions were established through collaborative agreements. These organisations are:

- National Museums Kenya for bio-indicator studies.
- Selected national universities for capacity building
- Viking Ltd. and Milba Brands Associates, and other private sector actors for marketing.

The requirements of the different institutions brought together to implement the project objectives and develop a sustainable model of livelihood and forest conservation were well articulated within the management arrangements of the project. Each institution that was brought on board came with its own institutional strengths, as explained below.

For effective technical and administrative management of the project *icipe* established a Project Management Unit. The Programme Coordinator was assisted by a silk scientist and two postdoctoral consultants working in the areas of honey and silkmoth production at the Headquarters in Nairobi. In addition, three doctoral students, one at each project site, were working with communities on promoting silk production while one pre-doctoral student worked on meliponiculture (promoting honey production from stingless bees).

The communities manage the marketplaces with executive committees that coordinate purchases, processing and sales of honey produced by community groups and also to purchase and process silk cocoons sourced from producer communities.

A unique implementation modality for the project that has been adopted by *icipe* is through support to value chain development for the various products. The central goals of this approach are poverty alleviation and employment creation which result in biodiversity conservation. *icipe* supports these value chains through investment in improved production infrastructure and human capital development through training and capacity building. Producer communities such as butterfly pupae producers in Arabuko-Sokoke and beekeepers in Mwingi and Kakamega have been provided with improved equipment and linked to national and international markets from which direct benefits are being realised. At all project sites, the participating communities acknowledged that the increased benefits they were realising from biodiversity had motivated them to promote sustainable exploitation of the resources at their disposal. Previously conflictual relationships between community groups and park and forest managers have been replaced by collaborative management systems with communities engaged in buffer zone reforestation projects.

UNDP and GEF

The Global Environmental Facility (GEF) funds projects through designated agencies. UNDP is one of the three key agencies. It contributes to the administrative and technical functions from both the GEF Regional Technical Advisors and in-country GEF focal points based in the project host countries. The UNDP-GEF contributions are mostly manifested through the project formulation processes where its technical guidance is required and also at the policy-making stages at the PSC/TPR where again guidance on emerging GEF requirements and procedures is given. In the same yearly meetings, project progress and challenges are reviewed with a view to enhancing implementation of work plans. Information generated is put into practice at the mid and final project reviews in which lessons learned are picked up and packaged into best practices and shared globally. The same information is utilised at the country level by UNDP country offices that must position such good best practices at the national agenda to influence policy.

International Centre of Insect Physiology and Ecology (*icipe*)

icipe has given rise to a vibrant scientific knowledge on the production and marketing of bee and silk products. *icipe* has harnessed ethical certification systems and fostered private sector collaboration to ensure sustainability in the production and processing systems and in terms of nurturing long term improvement in the livelihoods of rural communities. Riding on the rich institutional capacity, both in terms of infrastructure and technical expertise, *icipe* was able to recognise the role of forest conservation and management in influencing the sound development of conservation supportive enterprise based on bee and silk products. To further this, *icipe* has conducted formative laboratory and applied research to enable communities to sustainably exploit wild silk as a commercial enterprise.

This has involved *icipe* in developing expertise in the management of the wild silkmoth and of the host acacia trees, and to explore and master innovative and adaptive production and processing systems. *icipe* has sourced funding from four (IFAD,UNDP-GEF, Toyota Environmental Grant Facility, USAID) agencies to support this work. *icipe*'s field-trials provide key information and demonstrate how forest conservation can be positively influenced by communities as a result of their engagement in and reward from honey and silk production.

These linkages have to be accurately documented and supported by pragmatic results; within this project *icipe* has been able to realise this information at the same time as bringing about tangible demonstration and models of successful, sustainable socio-economically as well as environmentally supportive forest-based enterprises.

Kenya Forest Service

The KFS is the Government agency charged with the responsibility of managing and protecting all forest resources in Kenya. The current Act, however, requires that KFS does this function by actively involving Community Forest Associations (CFAs) living adjacent to forest boundaries. While the project befitted the KFS reform agenda by supporting in the formation of some of the CFAs after its translation from the former Forest Department into a service, these grassroots institutions remained incapacitated to fulfill their legal mandates. Since CFAs will remain the vehicle for transforming the forest sector countrywide, it was prudent that the project supports their formation and function in the project sites. It is clear that use of forest-based livelihoods to entice the communities to protect, and increase forest cover and area was demonstrable through the involvement and participation of the communities and KFS staff.

The service was also able to strategically place the project into the national limelight with regards to its contribution to CFA development at the time when a new Act was passed requiring joint forest management by communities and the state. The development of the management plans for those CFAs supported by the project remains a challenge that the KFS will need to address given that legal entities now exist in the project sites.

Nature Kenya

Long-term monitoring of the biodiversity status in Arabuko-Sokoke and Kakamega forests catapulted the need to have Nature Kenya, a civil society organisation, as an important institution to take forward the project activities of biodiversity monitoring. Strengthened by a functional national liaison committee in which biodiversity data are analysed and discussed, the project contributions found an easy entry into national accounting and policies. Similarly, the project benefitted from information emanating from similar buffer zones and forest patches not targeted in the project sites. Nature Kenya's contribution was complemented by its position to access information that came from a monitoring protocol under a Darwin initiative grant, the German-funded Biota Project and the USAID contributions towards the Arabuko-Sokoke forest inventories.

Nature-Kenya followed a national approach to collect biodiversity information and relied on its infrastructure within the project sites to assess project impacts. In this respect, clear biodiversity monitoring of stingless bees, honeybees, wild silkmoths, birds, reptiles, and plants was undertaken in all project sites.

NEMA

The National Environment Management Authority (NEMA) is established under the Environmental Management and Coordination Act (EMCA) No. 8 of 1999, as the principal instrument of government of Kenya in the implementation of all policies relating to the environment. The project received overwhelming support from NEMA during the initiation and implementation stages.

Commercial Partners

The other important actors included Viking Ltd, a private entity that focused on marketing of the products, Milba Brands, Wild Living and Kiko Romeo.

Associate Partners

IFAD provided the baseline information for the project and continued to provide logistical and technical support towards improving the income base of the poor to improve their livelihoods. Particularly noteworthy is the contribution of IFAD in developing innovative technologies in silkmoth and honeybee conservation and utilisation that provided baseline information for the GEF project. In addition, the predecessor of the IFAD project developed training modules for small-scale land users. Additionally, the project benefitted from the studies undertaken previously by IFAD in respect to the economics of sericulture and apiculture in three project sites, which provided important entry information to the target communities.

The Kenya Organic Agriculture Network (KOAN) supported the certification process of honey in Mwingi. This was useful in putting the project's main product in the market with an added advantage in terms of providing quality assurance.

Project Strategy

The overall strategy of the project is focused on developing linkages between participatory forest management (PFM) and sericulture and apiculture technologies (SAT) Figure 1. By linking them to productive buffer zones, commercial insects enterprises have motivated communities to maintain forest biodiversity and protect the environment as well as increasing their economic well being. The strategy is outlined below.

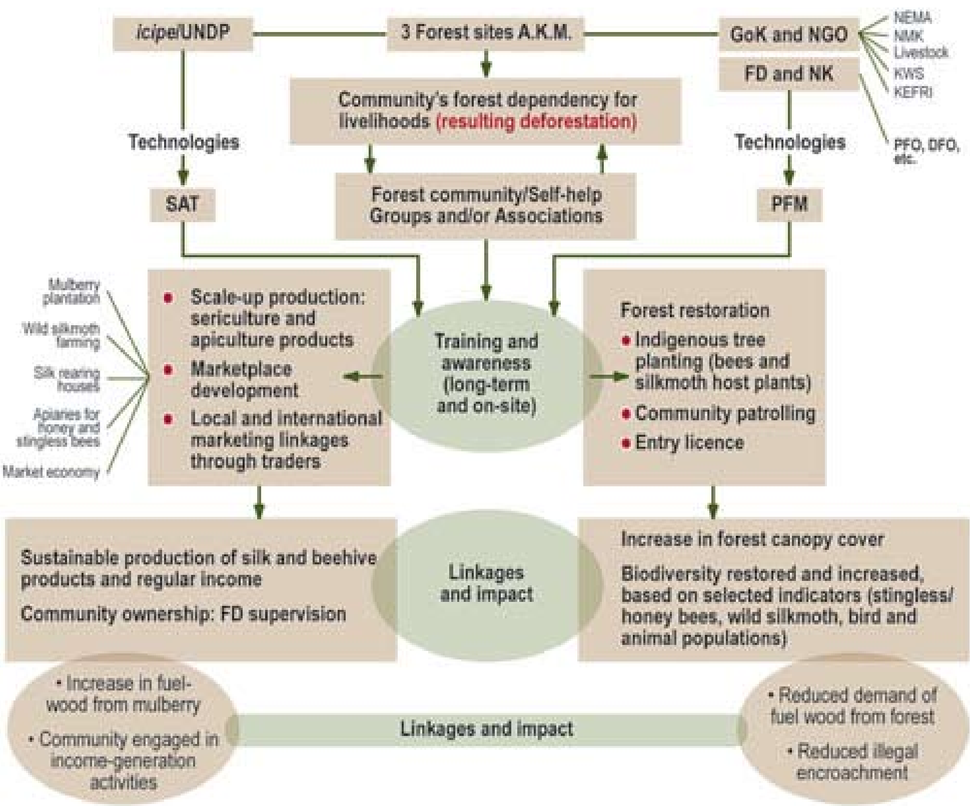


Figure 1. Strategy for developing linkages between Participatory Forest Management (PFM) and sericulture and apiculture technologies (SAT)

Project Setting

Site Selection

The three focal areas were chosen to cover the range of Kenya's ecological zones. These were: Arabuko-Sokoke evergreen forest in coastal Kenya, Kakamega wet evergreen forest in western Kenya, and Mwingi dry woodlands in eastern Kenya (Figure 2). These sites represent dry coastal forest, rainforest and woodland ecosystems respectively. Each of these areas hosts regionally and globally important biodiversity. Arabuko-Sokoke, Kakamega, Nuu and Mumoni hill forests are in the Protected Area (PA) system of forest management. These forest reserves have always been most vulnerable to encroachment, overuse and degazettement due to growing demand for agricultural land and fuel-wood resources, which override perceived benefits from the forest.

Figure 2. Map of the three forest sites: Kakamega, Mwingi and Arabuko-Sokoke

Natural and Socio-Economic Characteristics of the Sites

Kenya's loss of forest cover and associated biodiversity, has led to serious environmental deterioration and consequent decreased food production and increasing rural poverty. Closed canopy forests cover less than 2% of the total land area, yet every year forests in Kenya are under increasing pressure from encroachment, burning and overuse and, until early 2003, from 'legal' excision. Thousands of people live within five kilometres of forest boundaries in Kenya and benefit from a whole range of goods and services from the forest.

The forest reserves have always been most vulnerable to encroachment, overuse and degazettement due to growing demand for agricultural land and fuel-wood resources, which override perceived benefits from the forest. The new forest policies and legislation as well as the over-arching environment policy and legislation provide for seeking incentives for local communities to accept and actively conserve the natural forest cover, through participatory management processes.

Kakamega Forest Reserve and National Reserve

Natural environment

Kakamega Forest (20,000 hectares) is a Forest Reserve under KFS and part of it is also gazetted as a National Reserve under KWS. It is a mid-altitude tropical rainforest (the only one left in Kenya), and is the eastern most outlier of the Congo Basin forests. Kakamega hosts 2 globally threatened and 15 regionally threatened bird species. Its mammalian fauna is diverse and shows clear affinities to the West African rainforest. Kakamega is a complex and fragmented wet forest, divided into southern and northern blocks by past encroachment; and the forest has been under attack from inside and outside for many years (Kokwaro, 1988).

Biodiversity of birds

Kakamega forest reflects its altitudinal position between lowland and montane forest. Its avifauna is unique not only nationally, but continentally. Forest-dependent bird species (194) include many of Kenya's Guinea-Congo Forests biome species, as well as 33 of Kenya's 70 Afrotropical highlands biome species. Several species have isolated, relict populations here, including *Andropadus ansorgei*, *Merops muelleri*, *Muscicapa lendu* and *Eremomela turneri*, which are absent from superficially similar mid-elevation forests in Uganda. Two globally threatened species occur, *Muscicapa lendu* and *Eremomela turneri*. A restricted-range species *Muscicapa lendu* characterises the Kakamega and Nandi forests Secondary Area, and is also present in the Albertine Rift mountains Endemic Bird Area.

Kakamega forest has few endemic taxa among birds. There is an endemic subspecies (*kavirondensis*) of *Andropadus ansorgei* and 16 endemic bird species occur in Kakamega and another 30 (such as *Psittacus erithacus*) are probably now confined to this forest site. The grassy glades in the forest have their own distinctive avifauna, with many moist-grassland species that are now rare elsewhere in western Kenya. Regionally threatened species include *Circaetus cinerascens*, *Hieraaetus ayresii*, *Stephanoaetus coronatus*, *Glaucidium tephronotum* (widespread at low density), very common *Indicator exilis*, rare *Indicator conirostris*, *Prodotiscus insignis*, *Phyllastrephus baumanni*, *Kakamega poliothorax* (extremely local and generally scarce), *Sheppardia polioptera* (patchily distributed), *Hyliota australis* (uncommon in forest canopy), *Dyaphorophyia concreta* (very local), *Campephaga quiscalina* (rarely recorded) and *Euplectes hartlaubi* (local) (BirdLife International, 2007).

Other biodiversity

Several West African forest mammals occur, including *Potamogale velox* (EN). The small mammal community is also very rich and shows strong affinities to the Congo basin. At least 28 snake species are recorded, including the rare *Pseudohaje goldii* and other West African species such as *Philothamnus heterodermus carinatus*, *Hapsidophrys lineata*, *Dendroaspis jamesoni kaimosae*, *Atheris squamiger squamiger*, *A. hispida* and *Bitis nasicornis*. Two notable and probably endangered forest amphibians, *Leptopelis modestus* and *Hyperolius lateralis*, are recorded. The forest's butterfly fauna is diverse and important, both regionally and continentally; around 350 species have been reported but the project could not record them all. At least one endemic, *Metisella kakamega*, and a near endemic, *Euphaedra rex* species were recorded. Kakamega has a rich diversity of trees, although endemism is low, the only woody endemic being the liana *Tiliacora kenyensis*.

Conservation issues

Kakamega is a complex and fragmented forest, and one that has been under attack, from inside and out, for many years. Kakamega District is one of the most densely populated in Kenya (1000 people/sq. km) and human pressure on the forest is extremely severe. Agricultural encroachment has led to large-scale destruction (e.g. within Yala Nature Reserve) in recent years, and illegal tree felling and charcoal burning are rampant. Hunting for bush-meat, debarking of certain trees for traditional medicine, and firewood collection are also serious problems.

Logging for commercially valuable timber, and clear felling of indigenous forest to make way for plantations, was extensive under the colonial Forest Service and continued until the late 1980s. This began the process of isolating the northern and southern blocks. Excisions for settlement, schools and tea plantations (the 'Nyayo Tea Zones') have claimed additional chunks of the forest. Local people are estimated to derive products worth US$ 1.7 million from the forest each year. This use is non-sustainable (Emerton, 1991). Forest protection was inadequate a decade ago, especially in the biologically important southern sector (Emerton, 1991), and there has been no improvement since then. Poverty among the forest adjacent communities is of great concern and needs to be addressed if the forest encroachment is to be reduced.

The forest is one of Kenya's top bird watching destinations, and has enormous potential for tourism if properly protected. This is one obvious means of generating revenue to help conserve Kakamega's immensely important biodiversity.

Arabuko-Sokoke Forest Reserve

Natural environment

Arabuko-Sokoke Forest (41,760 hectares) is a Forest Reserve under the joint management of the Forest Department (FD), Kenya Wildlife Service (KWS), National Museums of Kenya (NMK) and the Kenya Forestry Research Institute (KEFRI). Arabuko-Sokoke is one of the most important biodiversity sites in Kenya and ranked as the second most important forest for threatened bird conservation on mainland Africa (Collar and Stuart, 1988). It is one of 19 important bird areas that have been prioritised as critical sites for intensive and immediate conservation action in Kenya (Bennun and Njoroge, 1999). It is part of the East African Coastal Forest/Eastern Arc Mountain forest complex that ranks among the top 25 biodiversity hotspots on earth (Myers *et al*., 2000). Arabuko-Sokoke is home to 6 globally threatened bird species and 5 globally threatened mammals; an additional 5 bird species are strict coastal forest endemics. A small population of around 100 elephants lives in the forest and these are responsible for periodic crop raiding which causes great bitterness among the 110,000 subsistence farmers who live on its margins.

Biodiversity of birds

Arabuko-Sokoke has been ranked by Birdlife International as the second most important forest for bird conservation on mainland Africa. More than 230 bird species are recorded including nine globally threatened species. *Ploceus golandi* is known only from Arabuko-Sokoke and the little-studied Dakatcha woodland. It occurs mainly in *Brachystegia* woodland, although its numbers fluctuate. *Otus ireneae* is known only from this forest and one other site in northeast Tanzania. It is confined to *Cynometra* forest and (at much lower densities) intermediate *Cynometra*. Arabuko-Sokoke holds by far the bulk of the world's population, with an estimated 850–1200 pairs. Arabuko-Sokoke may also hold the world's largest population of *Sheppardia gunningi*, with as many as 9000 pairs thought to be present, primarily in the *Cynometra* forest. It is also a world stronghold for *Anthus sokokensis*, with around 3000 individuals estimated to occur in the *Brachystegia* woodland alone. *Zoothera guttata* is a scarce but regular intra-African migrant from March–October and *Anthreptes pallidigaster* is very local, occurring principally in the *Brachystegia* woodland, with an estimated population of 2800 birds. Regionally threatened species include *Casmerodius albus*, *Thalassornis leuconotus* and *Podica senegalensis* (all recorded occasionally on forest pools), *Hieraaetus ayresii*, *Stephanoaetus coronatus*, *Pitta angolensis*, *Turdoides squamulatus* (local and rarely recorded) and *Erythrocercus holochlorus* (BirdLife International, 2007).

Other biodiversity

Arabuko-Sokoke is rich in rare and endemic wildlife, and supports at least 50 globally or nationally rare plant taxa. Six taxa of butterfly endemic to the East African coast are present, as well as three rare, near-endemic mammals: *Rhynchocyon chrysopygus* (EN), *Cephalophus adersi* (EN) (found only in Sokoke and Zanzibar) and the distinctive small carnivore *Bdeogale crassicauda omnivora*. There is also a small population of *Loxodonta africana* (EN), and *Felis aurata*, rare in Kenya, may occur. Unusual reptiles include the lizard *Gastropholis prasina*; the forest is exceptionally rich in amphibians, including coastal endemics such as *Mertensophryne micrannotis*.

Conservation issues

The over-exploitation of the forest resources, driven by extreme poverty (per capita incomes of less than US$ 50 a year) of these neighbouring communities, has been responsible for the degradation of the forest (Gordon and Ayiemba, 2003). Local people use forest products for many purposes, including fuelwood and medicinal plants, and collect water at the seasonal pools. The forest is surrounded by agriculture on all sides. The Mahaji settlement was excised from the eastern edge of the forest after independence, and pressure remains high from some quarters for degazettement and settlement of the southeastern Kararacha-Mpendakula section, despite the fact that the soils there are extremely infertile and quite unsuitable for agriculture.

The Arabuko-Sokoke forest is managed jointly by the Kenya Forest Service and the Kenya Wildlife Service under a Memorandum of Agreement, through the Arabuko-Sokoke Forest Management Team (ASFMT) that brings together these two institutions with the Kenya Forestry Research Institute and the National Museums of Kenya. Extensive licensed logging has occurred in the past, with noticeable negative effects on bird communities in the degraded areas. Licensed selective logging continues on a smaller scale, along with licensed collection of dead wood for fuel. Both these practices have proven difficult to police, and regular poaching of valuable trees continues to be a major problem. *Brachylaena huillensis*, which is preferred for the carving industry and construction, has been severely affected, as have timber species such as *Pleurostylia africana*.

More profitable and sustainable uses are possible, including ecotourism, which has already grown in scale, and butterfly farming. Other conservation initiatives have been working in Arabuko-Sokoke, mainly on forest biodiversity assessment management plan preparation, habitat restoration and the start of successful community conservation (CC). USAID financed many of these activities within the core forest blocks, through BirdLife International's Kenya partner (Nature Kenya). This community process has stressed the need for broader and diversified income sources than agriculture and an initial reliance on butterfly farming.

Mwingi Forest Reserves, Eastern Province

Natural environment

Much global attention has been focused on destruction of tropical rainforest and its consequences, but less attention has been given to the tropical and sub-tropical dry forests and woodlands in Kenya. Yet these habitats are at least as problematic and are disappearing as fast or faster, and their loss is likely to have a more severe impact on people living nearby. The habitats are major sources of fuelwood and poles for rural and urban markets. Like the rainforests, they protect and cool soil, directly affecting soil fertility and productivity. They also act as carbon stores and are therefore relevant to dealing with climate change. They also harbour significant biodiversity resources within a complex of thorn tree (*Acacia*, *Commiphora*) woodland communities. Indigenous people have learned to live in symbiosis with these woodlands by relying both upon the milk and meat that animals produce from tree-browse, and upon the replenishment of soil fertility that the trees bring to agriculture. Woodland degradation increases rural poverty and local desertification.

There are two significant Forest Reserves in Mwingi: Nuu–Imba in the south and the larger Mumoni–Gaikuyu complex in the North. Mumoni has hill-top dry forest patches at higher altitude, and dry woodland and riverine forest lower down, covering an area of 14,550 hectares. Hill forests are as yet little degraded, as they are further from markets for fuelwood. Some degree of community conservation still persists. However, away from the hills, on both communal and private land there is continuing forest fragmentation and destruction, particularly for charcoal. The globally threatened Hinde's babbler, which has a very restricted range in Central Kenya from Machakos to Mwingi (Bennun and Njoroge, 1999), occurs in the riverine thickets and woodland. The pancake tortoise, *Malacochersus tornieri*, is endemic to these hilly habitats in Kenya and northern Tanzania. In Kitui–Mwingi it is now found on scattered rocky hilltops, threatened by habitat destruction and over-collection for trade.

The Mwingi area has low potential for conventional agriculture, and the local population augments their agro-pastoralist income from the forest and woodland resources. Bee-keeping has long been an important source of income using traditional hives.

Biodiversity of birds

A total of 150 bird species within 44 families have been reported. Some four Afrotropical and 14 Palaearctic migrants have been recorded. These hills are clearly important sites for raptors (including Afrotropical and Palaeartic migrants). The occurrence of the regionally vulnerable African crowned eagle (*Stephanoaetus coronatus*), the near threatened southern-banded snake eagle (*Circaetus fasciolatus*, a coastal biome species) and the Hinde's babbler (*Turdoides hindei*), an endangered species endemic to Kenya was recorded. Other birds of conservation concern include the martial eagle (*Polemaetus bellicosus*, vulnerable) and the European white stork (*Ciconia ciconia*). Game birds form an important source of protein to the local community in this region, with some reports of small-scale efforts of game bird farming. Five forest specialist bird species have been recorded.

Other biodiversity

Over 748 different vascular plant species in 116 families and 420 genera have been recorded. Species of reptiles and amphibians (45) were recorded. This comprised of 21 species of lizards, 12 snakes, one tortoise and 11 anurans. These were contained in six families of lizards, seven families of amphibians, five families of snakes and only one family of tortoise. A total of 165 individuals of small mammals of 19 species were captured belonging to the orders Rodentia, Chiroptera and Macroscelidea. A total of 88 species/morpho-species of butterflies were recorded. The invertebrate species recorded appear to be dominated by widespread and arid/savanna species. There are a few forest range restricted species. For instance, the butterfly species *Baliochila fragilis* and *Hypolimnas anthedon* were mainly recorded in undisturbed forest habitats. The *Acraea anemosa* which was previously known to be restricted to eastern Kenya savanna has been reported here for the first time. Most species of snails were of widespread distribution. Some of the recorded taxa suggest biogeographic affinity to the coastal flora and fauna. For instance, association to the coastal flora as indicated by discovery of plant endemics such as *Balanites wilsoniana*, *Oryza punctata* and *Ehretia bakeri*. The coastal fauna included the Kenya pygmy chameleon and the land snail *Gulella radius*.

The reporting of forest range restricted species suggests that conservation of these forests is vital for promoting range restricted species. Similarly, the rich diversity of butterfly species portrays potential for butterfly farming initiatives by the local communities. It is also noted that the conservation of invertebrates may enhance other biodiversity as a source of food, e.g. for birds, and promote wild and agro-ecosystems plant pollination and facilitate maintenance of soil fertility.

Species of land snails (19) were also recorded. Plant species (77) recorded were dryland endemics restricted to Kenya or the East African floral region. Some reptiles and amphibians were recorded in this region for the first time, hence representing wide range extensions. The Kenya pygmy chameleon, *Rhampholeon kerstenii kerstenii*, recorded at Nuu hill represents the most inland population. The Taita toad, *Bufo taitanus*, which was previously only known to be restricted to Taita Hills, is reported for the first time from Nuu and Mumoni hills. Two undescribed forest geckos, *Cnemaspis* sp., which were recorded from Endau and Muthaa hills, may represent two new species. The pancake tortoise (*Malacochersus tornieri*), southern Africa rock python (*Python natalensis*) and five species of chameleon are among species recorded which are known to be of economic value elsewhere. All these species are currently listed in CITES Appendix II therefore calling for higher conservation priority.

Conservation issues

Endau, Nuu, Imba and Mumoni are gazetted government dryland indigenous forests with some small pockets of exotic plantations. Early in the 19th century before forest gazettement and environmental awareness, people had settled and cultivated some high elevations of the hills growing crops such as maize and sorghum. Degradation of biodiversity in these areas has reduced owing to project intervention with income generation options and conservation awareness. Illegal harvests of timber, medicine and charcoal burning have been reduced considerably. The plant species were noted as important sources of medicine, fibre, food, fodder or forage, timber and fuelwood. Some important species of medicinal plants include *Warburgia ugandansis*, *Pittosporum viridiflorum* (Mumoni), *Securidaca longipedunculata*, *Xanthoxylum* and *Strchnos* species (Mutha, Nuu and Endau). Illegal collection and habitat alterations through subsistence cultivation are major threats to the future survival of reptiles and amphibians at this site.

Mwingi in this project was initially used as a field training base for other regions since it has a strong group of beekeepers, which had already developed a honey marketplace for their hive produce, and a strong market linkage had been established with Viking Ltd.

The project helped to prevent habitat destruction, as the commercial returns from beekeeping and wild silk farming provide the population sound incentive to conserve trees.

Section 2

The Project in Action

Tackling the Main Issues

Action Planning

The overall objective of this Pilot Project is to reduce poverty through improved food security and income levels of farmers and rural women by promoting more effective use of forest resources and its biodiversity through introducing income generating activities using honeybees and silkmoths. By linking these to Participatory Forest Management initiatives, the project will contribute to both the government's poverty reduction and its environmental conservation strategies.

The project used a two-pronged approach to ecosystem restoration and poverty reduction. The first is by addressing the causes and impacts of ecosystem degradation through support for incoming government policies on forest management. The second is by introducing through capacity building, alternative sources of income through the development of silkmoth and honeybees technologies using forest resources and by improving agricultural produce through pollination services.

This involved the construction of three marketplaces (in Mwingi for wild silk, Arabuko-Sokoke for honey and silk, and in Kakamega for honey and silk), and the plantation of mulberry for the conventional silkmoths and the host plants for the wild silkmoth. Training of trainers, ministry field staff and the beekeepers in hives management, harvesting techniques and handling of the honey comb enabled the beekeepers to attain the necessary quality for meeting the market standards. Further training in the management of the Internal Control System (ICS) for organic certification then enabled the producer groups to gain organic certification and access to premium internatrional markets. Management Effectiveness Tracking Tool (METT) and the Threat Reduction Assessment tool were used to monitor the management impact under this project. Biodiversity monitoring was carried out through surveys of stingless bees, honey bees, wild silkmoth at all three sites and also on two threatened species of birds and one red-listed mammal in Arabuko-Sokoke. In Kakamega, the project built on a monitoring programme developed by Nature Kenya and implemented by the community-based Kakamega Environmental Education Programme (KEEP).

Central Activities and Their Drivers

Biodiversity conservation and poverty reduction were the project's cross cutting themes and combine the main project components and related activities described below.

1. Forest management framework in place that facilitates community participation in buffer zone enterprise and conservation in all project sites. The activities were implemented through the Kenya Forest Department, and involved:

- Awareness raising and capacity building within District Partners (Forestry and District Environment Committees) for community partnership, with specific PFM – ICD training for partner staff. Networking district partners (and between districts for Kakamega).
- Identification of buffer zone management planning within Forest Management Plan processes, including buffer zone pilot intervention areas.
- CBO survey and link to District PRSP processes (livelihood/poverty mapping), and reserve boundary demarcation in Mwingi, buffer demarcation elsewhere.
- Biodiversity assessment in buffer zones (contrast core) focus on tree regeneration and use, and useful commercial insect indicators.

2. Forest adjacent communities, through registered Forest Associations, actively engaged in forest conservation through buffer-zone management. Activities were implemented by FD/*icipe*:
   - Creation of Village Forest Committees (model from Cross Borders/Arabuko), and scale up as registered Forest Associations (as per Forest Bill).
   - Training for Forest Associations (FA)—study tours, cross visits, site-training workshops.
   - Scale up to overall site based association, linked to DFO/Dist. Environment Committee.
   - Buffer zones patrolled and protected, sustainable resource strategies in place.
   - Fire breaks installed and village jurisdictions agreed and in management plan.
   - Degraded areas restored (buffer planting, regeneration tending, gully plugging). Tree nursery support for restoration.
   - FAs involved in buffer zone M&E processes, targeting insects and tree growth, promotion of farm tree use, fuel wood surveys, pole use surveys, and improved energy stoves on-farm.

3. Capacity of communities and institutions to manage and utilise both wild and mulberry silkmoth and honeybee biodiversity to increase income. Activities were implemented by *icipe*:
   - Selection of villages, sub-villages and household clusters (link to buffer zone areas).
   - Household livelihood and income mapping in pilot areas.
   - Training of participating groups on-site and in *icipe* for apiculture and sericulture ventures.
   - Training for apiaries and hive products, and for processing and packaging facilities.
   - Training community members in wild silkmoth recognition, collection and monitoring.
   - Training for mulberry planting on field borders, for domestic silkmoth, fuel and fodder.

- Training and support for silk preparation including reeling and weaving in village marketplaces.
- Upgrade these household activities to village processes.
- User groups are formed, registered, trained and capacity to manage enterprise is built.
- Communities are linked to and working with private sector markets (Link to Output 4).

4. Improved methodologies and insect resources are available to allow efficient resource use for improved livelihoods and conservation practices. Activities were implemented by *icipe* and partners:
   - Apiaries established and operational in all three sites.
   - Queen rearing and royal jelly production system established.
   - Silkmoth rearing houses and wild silkmoth farming sites established and operational.
   - Market centres (including processing/packaging facilities) established for silk/honey products at all three sites. Marketing linkages established through Viking Ltd.

The overall outputs from these activities are presented below.

Forest Monitoring

Management Effectiveness Tracking Tool

Management Effectiveness Tracking Tools (METT) are tools for monitoring progress towards improving management effectiveness, e.g. of a forest. It is obligatory for all GEF protected area projects that the tracking tool is used throughout the project's lifespan. In this project, simple questionnaires covering basic issues for forest management were used. Twice during the project lifespan, in 2005 and 2008, the tool was administered to the district forest officers at each of the three forest sites and the scores compared (See Technical Study 1).

TECHNICAL STUDY 1:
Management Effectiveness Tracking Tool (METT)

The management effectiveness tracking tool (METT) is a simple questionnaire covering basic issues for forest management (e.g. monitoring and research management planning). It was administered to the District Forest Officers at the beginning and end of the project and the scores were compiled. Despite problems of standardisation, scores reflected the different levels of conservation investment in the three forests: Arabuko > Kakamega > Mwingi. We are therefore confident that the METT scores are meaningful.

Forest	METT score 2005	METT Score 2008
Arabuko	54	55
Kakamega	43	53
Mwingi	28	47

— Courtesy of E. Wang'ombe *et al.*

Monitoring and evaluation processes were coordinated at site and national levels, from baseline to impact assessments on both forest trees and biodiversity.

Threat Reduction Assessment

In addition to the METT, forest managers were introduced to the Threat Reduction Assessment (TRA). This is again a simple questionnaire but it has the added advantage that it directly tackles threats to biodiversity and provides a means of tracking the effectiveness of a project in reducing these threats and of comparing management success at different sites. In total, the TRA is a ten-step process and leads to the calculation of a TRA Index. Step 1 defines the project area, Step 2 the major threats, and Step 3 what a 100% reduction in the threat would mean (e.g. poaching reduced to zero). Steps 4–6 involve the ranking of the threats in terms of the area affected, intensity, and urgency, and in step 7 all these ranking scores (e.g. from 1–5) are added to get the total ranking for each threat. Step 8 is done subsequently and estimates the extent (%) to which each threat has been reduced. In step 9 the total rankings and the % reduction are multiplied together and the results added to give the total raw score. In step 10 the total raw score is divided by the total ranking to give the final TRA Index.

The work revealed that these forests were under a serious threat in form of forest excisions, encroachments, forest fires, charcoal burning, illegal grazing and over-exploitation of forest resources. Nuu and Mumoni hills in Mwingi district displayed the highest threats followed by Kakamega forest, and then Arabuko-Sokoke forest. The over-exploitation of the forest resources, driven by extreme poverty (per capita incomes of less than US$ 50 a year) of these neighbouring communities, has been responsible for the degradation of the forests. A large and growing human population surrounds Kakamega Forest, reaching densities of over 1000 people per square kilometre in Vihiga. Nuu and Mumoni hills habitats are at least as problematic and are disappearing as fast or faster, and their loss is likely to have a more severe impact on people living nearby. They are major sources of fuelwood and poles for rural and urban markets. They also act as carbon stores and are therefore relevant to dealing with climate change.

Illegal activities in forests show reduction

Through monitoring of cut trunks, there is evidence that there is reduction in illegal cutting of trees and fire incidence has decreased. The monitoring carried out on populations of forest dependent and threatened bird species demonstrated no loss of species or population abundance in core and buffer areas.

Biodiversity Monitoring

Biodiversity monitoring was carried out through surveys of stingless bees, honeybees and wild silkmoths at all three sites and also on two threatened species of birds and one red-listed mammal in Arabuko-Sokoke. One red-listed bird endemic to Mwingi and the threatened pancake tortoise were monitored in Mwingi. Except for insects, biodiversity monitoring was undertaken through Nature-Kenya. In Kakamega the project expanded the monitoring programme developed by Nature-Kenya and this was implemented by the community-based Kakamega Environmental Education Programme (KEEP).

The main targets of this monitoring included biodiversity and socio-economic monitoring, forests condition, focus on tree regeneration and use, and useful commercial insect indicators.

Biodiversity monitoring of the targeted commercial insect species includes stingless bees, biodiversity assessment in buffer zones, identification and


Left: Pancake tortoise *Malacochersus tornieri.*
Right: Stingless bee, *Pleibeina hildebrandi* loaded with pollen


Left: Monitoring *Hypotrigona* populations in Mwingi. Right: *Gonometa postica* cocoons on *Acacia* monitoring of silkmoth host plants distribution, data collection on silkmoth development and health (number of eggs in the later laying egg-cluster and duration of larval stage, time a cohort of larvae used to eat, quantity of leaves eaten, weight and the length of adult moth at emergence, length, weight and number of inner cocoons in the cocoon nest, wing length of later emergence moth, observation on larvae parasitism), stingless bees biodiversity in the three forests, and nesting preference of the stingless bees in the three forests.

Commercial Insects Monitoring

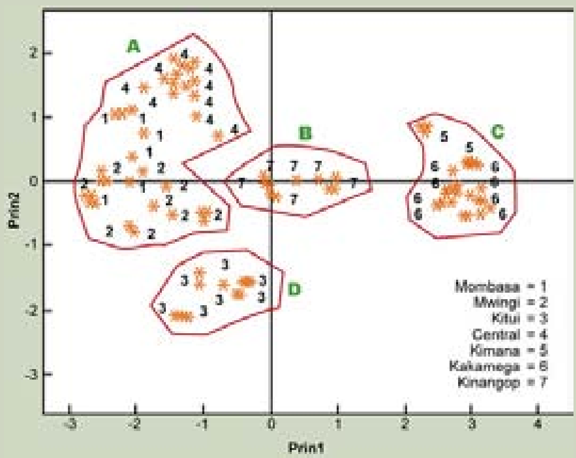
Example of commercial insects monitoring—Honeybees

Sampling of honey bees was done across the three project sites, which represent distinct ecological zones. Colonies were randomly selected from which adult workers were sampled to examine their size, body colour bands and different morphological characters including length and width of the right forewing, length of proboscis, right antenna and right hind leg. This sampling was done across seasons so as to determine the honeybee races and monitor their characteristics as a base for future monitoring for various commercial activities such as honey production, pollination ability and royal jelly production.

TECHNICAL STUDY 2:

Variations in Races of the Honeybee *Apis mellifera* (Hymenoptera: Apidae) in Kenya

The three races of the honeybee *Apis mellifera* Linnaeus in Kenya (*A. m. scutellata, A. m. monticola* and *A. m. litorea*) differ from each other with respect to size, cubital index and abdominal colour banding pattern. These differences were used to assess the extent of interbreeding and hybridisation between the races. This was verified on the basis of selected morphometric traits. Bee samples were collected from traditional log hives in different ecosystems in Kenya. The length and width of the right forewing, length of proboscis, right antenna and right hind leg were measured, and the cubital index was computed for each specimen. The bees were classified according to size and colour banding pattern. Data analysis indicated there was hybridisation among the three races of *A. mellifera* in Kenya due to swarming and migration under seasonal pressure.



Principal component analysis of the morphometrics of honeybee races in Kenya (dark points correspond to several points of close coordinates which project onto the same point)

— Courtesy S.K. Raina *et al.*

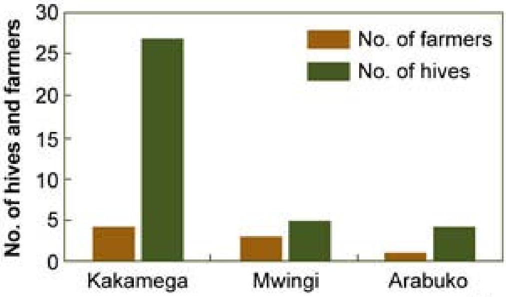
Example of commercial insect monitoring—Stingless bees

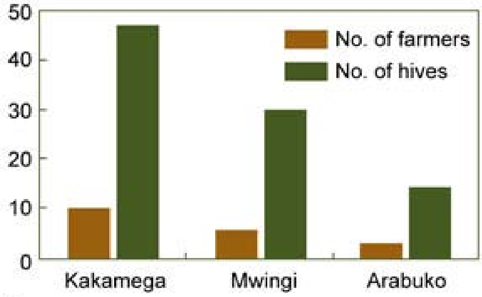
The biodiversity of stingless bees monitoring involved the setting of 30 traps in the forest for natural colonisation. The traps were set at different heights in 3 different species of trees, which are preferred by the bees. There was no natural colonisation of the nests within a period of 6 months. The hives colonised through colony transfer and colony division are being monitored in the meliponiary.

In Mwingi, many farmers distinguish stingless bees by their 'very sweet honey'. They have also a traditional way of differentiating the different species depending on their morphological features and their nesting habits. So far, the project has identified two stingless bee species, *Hypotrigona* spp. and *Meliponula* spp. Stingless bees depend on tree cavities for nesting and with the increase in deforestation, many nests are being destroyed. Traditionally, the honey is mostly obtained by harvesting from feral colonies, an activity which destroys colonies. With the project intervention, colonies are being domesticated in hives and farmers trained in colony division. Todate 200 stingless beehives have been set in various sites in Imba, Nguni, Ngomeni, Kasanga and Kathiani to develop meliponiculture.


Left: Inspecting trap nest. Right: Meliponiary in Kakamega forest

The study indicated there was an increase in number of colonies in the forests after the GEF project intervention. Farmers have realised the importance of stingless bees in pollination apart from honey production. The number of colonies domesticated is increasing as the farmers learn colony division. Figures 3 and 4 summarise the status of stingless bees in the three forests in two years.





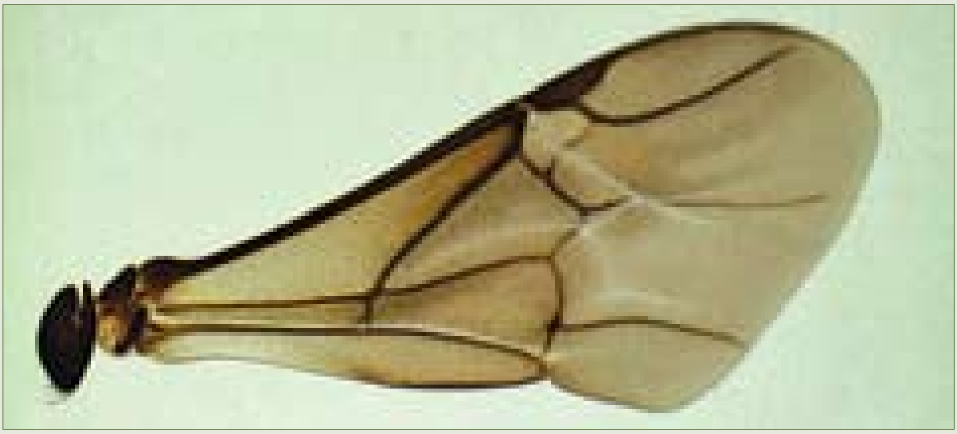
Regions

Figure 3. Status of stingless bees in three forests by March 2005

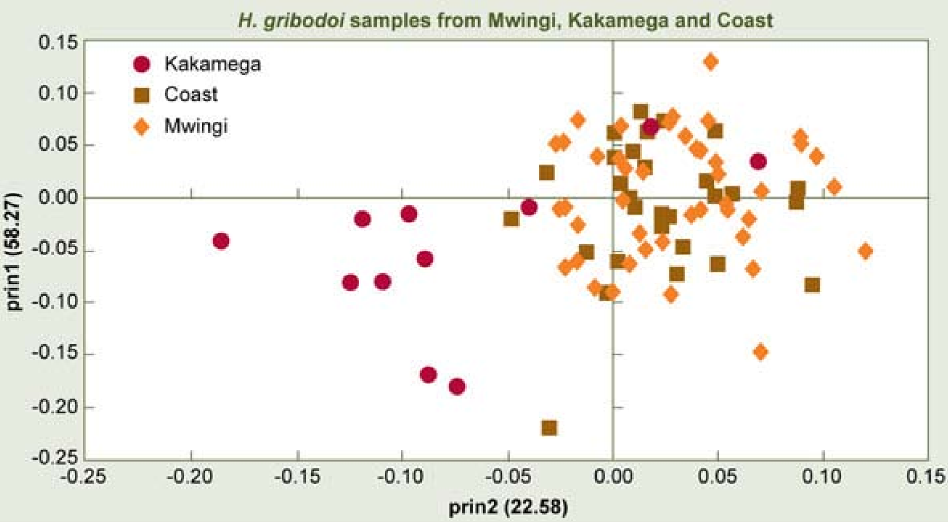
Figure 4. Status of stingless bees in three forests by December 2006

TECHNICAL STUDY 3:
Development of Research Tools
Morphometric differentiation of stingless bees
(Apidae: Meliponinae) species from three forests in Kenya

Thirteen morphometric characters were measured to determine the extent of morphological variation of stingless bees (*Trigona* species) in Kenya. The morphometric variables were effective in discriminating three populations of *Hypotrigona gribodoi* and *Meliponula bocandei* from three geographically isolated regions of Kenya. Samples were collected from three locations, namely Mwingi, Kakamega and Arabuko-Sokoke forests, ranging from lowland (Arabuko-Sokoke and Mwingi) to high altitude (Kakamega). *Hypotrigona gribodoi* samples from three localities were separated using the PCA (principal component analysis) and CVA (canonical variate analysis), first axis and a second canonical axis, respectively into two population groups, Kakamega populations standing alone whereas, Mwingi and Coast did not show much variation. On the other hand, the three populations of *M. bocandei* were separated into two groups on the first axis but further separated along a second canonical axis into three distinct groups. These results are also verified using analysis of a mitochondrial gene, cytochrome c oxidase 1 (*CO1*).



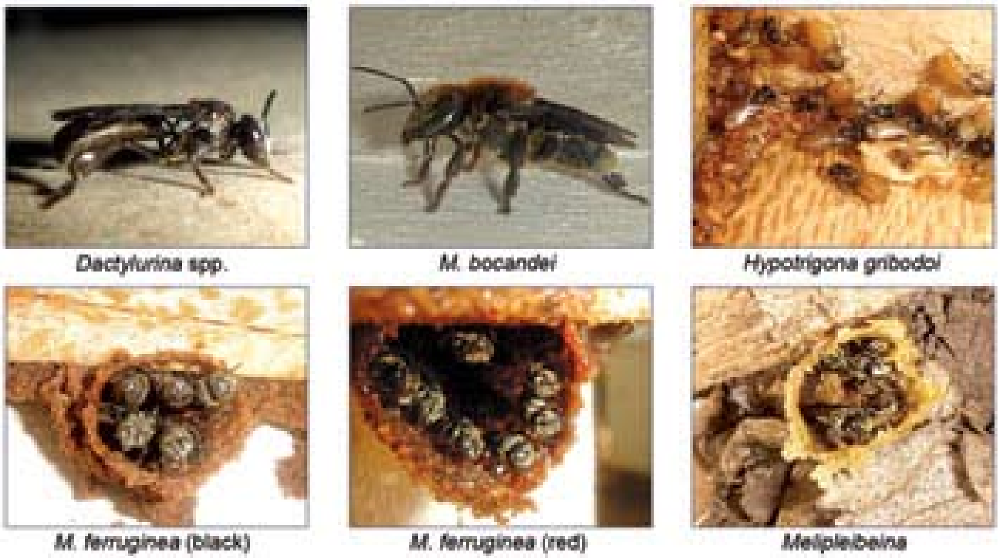
Right forewing showing veins (WL, WW, v3–v8) used in morphometric analyses



Principal component analysis of *Hypotrigona gribodoi* in Kenya

—Courtesy of N. Ndung'u *et al.*

Stingless bees honey is liked and used as traditional medicine. People believe stingless bee honey has high medicinal value in treating colds, chest pains and vigorous healing of burns and wounds. Analysis of the honey was conducted and its high microbial properties were comparable to standard specifications for stingless bee honey. Preliminary research of the antibacterial activities of stingless bee honey has shown that this honey type has inhibitory effect on *Pseudomonas aeruginosa*, *Escherichia coli* and *Staphylococcus aureus*.



Some of the stingless bees species found in Kenya

Example of commercial insect monitoring – Silkmoths

The insight on spatial distribution of wild silkmoths in the indigenous forest and mixed indigenous forest was one of the several challenges facing wild silk production in Kenya. Furthermore, information is required on spatial distribution of species to assist in developing management plans for conservation and their sustainable utilisation for income generation. The use of new technology such as GIS becomes necessary to analyse environmental changes with the aim of developing recommendations for sustainable biodiversity management. In the Kakamega forest GIS revealed that distribution of *B. micrantha* and *A. panda* cocoon nests and egg-clusters were not uniformly distributed in the two types of forest (indigenous and mixed indigenous). This confirms the insufficient populations in the wild. *Bridelia micrantha*, cocoon nests and egg-clusters were recorded at different densities in the indigenous forest and mixed indigenous forest. This study also reveals that *A. panda* host plant (*B. micrantha*), cocoon nests and egg-clusters are not randomly distributed in the Kakamega forest and they are overdispersed or underdispersed according to the type of forest (indigenous or mixed indigenous forest). This study recommends utilisation of GIS for the long-term monitoring of biodiversity to determine population fluctuation (declining or increasing). The studies monitored population dynamics and seasonal fluctuations in the population structure as an indicator of the forest biodiversity and income generation for the community.

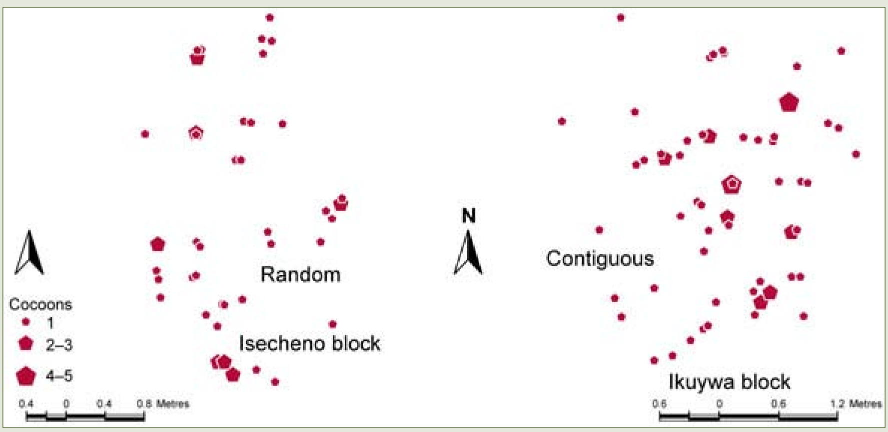
Unidentified wild silkmoth larvae

Cocoon of unidentified wild silkmoth

Anaphe panda wild silk larvae on a farm of
Shikutsa Community-based Distributors Group

TECHNICAL STUDY 4:
Spatial Distribution of the Silk Cocoon Nests and Egg-clusters of the Silkmoth *Anaphe panda* and its Host Plant *Bridelia micrantha* in the Kakamega Forest of Western Kenya

A study on the spatial distribution of the silkmoth *Anaphe panda* cocoon nests, egg-clusters and the host plant *Bridelia micrantha* (Hochst) was conducted in two blocks of the Kakamega forest (Isecheno and Ikuywa) western Kenya. The mean densities of cocoon nests, egg-clusters and *B. micrantha* were significantly different in the two blocks. The host plants and the silkmoth egg-clusters were randomly distributed in the two blocks, whereas cocoon nests were random at Isecheno block and contiguous at Ikuywa block. Flight range was recorded between 1.11–5.30 meters and was significantly higher in Isecheno than Ikuywa. This study reveals that *A. panda* tends to distribute its egg-clusters uniformly over the lower and middle crown of *B. micrantha* with a preference to eastern localisation and confirms the insufficiency of the silkmoth populations in the wild.



Geographical distribution of *Anaphe panda* cocoon nests in the Kakamega forest

—Courtesy of N. Mbahin *et al.*

TECHNICAL STUDY 5:
Monitoring Wild Silkmoth *Gonometa postica*, Abundance, Host Plant Diversity and Distribution in Imba and Mumoni Woodlands in Mwingi, Kenya

A survey of the abundance of larvae and pupae of *Gonometa postica* Walker and host plants was undertaken in the long rainy season in 2006 at six sites in the Imba and Mumoni forests of Mwingi, eastern Kenya. One hundred trees of the primary host species of *G. postica* were sampled at each site, in addition to minor host species with *G. postica* pupae. The density of each tree species was calculated and the height, canopy, diameter and number of branches measured. In order of decreasing abundance, the host plants in Imba forest were *Acacia tortilis*, *A. elatior* and *A. nilotica;* and in Mumoni forest, *A. tortilis*, *A. nilotica*, *A. mellifera* and *A. brevispica*. *Acacia elatior* had significantly more larvae than other host plants in Imba. In Mumoni, *A tortilis* and *A. mellifera* had significantly more larvae, followed by *A. nilotica* and *A. brevispica*. The minor host plants harbour significantly more pupae than the major host plants in the two forests. In general, Imba had a significantly higher abundance of larvae and pupae than Mumoni. Host plant species richness did not differ between the two forests but their evenness was significantly higher in Imba than Mumoni.

—Courtesy of K. O. Fening

TECHNICAL STUDY 6:
Morphological Characterisation and DNA Barcoding of Two *Gonometa* species in Mwingi (Kenya)

Morphometric studies of males of two sympatric species of *Gonometa*, from Nuu, Nguni and Mituki in Mwingi district (Kenya) was done. Mophometric measurements of forewing and full body length were taken and analysed using Statistical Analysis System software version 9.1.2. The Principal Component Analysis (PCA) did not show any clear separation of the two moth species. DNA barcoding, which focuses on a 648-bp subunit of the mitochondria cytochrome oxidase 1 (5′ COI) gene, which is a molecular tool, was used to compare the molecular variations between these two species. DNA was extracted from the middle left leg of the moths using the CTAB DNA extraction protocol. The *COI* region of the mitochondrial DNA was amplified using universal primers and direct sequencing was done on the cleaned PCR product. Analysis of the *COI* region was initially done using the Chromas software program to edit the sequences. Clustal X software program was then used to do multiple sequence alignments to check for any segregating sites within the sequences. Drawing a Neighbour-joining tree using Molecular Evolutionary Genetics Analysis (MEGA) software version 4.0 followed this to observe the distance between the two species. Using this approach, it was possible to identify the two species*, G. postica* and *G. nigrottoi* from Mwingi.

Gonometa postica male

G. nigrottoi male

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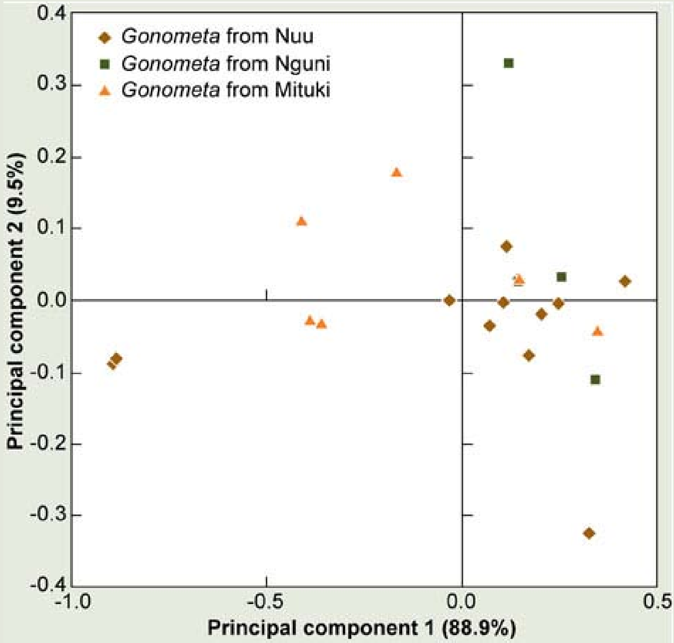
Technical Study 6 contd.



Projection of mean vectors of the *Gonometa* male species from the different localities derived from the PCA of morphometric characters

Neighbour-joining profile with bootstrap analysis based on mitochondrial gene Cytochrome C Oxidase subunit 1 (*COI*) sequences, from 19 congeneric *Gonometa* male species from Mwingi District in Kenya. Sequence divergence in 658 base pair (bp) of *COI* gene was calculated using Kimura's two-parameter model.

—Courtesy of P.K. Kamau *et al.*

TECHNICAL STUDY 7:
Host–Parasitoid and Plant Interactions of Six Larval Parasitoids of the African Wild Silkmoth, *Gonometa postica* Walker (Lepidoptera: Lasiocampidae) in Mwingi Forests, Kenya

Gonometa postica Walker produces high quality silk, but it is affected by parasitoids attack in the field. A survey of parasitism rates of *G. postica* larvae and pupae on host, non-host plants, development behaviour and aspects of morphology of parasitoids was undertaken for two generations in 2006 at six field sites, three each in Imba and Mumoni forests of Mwingi, eastern Kenya. All freshly spun cocoons of *G. postica* were sampled from a total of 100 trees of the host plants and other non-host plants per site. The cocoons were kept individually in fine net-sealed plastic vials to determine percentage parasitism. Characteristics of emergence hole of parasitoids from pupal cocoon were measured. Six species of larval parasitoids of *G. postica* were identified from two forests: two dipterans and four hymenopterans. All the identified parasitoids were gregarious, endoparasitic koinoboints. The ovipositor was present in hymenopterans but absent in the dipterans. The two key parasitoids, which were identified included *Palexorista* sp. (Diptera: Tachinidae) and *Goryphus* sp. (Hymenoptera: Ichneumonidae) with parasitism rates ranging from 1.8–32.7% and 2.2–7.5%, respectively. Parasitoid species diversity was significantly higher for the second-generation cocoons in Imba than Mumoni. Parasitism rates of *G. postica* larvae by the key parasitoids varied significantly according to host/non-host plants, generations and sites. *Eurytoma transvaalensis* Cameron was found to be possibly a facultative hyperparasitoid of *Goryphys* sp. Multiparasitism was demonstrated in some species, as *Pimpla* sp. out-competed *Goryphus* sp. in the same female cocoon of *G. postica* and emerged successfully. This is baseline information on the host-parasitoid and plant interactions in the field.

Parasitism rates of *Gonometa postica* larvae and pupae on host, non-host plants in Imba and Mumoni forests of Mwingi

Order Family	Species	Mean parasitism⁺ (%) ± SE			
		Generation I		Generation II	
		Imba	Mumoni	Imba	Mumoni
Diptera					
Tachinidae	*Palexorista* sp.	32. 65 ± 5.48aA	4.17 ± 1.15 bAB	8.37 ± 0.88 aB	1.80 ± 0.32 bB
	Pimelimyia semitestacea	0.00 ± 0.00	0.00 ± 0.00	2.53 ± 0.66 CD	0.00 ± 0.00
Hymenoptera					
Ichneumonidae	*Goryphus* sp.	2.96 ± 0.14 aC	2.15 ± 0.63 aB	4.33 ± 0.85 aC	7.50 ± 1.86 aA
	Pimpla sp.	0.00 ± 0.00	0.00 ± 0.00	0.27 ± 0.06 E	0.00 ± 0.00
Eurytomidae	*Eurytoma transvaalensis*	0.00 ± 0.00	0.00 ± 0.00	1.48 ± 0.16 D	0.00 ± 0.00
Chalcididae	*Brachymeria* sp.	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.49 ± 0.14 C

⁺Mean parasitism (%) was calculated from cocoons collected from all three sites and all host plants in Imba and Mumoni forests of Mwingi.
Means within a column followed by the same capital and within a row followed by the same lower case letter(s) are not significantly different (P = 0.05, SNK) for the respective generations.

—Courtesy of K. O. Fening

Conservation and Communities

Community-Driven Approach

The project recognised the important conservation role that is played by communities living adjacent to key ecosystems. Hence, the project undertook the required training of the local communities to bring changes in behaviour on the part of resource use. Forest community groups were formed in all target villages while some were consolidated to form forest associations during the project period. These groups were actively involved in rehabilitation of degraded sites within the forests and in forest patrols. Village level organisations control by-laws and rules at the same time as acting as a stimulus for change within the social system. Capacity development at all levels (community, district, central forestry) was targeted within all core project outputs. The project provided local people with needed expertise in community forestry inputs, institutional support as well as product enterprise in sericulture and apiculture. The project assisted district involvement (in new districts, with little past institutional support) and provided support to the partnership process. There is a need for better market information services among local communities living in rural areas. This project provided that information in a village friendly manner.

Tree nursery in Kilifi, coastal Kenya

Tree planting in Mumoni, Mwingi

Acacia sp. in a tree nursery in Nuu, Mwingi

Participatory Forest Management

The Forestry Act of 2005, part IV sub section 47, provides for co-management of Kenyan forests through the Community Forest Associations (CFAs) and the policy to drive this Act articulates the development of participatory forest management. The formation of CFA and actualisation of Participatory Forest Management have been tested and sharpened through this project in all project sites. The experience gained and harnessed from this work in each of the project sites is now being replicated countrywide.

Authority of the institutions responsible for the project areas has been strengthened through this project at local level in all the three project sites in Arabuko-Sokoke forest, Kakamega buffer forest zones and in Mwingi (Mumoni, Nuu and Imba) hill top forests. For example, all forest areas in

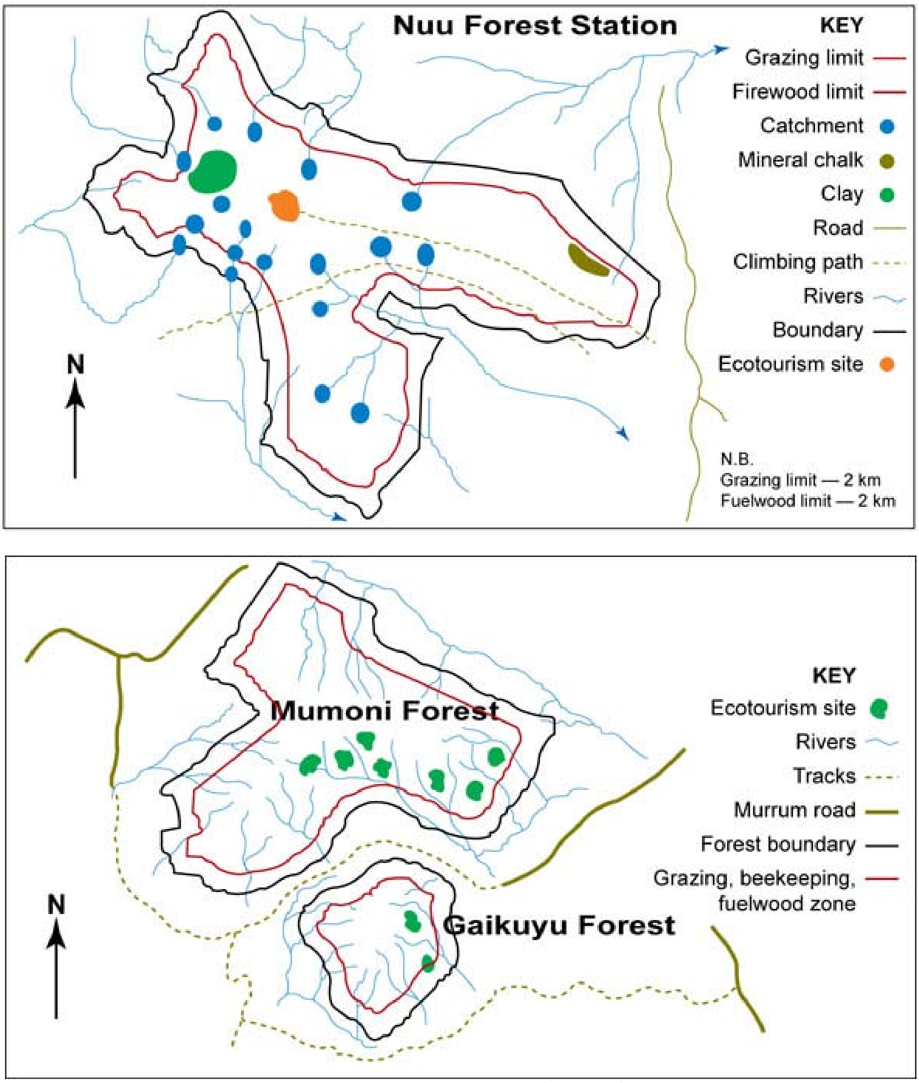


Figure 5. Maps showing community mapping of Nuu forest resources (top), and Muumoni and Gaikuyu forest resources (bottom)

project sites were re-demarcated and boundary beacons re-established thereby reclaiming lost land. In the Mwingi forests, the community members were involved in forest and buffer zone resource mapping (Figure 5).

Further community involvement was encouraged through the process of land use zoning. The zones were based on community needs assessment. Several zones were identified for sustainable conservation and utilisation of the natural resources. These included: zone for fuel wood and poles from the forest boundary, zone for beekeeping/ silkworm rearing, a zone for grazing and water catchment, a zone for afforestation area (all areas that were previously encroached), socio-cultural sites, eco-tourism sites, and a medicinal plants harvesting zone.

Zonation of Mutaitho Forest Hill was also carried out (Figure 6).

Other activities included boundary realignment around Nuu hill in Mwingi district, formation of and capacity development of village forest committees and Community Forest Associations in Arabuko-Sokoke, while in Kakamega tree planting with Community Forest Associations was done, as well as undertaking a cross site visit to Arabuko-Sokoke.

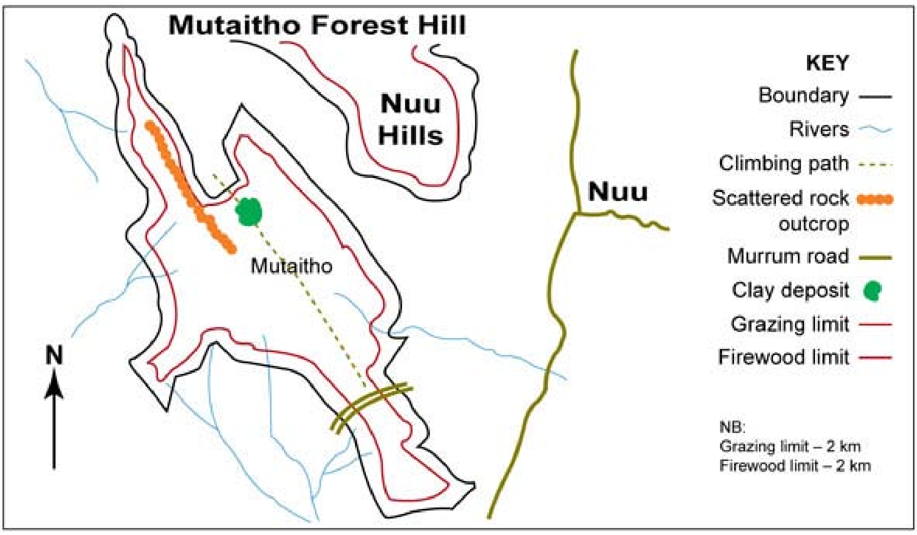


Figure 6. Zonation of Mutaitho Forest Hill

Buffer Zone Tree Planting

All communities participated in buffer zone tree planting and spot weeding for seedlings planted.

A total of 12,000 ha of forest and woodland across the three separate Forest Reserves were under improved multi-stakeholder management during the project period.

Improved Livelihoods

The implemented project activities in the commercial insect areas focused on improving the income of the poor and their livelihoods through apiculture and sericulture technologies. Throughout the project period, emphasis was laid on the role of the forest in enhancing the commercial insects farming activities. All implementers supported capacity building through on-site training on ecosystem management activities in forest areas within Kakamega, Arabuko-Sokoke and Mwingi.

Within this project, *icipe* assisted the communities to increase their technical and management skills through capacity building and advisory support. The activities to develop these two value chains, honey and silk, were made from the point of production through to the point of sale. To improve the market potential of the products, *icipe* worked with the communities to bring about the label 'Eco-Honey'. Organic certification systems were established to increase the market profile and economic advantage, and private traders were introduced as part of the marketing strategy.

The construction of hives, rearing cages, and related appliances for rearing and harvesting of silkmoth and honeybees offered employment for local artisans. The use of mulberry as a multipurpose tree (fuel, fodder and fruits in addition to silk) reduced pressure on forest resources.

Training and Capacity Building

Farmers were trained on management of apiculture and sericulture technologies, conservation of forests and improvement of their local environment through tree planting and sustainable utilisation of locally available natural resources.

The initial target for the project was to have 900 community members of organised groups trained in apiculture and sericulture technologies. However, the project trained a total of 3980 trainees. This was made possible through the trained trainers from the groups and support given to on-site training. Key ministry staff, including the livestock production extension officers and foresters, were also trained so that they have adequate knowledge on the apiculture and sericulture technologies. In Kakamega the trained include 46 extensionist KFS and DLPO, 33 ToTs trained in *icipe*, 22 ToTs trained on-site and 1175 community members. In Mwingi the trained include 22 extensionist KFS and DLPO, 10 ToTs trained in *icipe*, 23 ToTs trained on-site and 1623 community members. In Arabuko-Sokoke, the trained include 32 ToTs trained in *icipe*, 18 ToTs trained on-site and 1044 community members.

GPS/GIS training for all District Forest Officers and foresters in the project area was carried out in 2007. Training was also provided on participatory forest management (PFM) in Arusha, Tanzania. Foresters (25) from the project area were trained on PFM techniques by a team from the Forest Department with facilitation from the project. These foresters have been instrumental in implementation of PFM activities around Arabuko-Sokoke, Kakamega, Nuu and Mumoni hills.


Wild silkmoth grainage (left), and training on handloom weaving (right)

Training on queen rearing

Training on candle making for Kakamega trainees


Stingless bees trainees transferring a colony (top), and trainees setting stingless bees hives (bottom)

Training in silk spinning

Study tours

Study tours were undertaken by various groups. These included a tour to Uganda by five members of the FD CIP project management committee. The objectives of the tour were to:

- Familiarise with modalities underpinning the reform process in the forestry sector
- Gain insights on field-based forest programmes
- Familiarise with the participatory (collaborative) forest management approaches.

Cross site visits within sites and across project sites were undertaken. A selection of group members was facilitated through the project to visit groups within their forest sites to exchange ideas. For example, in Kakamega, Makuchi and Muhudu group members visited Muliro farmers conservation group to see their activities and exchange ideas.

Farmers from Mwingi forest site had a study tour to Arabuko-Sokoke Forest site where they exchanged ideas on the various commercial insects farming activities and participatory forest management.

Participants during the foresters GPS training in Arabuko-Sokoke

Technical Research to Improve Commercial Production

To enhance the understanding of the commercial insects species, their population dynamics, ecological and seasonal patterns and overall production performance in the various ecosystems, technical research was undertaken and studies are summarised in boxes 8–16.

TECHNICAL STUDY 8:
Physicochemical Composition of *Apis mellifera* Honey and Stingless Bee Honey From Different Areas of Kenya

Honey has been used by man since ancient times as a source of food, medicine and for religious and cultural ceremonies. In Kenya stingless bee honey is popular due to its medicinal properties; however, little is known scientifically about it. *Apis mellifera* honey in Kenya is mostly harvested and processed traditionally. This work compares the physicochemical composition of both *A. mellifera* honey and stingless bee honey collected from Kakamega Forest, Mwingi and Arabuko-Sokoke Forest. Depending on the nectar source, honey varies widely in colour, viscosity, and chemical composition. The quality markers analysed were moisture content, pH, free acidity, hydromethylfurfural (HMF), proline, diastase and sugar content. The moisture content was determined using hand held refractometer; pH was determined using pH meter (corning pH/conductivity meter 442). Free acidity was quantified by volumetric-titration method. Hydromethylfurfural (HMF), proline and diastase were determined by spectrophotometry. Reducing sugars (fructose and glucose) were determined using the Lane and Eynon method (Codex Alimentarius, 1997). Sucrose content was obtained by multiplying the difference in concentration of reducing sugar by a factor of 0.95. The average constituent values were 16.00–27.00 (moisture), 3.19–4.20 (pH), 30.00–139.00 (free acidity), 4.4–72.0 (HMF), 8.6–60.0 (diastase), 75–290 (proline), 58–74 (reducing sugar) and 0.0–5.0 (sucrose). Stingless bee honey possesses several physicochemical properties that are distinctly different from that of *A. mellifera* honey, with higher values of moisture (21.0–27.0) and free acidity (94.0–139.0) and lower diastase (6.6–17.5). The pH, HMF, proline, reducing sugars and sucrose are the same as those of *A. mellifera* honey.

— Courtesy of A. Munguti *et al*.

TECHNICAL STUDY 9:
Antibacterial Activity of Honey from Kenyan Stingless Bees and Honeybees

This study investigated the antibacterial activity of honey produced by stingless bees, *Meliponula bocandei*, *M. ferruginea* (black), *M. ferruginea* (white), *Hypotrigona gribodoi*, *Pleibeina hildebrandti* and *Apis mellifera scutellata* from 5 forest sites in Kenya situated in different ecological zones. Twenty-one honey samples (15 from stingless bees and 6 from *A. m. scutellata*) were tested for their antibacterial activity against 5 strains of bacteria, *Pseudomonas aeruginosa* (ATCC 27853), *Salmonella typhi* (ATCC 2202), *Escherichia coli* (STD 25922), *Staphylococcus aureus* (ATCC 20591) and *Bacillus subtilis* (ATCC 6633) using the agar diffusion method with filter paper discs. Streptomycin was used as a control to test the antimicrobial activity.

Significant difference was observed in the antibacterial activity of honey from the stingless bees and *A. m. scutellata* from the 5 regions depending on the test bacteria. *Escherichia coli* and *P. aeruginosa* were susceptible to all test honey. Honey from *P. hildebrandti* and *M. ferruginea* was effective on all test bacteria. The study shows that traditional use of stingless bees honey in Kenya, as a panacea against different illnesses is rational if the infection is caused by bacteria.

— Courtesy of E. Muli *et al*.

TECHNICAL STUDY 10:
Biology of the Wild Silkmoth *Anaphe panda* in the Kakamega Forest of Western Kenya

A study on the life cycle of the silkmoth *Anaphe panda* (Boisduval) (Lepidoptera: Thaumetopoeidae) was conducted in two different habitats of the Kakamega forest in western Kenya: Ikuywa an indigenous forest and Isecheno a mixed indigenous forest. Eggs were laid in clusters and the incubation period ranged from 40 to 45 days. Larvae fed on *Bridelia micrantha* (Hochst) (Euphorbiaceae) and passed through seven developmental instars. The developmental period took between 83–86 days in the dry season and 112–118 days in the rainy season. The pupal period in the rainy season ranged between 158–178 days, whereas those that were formed during the dry season lasted between 107–138 days. But, the latter were negatively impacted by the development of those that formed earlier. Moths emerged from mid-October until mid-May. Longevity of adult *Anaphe panda* moths took between 4–6 days, but generally females live longer than males. The moth also seems to have higher life span in the indigenous forest compared to the mixed indigenous forest.

Means (±SD) incubation period in days of *Anaphe panda* in the indigenous and mixed indigenous forest in Kakamega

Years	Isecheno block (mixed indigenous forest)				Ikuywa block (indigenous forest)			
	1st Brood		2nd Brood		1st Brood		2nd Brood	
	n	Incubation	n	Incubation	n	Incubation	n	Incubation
2005	12	41.75 ± 1.82	8	49.88 ± 3.91**	13	41.69 ± 1.65	10	49.9 ± 3.57**
2006	17	42.82 ± 1.91	18	50.78 ± 3.69**	16	42.19 ± 1.97	15	49.87 ± 3.58**
2007	16	42.13 ± 1.86	18	50.39 ± 3.15**	18	41.83 ± 1.79	17	50.77 ± 3.54**

N, Number of egg clusters; **, Highly significant difference between the 1st and 2nd broods.

Mean (± SD) pupal period (days) of *Anaphe panda* in the Kakamega forest

Years	Brood	Isecheno (mixed indigenous forest)		Ikuywa (indigenous forest)	
		n	Pupal period (days)	n	Pupal period (days)
2005	1	6	167.5 ± 7.52**	9	167.0 ± 7.7
	2	7	122.14 ± 10.49	8	126.25 ± 11.88
2006	1	10	168.0 ± 6.06**	8	168.0 ± 7.86
	2	9	123.33 ± 12.94	6	121.5 ± 5.24
2007	1	9	166.67 ± 5.43**	8	169 ± 8.33
	2	9	122.33 ± 10.69	11	124.64 ± 11.94

N, Number of cocoon nests; **, Difference highly significant between the 1st and 2nd broods.

Adult life span (in days) of *Anaphe panda* from indigenous and mixed indigenous forest in Kakamega (2005–2007)

Years	Isecheno block (mixed indigenous forest)					Ikuywa block (indigenous forest)				
	n	Male	n	Female	t-test	n	Male	N	Female	t-test
2005	51	4.545 ± 1.036	51	5.182 ± 0.982	ns	50	5.0 ± 0.943	60	6.25 ± 0.639	**
2006	65	3.88 ± 1.013	51	5.091 ± 0.701	**	60	5.25 ± 1.209	64	6.25 ± 1.032	*
2007	71	4.323 ± 1.043	56	5.0 ± 0.632	*	57	5.235 ± 1.251	79	6.333 ± 0.701	**

Ns, Non significant difference; *, significant difference between male and female; **, highly significant difference between male and female; n, number of male or female moths.

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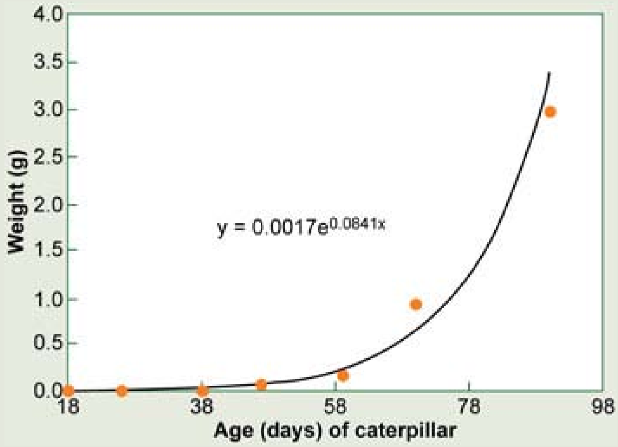
Technical Study 10 contd.



Developmental velocity of *Anaphe panda* silkworms in the Kakamega Forest

— Courtesy of N. Mbahin *et al.*

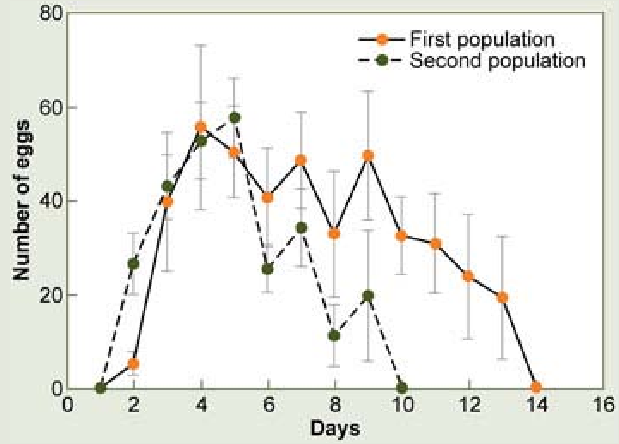
TECHNICAL STUDY 11:
Use of Sleeve Nets to Improve Survival of *Anaphe panda* in the Kakamega Forest of Western Kenya

Prospects for development of a wild silk industry in Africa would be brighter if silkworm survival during mass production could be improved. A study on the survival of the Boisduval silkworm, *Anaphe panda* (Boisduval) (Lepidoptera: Thaumetopoeidae) was conducted with and without protection by net sleeves in two different forest habitats (natural and modified) in the Kakamega forest of western Kenya. Overall, cohort survival was significantly higher ($P < 0.001$) in the natural than in the modified forest, but larval survival was improved over three-fold by protection with net sleeves in both habitat types. In the modified forest, only 16.8% of unprotected larvae survived to the pupal stage and formed cocoons, whereas 62.3% survived in the same environment when they were protected with net sleeves. In the natural forest, 20.4% of unprotected larvae survived, whereas 67.7% survived in net sleeves. There was also a significant effect of season; cohorts of larvae that eclosed in the wet season had significantly lower survival than those eclosing in the dry season. Sources of mortality appeared to be natural enemies (parasites, predators and diseases) and climatic factors.

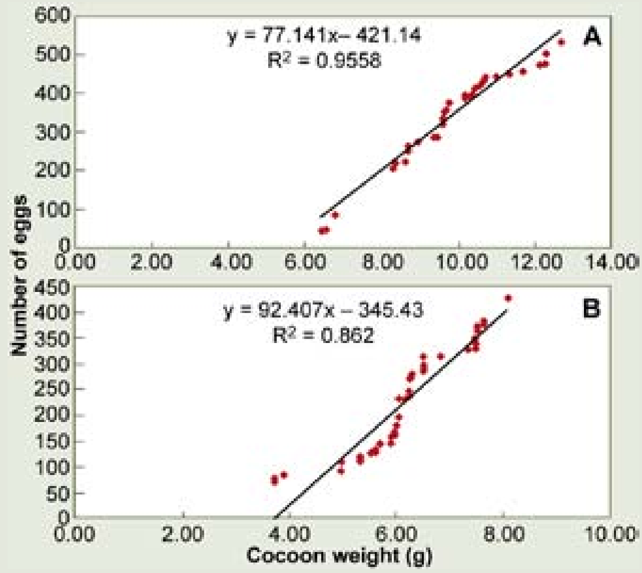
— Courtesy of N. Mbahin *et al.*

TECHNICAL STUDY 12:
Oviposition of the African Wild Silkmoth, *Gonometa postica* Walker (Lepidoptera: Lasiocampidae) on Different Substrates

Gonometa postica Walker (Lepidoptera: Lasiocampidae) is currently being utilised for commercial wild silk production in eastern Kenya. The oviposition preference of female *G. postica* on four substrates in a net-sleeved cage was studied in the laboratory in the long and short rainy seasons in 2007 for two populations of the moth. The first population moths laid the highest number of eggs on net sleeves followed by plastic container, twigs and wooden board, whereas the second population moths preferred wooden board and net sleeves over plastic container and twigs. The mean number of eggs, egg clusters laid and percentage egg viability were significantly higher, and the oviposition period was longer for the first than the second population. The mean weight of cocoons was significantly heavier for the first than the second population. A highly significant positive linear relationship existed between the total number of eggs laid and the cocoon weight. This information serves to optimise the production of eggs in net sleeved cages in an indoor environment for the semi-captive rearing of the larvae.



Number of eggs laid per day by two populations of female *Gonometa postica* within net-sleeved cages in Mwingi, 2007



Relationship between mean total number of eggs laid by *Gonometa postica* females and their mean cocoon weight, first (A) and second (B) populations

— Courtesy of K. O. Fening *et al.*

TECHNICAL STUDY 13:
Performance of Six Bivoltine *Bombyx mori* (Lepidoptera: Bombycidae) Silkworm Strains in Kenya

The economic and field performance of six *Bombyx mori* Linnaeus bivoltine strains was evaluated, namely *icipe* I, Chun Lei × Zheng Zhu (C × Z), Quifeng x Baiyu (Q × B), Quingsong × Haoyoe (Q × H), Suju × Minghu (S × M) and 75xin × 7532 (75xin). Performance was based on larval, cocoon, pupa and shell weights, relationship of food consumption to larval weight, cocoon weight and shell weight. *icipe* I recorded the shortest larval development period in location 1 (S1) during the short rains (SR) (26.53 ± 5.05 days) and it was significantly shorter compared to that of the other strains. It also had the highest cocoon shell weight (CSW) in location 1 (S1) and location 2 (S2), 0.38 and 0.36 g respectively. *icipe* I and C × Z strains gave better performance for the parameters evaluated and are most suitable for the Kenyan conditions.

Average larval duration in location 1 (S1) and location 2 (S2) during short rains (SR) and long rains (LR)

Season/ Location	Strain					
	icipe I	C × Z	75xin	Q × H	Q × B	S × M
SRS1	26.53 ± 5.03 aA	29.86 ± 5.55 abA	30.90 ± 5.74 bA	30.27 ± 5.62 bA	31.17 ± 5.61 bA	31.37 ± 5.84bA
SRS2	29.77 ± 5.56 aB	30.87 ± 5.73 abA	31.07 ± 5.77 abA	30.97 ± 5.74 abA	32.30 ± 5.90 abA	33.30 ± 6.19bA
LRS1	28.40 ± 5.27 aA	30.30 ± 5.63 abA	28.50 ± 5.24 aA	32.37 ± 6.01 bA	30.33 ± 5.63 abA	33.47 ± 6.21bA
LRS2	27.27 ± 5.07 aA	28.30 ± 5.25 aA	28.37 ± 5.29 aA	30.50 ± 5.63 abA	30.20 ± 5.47 aA	30.30 ± 5.63abB

Means followed by a same small letter (a–b) within rows indicate that there is no significant difference on the effect of seasons and locations on larval duration across the strains (P >0.05) by Tukey's test.
Means followed by the same capital letter (A–B) within columns indicate that there is no significant difference on the effect of seasons and locations on larval duration within the same strain (P > 0.05) by Tukey's test.

— Courtesy of E. Nguku *et al.*

TECHNICAL STUDY 14:
Evaluation of Raw Silk Produced by Bivoltine Silkworm *Bombyx mori* L. (Lepidoptera: Bombycidae) Races in Kenya

Evaluation of raw silk produced in location S1 (laboratory) and S2 (field) was assessed during long rains (LR) and short rains (SR), using selected bivoltine *Bombyx mori* silkworm strains initially obtained from China and India. They included Chun Lei × Zen Zhu (C × Z), Quifeng × Baiyu (Q × B), Quingsong × Haoyoe (Q × H), 75xin × 7532, Suju × Minghu (S × M) and *icipe* I.

This study aimed to evaluate the quality of raw silk produced by the domesticated silkworm *B. mori* L. in Kenya. Silkworm rearing was done following the procedure of Jolly (1987). Setting of the silk quality control lab was done following specifications from the Chinese Academy of Agricultural Sciences (CAAS) and the International Silk Association (Lee, 1999). Raw silk characteristics were evaluated and performance tested to determine its suitability for silk production. Quality tests of each post-harvest production process were carried out to establish the overall quality of the product. Silk winding breaks varied among the different strains, with *icipe* I having the least counts while 75xin recorded the most counts 13, 16, 12 and 12 during/in SR S1, SR S2, LR S1 and LR S2 respectively. Elongation percentages differed between the seasons and strains, between 18 and 20%. It was also observed that silkworm strains with high elongation count had the least number of winding breaks. *icipe* I had an average elongation of 20% and an average of 5 winding breaks counts, whereas 75xin had 18% and 13 of the same respectively.

Cleanliness and neatness percentages differed among the strains and were within the acceptable ISA standards but notably *icipe* I cleanliness and neatness percentages were higher than the other silkworm strains during the two seasons, 97 and 96% respectively. The data obtained identified *icipe* I as a more economical strain to rear for quality production of raw silk and yarn.

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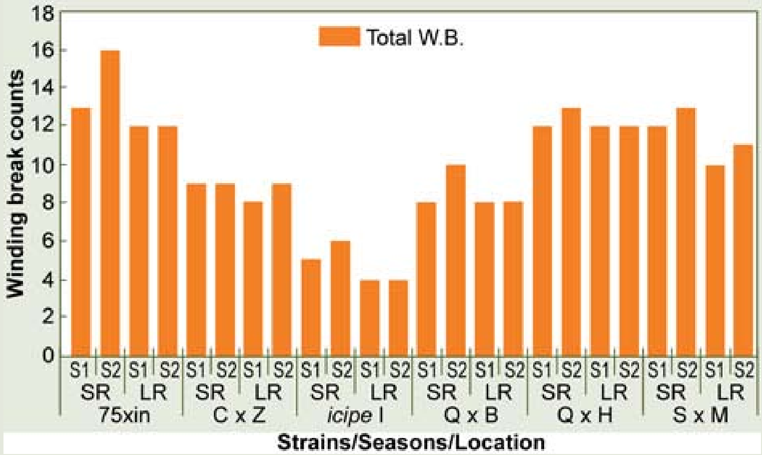
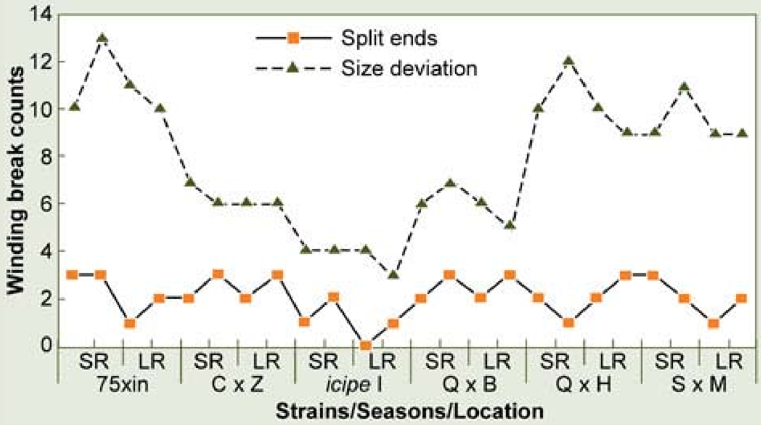


Total winding breaks count during LR and SR in S1 and S2



Comparative winding breaks count during LR and SR in S1 and S2

— Courtesy of E. Nguku *et al.*

TECHNICAL STUDY 15:
Performance of the Silkworm *Bombyx mori* (Shaanshi BV-333) Bivoltine Hybrid Race Using Various Cultivars of Mulberry *Morus* spp.

The performance of *Bombyx mori* L. bivoltine hybrid, Shaanshi BV-333, was evaluated on six mulberry cultivars of *Morus* spp. based on economic characters in rearing and mulberry leaf quality. The growth rate and morphological characteristics for all the cultivars were studied using several parameters. Several characters such as disease resistance, survival percentage, cocoon weight, pupal shell weight, and single cocoon filament length were recorded during the rearing of silkworm larvae. Kanva-2/M5, Thailand, Thika and S-36 cultivars exhibited superiority in rearing performance over other cultivars tested. Thailand fed to silkworms, showed highest survival percentage in the short (S1) and long (S2) rainy seasons as compared to other cultivars. However, Embu exhibited lowest mortality during the dry season (S3) while S-41 showed the lowest survival rate in all seasons. Embu had significantly higher filament length and cocoon yield compared to the other cultivars during (S3). However, S-41 performed poorly in survival percentage, cocoon yield, silk reeling and pupal shell weight. Waller-Duncan K-ratio t test groupings confirmed that there were significant differences among some of the cultivars for all parameters tested ($P < 0.05$).

Continued on next page

Technical Study 15 contd.

Average silk filament length (m ± SE) from a single cocoon and F-values

Cultivars	S1	S2	S3
Kanva-2/M5	1103.05 ± 22.10 ^{a}	1115.9 ± 23.45 ^{a}	905.00 ± 26.35 ^{b}
Thailand	1057.15 ± 23.18 ^{ab}	1128.90 ± 23.86 ^{a}	926.45 ± 22.74 ^{ab}
Thika	1052.25 ± 20.73 ^{b}	1117.20 ± 26.95 ^{a}	834.25 ± 21.38 ^{c}
S-36	1032.20 ± 17.39 ^{b}	1085.30 ± 21.84 ^{a}	827.20 ± 27.24 ^{c}
Embu	895.5 ± 17.52 ^{c}	1070.7 ± 26.30 ^{a}	977.45 ± 18.40 ^{a}
S-41	919.8 ± 17.61 ^{c}	996.8 ± 15.41 ^{b}	734.65 ± 13.95 ^{d}
F-value	*17.23*	*4.39*	*15.08*

Tabulated $F_{\alpha=0.05,\ 5,\ 114.}$ Grouping was done using Waller-Duncan K-ratio t test. Means followed by the same letters are not significantly different.

Growth rate and morphological characteristics of six mulberry cultivars at 75 days after pruning

Cultivar	Leaf Texture	Colour			No. of branches	Height of tallest shoot (m)	Leaf size (cm)		Petiole size (cm)	Internodes distance (cm)		
		NSL[1]	ML[2]	YS[3]			Length	Breadth		Top	Mid	Bottom
Kanva-2/M5	Smooth	Pale green	Green	Greenish	20.40 ± 0.83 ^{de}	1.63 ± 0.01 ^{bc}	23.89 ± 0.30 ^{a}	16.99 ± 0.42 ^{a}	4.26 ± 0.14 ^{b}	3.61 ± 0.08 ^{a}	4.48 ± 0.08 ^{d}	5.69 ± 0.12 ^{c}
Thailand	Very smooth	Brown	Green	Brownish	21.60 ± 0.64 ^{bc}	1.65 ± 0.01 ^{b}	19.11 ± 0.23 ^{e}	14.04 ± 0.16 ^{cd}	3.87 ± 0.10 ^{c}	3.00 ± 0.14 ^{b}	6.16 ± 0.12 ^{b}	6.90 ± 0.16 ^{b}
Thika	Semi smooth	Pale green	Light green	Greenish	24.00 ± 1.01 ^{a}	1.57 ± 0.01 ^{d}	21.29 ± 0.28 ^{c}	17.59 ± 0.30 ^{a}	3.81 ± 0.08 ^{c}	2.51 ± 0.07 ^{c}	3.93 ± 0.17 ^{e}	4.60 ± 0.13 ^{d}
S-36	Rough	Light green	Green	Greenish	23.40 ± 1.10 ^{ab}	1.85 ± 0.01 ^{a}	21.74 ± 0.26 ^{c}	14.75 ± 0.26 ^{c}	5.48 ± 0.17 ^{a}	2.61 ± 0.13 ^{c}	7.01 ± 0.27 ^{a}	8.20 ± 0.28 ^{a}
Embu	Smooth	Light brown	Light green	Purple brown	23.90 ± 0.59 ^{a}	1.62 ± 0.01 ^{c}	22.57 ± 0.15 ^{b}	16.02 ± 0.36 ^{b}	5.27 ± 0.14 ^{a}	3.72 ± 0.15 ^{a}	5.01 ± 0.11 ^{c}	6.11 ± 0.19 ^{c}
S-41	Rough	Pale green	Dark green	Greenish	19.10 ± 0.54 ^{d}	1.50 ± 0.01 ^{e}	20.09 ± 0.23 ^{d}	13.45 ± 0.16 ^{d}	3.99 ± 0.13 ^{bc}	2.66 ± 0.13 ^{c}	5.04 ± 0.14 ^{c}	7.21 ± 0.10 ^{b}
		F-value			***6.32***	***99.37***	***27.85***	***32.18***	***31.64***	***23.54***	***49.81***	***53.6***

[1]Newly sprouted leaves.
[2]Mature leaves.
[3]Young shoots.
Tabulated $F_{\alpha=0.05,5,114.}$ Grouping was done using Waller-Duncan K-ratio t test. Means in each column followed by the same letter are not significantly different at the α = 0.05 level.

— Courtesy of V. Adolkar *et al.*

TECHNICAL STUDY 16:
Larvae, Cocoon and Post-Cocoon Characteristics of *Bombyx mori* L. (Lepidoptera: Bombycidae) Fed on Mulberry Leaves Fortified with Kenyan Royal Jelly

Fourth instar *Bombyx mori* silkworm larvae were fed on mulberry leaves to which royal jelly had been added. The impact on the larval, cocoon, shell and pupal weight, shell ratio percentage, filament length and weight, and the number of breaks during reeling were examined. The results indicate that royal jelly-enhanced diet significantly increased larval, cocoon and pupal weights, but had no significant effect on shell weights and denier. Similarly filament length, weight and filament reeling breaks were significantly different between controls and royal jelly fed groups. The cocoon shell ratio percentage was significantly higher in the control compared to the royal jelly fed groups. Results established positive trends in all the values of different parameters observed in the experimental group against the control group, apart from the cocoon shell ratio percentage. Results imply that supplementing mulberry leaves with royal jelly has the potential to enhance the commercial qualities of silk and can be used in sericulture for yield improvement.

Mean larval weights showing effects of mulberry leaves fortified with royal jelly on *Bombyx mori* silkworms

Treatment	4th Instar			5th Instar		
	Day 1	Day 4	Day 7	Day 1	Day 3	Day 8
Control group	0.402 ± 0.069a	0.545 ± 0.022a	0.623 ± 0.004a	0.700 ± 0.113a	1.440 ± 0.253a	3.63 ± 0.537a
Royal jelly group	0.402 ± 0.058a	0.619 ± 0.058b	0.784 ± 0.002b	0.806 ± 0.165b	1.750 ± 0.404b	3.80 ± 0.475b

Means (±SE) followed by the same letters within the column are not significantly different (t-test, ∝ = 0.05).

Effect of mulberry leaves fortified with royal jelly on various cocoon characteristics of *Bombyx mori*

Treatment	CW	PW	SW	CSR %
Control group	1.66 ± 0.223a	1.30 ± 0.211a	0.354 ± 0.003a	21.5 ± 2.82a
Royal jelly group	1.88 ± 0.106b	1.52 ± 0.105b	0.356 ± 0.002a	19.0 ± 1.39b

Means (±SE) followed by the same letters within the same column are not significantly different (t-test, ∝ = 0.05). CW, cocoon weight; PW, pupal weight; SW, shell weight; CSR%, cocoon shell ratio percentage.

Effect of mulberry leaves fortified with royal jelly on various filament characteristics of *Bombyx mori*

Treatment	FL	FW	D	RB
Control group	1056 ± 32.1a	0.296 ± 0.015a	2.67 ± 0.031a	2.32 ± 2.28a
Royal jelly group	1087 ± 79.5b	0.322 ± 0.024b	2.67 ± 0.069a	1.57 ± 1.99b

Means (±SE) followed by same letters within the same column are not significantly different (t-test, ∝ = 0.05). FL, filament length; FW, filament weight; D, denier; RB, reeling breaks.

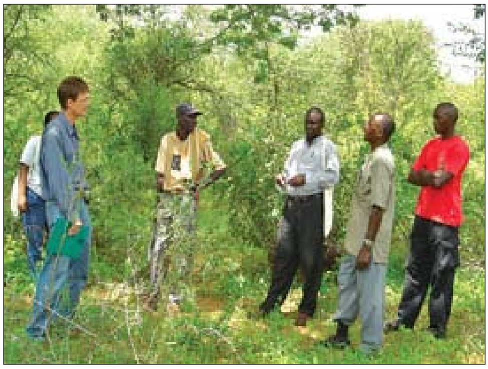
— Courtesy of E. Nguku *et al.*

Organic Certification

Organic production can provide the farmer economic advantages over conventional production systems through improved husbandry of the natural resources and land practices. Mwingi district has pioneered the organic certification of honey in Kenya. Demand from both the local and international organic markets for certified organic natural products is rising. The market for 'organic' and fair-trade certified products is the fastest area of growth in Europe and the United States. Due to these two factors, enterprise in certified organic products provides tangible and viable opportunity for producers to address their fundamental issues of food security and sustainable incomes. Organic and fair-trade certified harvesting/production and management systems, together with the development of market access for sustainable products, provide mechanisms and economic incentive to promote conservation of the fragile natural environment through trade.

The process of attaining organic certification of bee and silk products in Mwingi started in June 2007 with the selection and training of field officers, producer group leaders and the Association's management staff, producer group and farmer registration, and mapping of the bee and silkworm habitat and forage resource. Under the EU-ISO65 organic regulations the internal control system (ICS) must be developed as the mechanism for enabling certification of producer groups. The development of the ICS for the Mwingi Organic Beekeepers Association took a year to complete and involved the restructuring of the groups, further detailed training, developing appropriate recording systems and extension framework. The community also participated in the construction of the internal control system manual that guides the process. The initial and subsequent external inspection has been conducted through the engagement of the Institute of Marketecology (IMO), Switzerland. On finding no non-compliance, the organic certificate has been awarded to the association. To date, the organic certification includes over 1030 farmers; honey sales have increased from 6 tonnes in 2007 to 15 tonnes in 2008. The process of organic certification has stimulated the farmers to take keen interest in their bee keeping enterprise.

Inspection of beekeepers' farms



Inspection of Mwingi Honey Marketplace (left), Inspection (IMO) of apiary site in Nuu, Mwingi (right)

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control IMO
INSTITUTE FOR MARKETECOLOGY

CERTIFICATE

Nr. 27928

ICIPE
MWINGI DISTRICT BEEKEEPERS JOINT SELF HELP GROUP
P. O. Box 507, Mwingi, Kenya

The Institute for Marketecology (IMO) hereby confirms that the above mentioned operation was inspected and certified according to the control procedures as outlined in Regulation (EEC) N° 2092/91 and that the below listed activities and products were found to be in compliance with the production rules defined in said Regulation. It is the certificate holder who is responsible for permanent compliance with the applicable requirements.

Das Institut für Marktökologie (IMO) bestätigt hiermit, dass der obengenannte Betrieb gemäss dem Kontrollverfahren der Verordnung (EWG) 2092/91 kontrolliert und zertifiziert wurde und die nachgenannten Tätigkeiten und Produkte den Produktionsvorschriften dieser Verordnung entsprechen. Verantwortlich für die kontinuierliche Einhaltung der genannten Anforderungen ist der Zertifikatsinhaber

Certified Activity Zertifizierte Tätigkeit	**Organic Agricultural Production** **Processing and Marketing of Organic Products**
Validity Gültig	**2008/2009** (until inspection 2009)
Quality & Product Qualität & Produkt	**Organic** Honey

Institut für Marktökologie (IMO)
Institute for Marketecology (IMO)

Weinfelden, 17.02.09

Diese Bestätigung gilt nicht als Warenbegleitschein.
This acknowledgement may not be used as a trade transaction certificate.

SWISS CERTIFICATION
SCESp 004

Organic certificate awarded to Mwingi District beekeepers

Building the Value Chain

Apiculture activities

There are now modern apiaries operational in the three project areas. Arabuko-Sokoke has 300 Langstroth hives distributed in 18 apiaries around the forest, Mwingi has 600 Langstroth hives and Kakamega 150.

Some of the groups benefited with hives from a small grant given by the Netherlands Embassy. The number of trained trainers in modern beekeeping went up by 12 after training. The Mwingi Honey Marketplace staff and committee have continued to receive training for sustainability. The 7 Kakamega Forest groups that are carrying out the apiculture activity have gained experience over time, since colonisation of their hives.

The group members led by the trained ministry staff and community elected field officers conducted the on-site training to their communities. This raised the interest of the apiculture activity in the neighbouring community. One such group, Farm and Forestry Environmental and Conservation Group in Lurambi Zone has, through their beekeeping activities, attracted a neighbouring group. They have established their apiary and will benefit from the Kakamega forest marketplace.

Hive colonisation in Kakamega Forest is shown in Figure 7. In Arabuko-Sokoke, hive colonisation has been generally over 75%. There have been several challenges facing colonisation of the hives though. These include:

- Honey badger especially in Dida Zone and Mongotini. The farmers in these areas were advised to build strong bee houses with strong poles to bar the honey badger entry.
- Bee pirate in Mida creek. To solve this problem farmers developed trapping system of the pirate at the entrance of the bees. The trap includes a container with water and a mirror placed inside the water. The mirror lures the pirates in the water through image reflection that mistakes it for a bee. Finally the pirate drops in the water and gets trapped.
- Wax moth in all sites. This was managed through proper apiary management that entails proper disposal of unnecessary combs.
- Safari and sugar ants disturb the colonies and cause absconding but the farmers have been advised to apply neem powder/ash or other traditional non-insecticidal deterrents and maintain clean apiaries.

Carpenters at Shinyalu constructing Langstroth hives for the local community

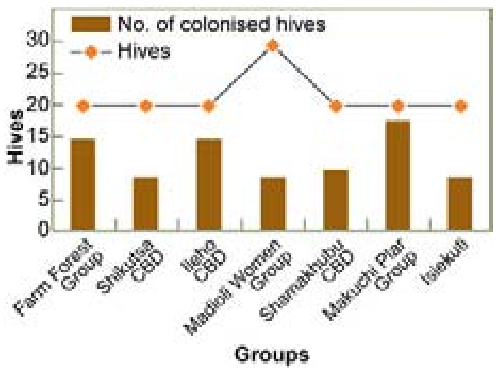


Figure 7. Hive colonisation in Kakamega Forest

Queen rearing and royal jelly production system established

Queen-rearing techniques for African honeybee races and royal jelly production have been developed at Chambuko beekeepers (Mida creek region). Training in queen rearing and royal jelly production was conducted in Chambuko, Dabaso and Tana group and over half kg royal jelly produced in the first year of inspection.

The table below shows the production level by community members of Chambuko women and men beekeepers. Strong colonies for royal jelly production have been established in other areas within Mida Creek (Msitu women group and Dabaso women group). Absconding of bees is low within the region.

Table 1. Royal jelly production in Arabuko-Sokoke

Site	Month	Amount in grams
Mida Creek	June	200.00
	August	109.00
	November	140.00
Tana	October	106.98
		555.98

Stingless bees

Stingless bees honey (500 g) was harvested from one hive during on-site training in Dida. Community groups have been trained on technologies to transfer wild stingless bee colonies to the rational, hive colony management and harvesting methods. The common species in Arabuko-Sokoke forest are *Hypotrigona gribodoi* and *Meliponula ferruginea*.

A total of 60 hives have been supplied, where 10 of them are trap nests set in Arabuko-Sokoke forest for trapping the wild colonies. Eight farmers were trained on the general management of stingless bees for honey production and pollination.

Sericulture activities

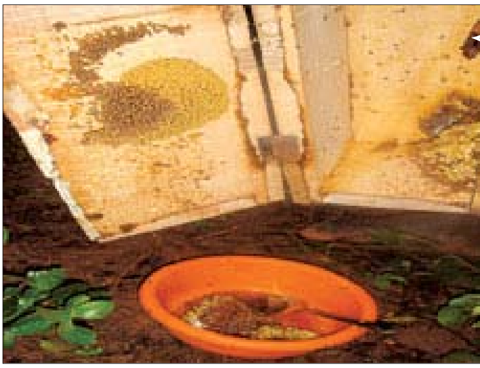
- Silkmoth rearing houses and wild silkmoth farming sites established and operational.
- Mulberry silkworm rearing is steadily establishing and as mulberry plants mature, production is increasing.

Table 2. Example of mulberry cocoon production in Kakamega in 2007

Zone	Group	Cocoons harvested (Kg)	Amount paid (Kshs)
Lurambi	Farm Forest Environment and Conservation Group	19.5	3900.00
Lubao	Lusero Forest Prevention Youth Group	13	3875.00
Isiekuti	Isiekuti Organic Group	13	8125.00
Ileho	Community Based Distributors	5	1000.00
Lurambi	Mulberry Common Working Group (A satellite group)	7.5	4200.00
GRAND TOTAL		**58**	**21,100.00**

Transferring wild stingless bee colonies from a house wall to rational hives at Msitu women

Stingless bee apiary in Dida group



Honey harvested from *Hypotrigona gribodoi*

Stingless bees hives being supplied

Established meliponiary in Ileho Zone

Makuchi Farmers selecting/sorting mulberry cocoons

Mulberry cocoon drying at the marketplace

Silk cocoon harvest from Farm and Forest Group in Kakamega forest

Silkworm rearing at Farm and Forest Group in Kakamega forest

Example: Farm and Forestry Environmental and Conservation Group, that has established about 3 acres (1.21 ha) of mulberry, supplied over 10,000 cuttings to the Isiekuti Organic Youth Group, Makuchi Plar Farmers Group in Makuchi Zone. The silk project gained recognition in the neighbouring communities. A group neighbouring Farm and Forest group took interest in silkworm rearing and planted mulberry. *icipe* supplied the groups with 5000 silkworms.

The groups are continuously increasing their mulberry acreage and rearing cycles have been established with individual groups.

Wild silk farming

Rearing took off well in majority of the groups carrying out the activity. Wild silk cocoon production has steadily grown. A total of 415 kg (see Table 4) of wild silk cocoons have been produced over the project period.

Mrs Sofia Kutisha of Msitu women group with her children weeding their mulberry farm

Example: The Sosobora groups have more than 15,000 cocoons of wild silk collected from group members rearing different wild silkmoth species (*Gonometa postica*, *Argema mimosae* and *Epiphora mythimnia*). Four groups fall under one umbrella (Sosobora groups): Amani group, Umoja Kipepeo, Hindeni group, Mchanganyiko group and Kombeni buffer zone. The 4 groups are under one chairman Mr Emmanuel Mangaro, a ToT in wild silk farming. Group representatives together with *icipe* staff participated in harvesting of 4000 *Gonometa postica* cocoons 14th and 16th October, 2006 at Kombeni area where rearing is done naturally without the use of net sleeves.

Wild silk production is ongoing and groups have started earning income from the activity. Group members have incorporated *Bridelia* seedlings in their nurseries. One member of the households has sold 30 seedlings at Kshs 10, which were planted at the marketplace.

Members of Sosobora Groups at Kombeni wild silkmoth rearing site

Margaret harvests cocoons of *Gonometa postica* from *Acacia reficiens* at Kombeni

Cocoons of *Gonometa postica* from *Acacia reficiens* at Kombeni

Isiekuti farmers sorting wild silk cocoons

Isiekuti farmers receiving payment for wild silk cocoons

Silk weaving at the Kakamega Silk Marketplace

Marketplaces for Silk and Honey Products

Market centre development was undertaken through construction of five 'marketplaces' (the term used throughout this document for these centres). These include Mwingi wild silk marketplace (one honey marketplace was already in place from 2000), Arabuko-Sokoke honey marketplace, Arabuko-Sokoke silk marketplace, Kakamega honey marketplace and Kakamega silk marketplace. These marketplaces provide a base for the farmers to bring and sell their products which are then processed and packaged for sale. There is therefore room for bulking, value addition and bargain for better prices. Through the marketplaces, the farmers are linked to private traders such as Viking Limited and Milba Brands among others.

The Mwingi wild silk marketplace was inaugurated on 30th November 2006, and was officially opened by Mrs Nados Bekele Thomas, UNDP Deputy Resident Representative on behalf of the UNDP Resident Representative, Kenya Mrs Elizabeth Lwanga.

Value Addition

To enable the growth of successful community driven enterprise from the conservation of forest biodiversity, market centres have been developed. These centres provide the community access to value addition and wider markets for their primary bee and silk products. As a result the community members receive a higher price and greater reward from their efforts. Through the vehicle of a market centre and the improved incomes as a result of their sustainable bee


Farmers selling honey at Mwingi Honey Marketplace

Marketplaces at the project sites

Table 3. Honey and silk cash returns to producers at the three sites. *Combined production and payment for all GEF sites from 2005 to 2008*

Honey in kg

Site	Honey (kg)	Kshs paid
Mwingi	24,467.50	2,202,075.00
Arabuko-Sokoke	4009.37	868,994.40
Kakamega	90.00	12,560.00
Total	**28,566.87**	**3,083,629.40**

Wild silk cocoons in kg

Site	Wild silk cocoons (kg)	Kshs paid
Mwingi	149.4	49,565.00
Arabuko-Sokoke	144.1	28,820.00
Kakamega	121.1	24,200.00
Total	**414.6**	**102,585.00** (@60 = US$ 1709.80)

Stingless bee honey in kg

Site	Stingless bee honey (kg)	Kshs paid
Mwingi	–	–
Arabuko-Sokoke	8.5	2125.00
Kakamega	17.0	4250.00
Total	**25.5**	**6375.00** (@60 = US$106.25)

Mulberry silk cocoons in kg

Site	Mulberry silk cocoons (kg)	Kshs paid
Mwingi	–	–
Arabuko-Sokoke	–	–
Kakamega	100	39,825.00
Total	**100**	**39,825.00**

Royal jelly (in grams)

Site	Royal jelly (g)	Kshs paid
Mwingi	–	–
Arabuko-Sokoke	921.98	–
Kakamega	–	–
Total	921.98	**–**

Total income to producers from 2005 to 2008 was KShs 3,232,414.4 and silk enterprises, *icipe* has been able to sensitise and train communities in forest conservation. The communities are now able to associate and link the proceeds from the sale of honey and silk cocoons with the conservation of the forests.

Bee products

An example of the additional rewards to the producers from value addition at the market centres is demonstrated below:

BOX 1. Mwingi Marketplace: Value Addition 2007

The marketplace purchased 6400 kilos of comb honey from farmers and processing at the marketplace has been completed. Honey and wax products are on sale at the market centres and sold to external markets through *icipe* under the brand of Eco-Honey. The price for bottled Eco-Honey is Kshs 150 per 500 g jar. Floating candles are in strong demand in the hotel industry and are sold for Kshs 20/piece.

Honey purchased from farmers	6.4 tonnes at Kshs 90/kg (Kshs 576,000)	
After extraction	4012 tonnes	
Bottled and sold through *icipe*	3060 bottles	1530 kg, Kshs 459,000
Bottled and sold at counter	256 bottles	1328 kg, Kshs 38,400
Bottled at counter	488 bottles	244 kg
Extracted honey	1680 bottles	850 kg
Total		**4012 kg**
Bees wax		
Floating candles sold through *icipe*	1896 candles	37.92 kg, Kshs 24,648
Floating candles sold at counter	262 candles	5.24 kg, Kshs 3406
Floating candles at counter	242 candles	4.84 kg
Balance of wax	2850 candles	57 kg
Total		**105 kg**

Silk products

Once the construction of the market centres had been completed the equipment was installed. The equipment comprised silk processing machines and spinning wheels for processing spun silk from wild silkmoth cocoons. *icipe* then trained the managers of the market centres and the processing staff in wild silk spinning and silk fabric production on the handloom.

Bottles of Eco-Honey at the shelves of Mwingi Honey Marketplace

Making of beeswax candles at Mwingi Honey Marketplace

Bottles of honey ready for delivery in the ASF Marketplace

Candles ready for marketing in the ASF Marketplace

Installation of reeling unit in Kakamega Marketplace

Re-reeling unit installed at the Kakamega Marketplace

Section 3

Experiences and Achievements

Contributing to the Millennium Development Goals

The Government of Kenya places value in conservation of biodiversity resources for development in and outside the protected areas. Poverty of forest-adjacent communities is a major cause of forest degradation. Providing alternative income generation through a focus on forest-related products can reduce such degradation and advance sustainable development. As well as addressing the national conservation goals, the project has contributed to the millennium development goals, as outlined below, and further explained under the relevant heading in the rest of this section.

Goal 1: Eradicate Extreme Poverty and Hunger

Sericulture and apiculture with other livelihood options provide lucrative products and other useful by-products. For example, other than feeding silkworms, mulberry leaves serve as animal feed and provide fruit. After reeling, the silkworm pupae are used as fish or chicken feed. Bees play a critical role in the pollination of commercial crops, improving the quality and quantity of crop yields, hence impacting on food security.

As a result of the project activities, six marketplaces for honey and silk products are in place in the three sites—Kakamega, Mwingi and Arabuko-Sokoke. Production of honey and silk has started in the three sites. The community adds value to the products and sells the retail packed products, thus maximising their returns. Those working in the marketplaces are also from the community, hence creating some employment in an area where there are few income generating opportunities. Economic values are enhanced by quality control procedures for sericulture and apiculture products. Quality control laboratories at *icipe* have been utilised for testing the honey, hive products, cocoons, raw silk, twisted yarn and silk cloth, to ensure the products meet the industry standards.

Goal 3: Promote Gender Equality and Empower Women

Through the project it was ensured that women played an equal part in the activities, and at least 50% of the trainees were women. There was also proactive effect to encourage youth to take part in the various project activities.

Goal 7: Ensure Environmental Sustainability

The project focused on insects' usefulness in supporting community-based efforts for minimising forest and associated biodiversity loss. Through introducing the proven sustainable productive activities of apiculture and sericulture, together with engaging the communities to take a lead role in participatory monitoring systems, the project demonstrated how communities can drive the conservation of entire forest system in Kenya. The results of the monitoring and evaluation showed that as a result of the project's activities there was no further destruction of the natural biodiversity in the targeted forest sites. As a result, there is greater security for future diversity and health of indigenous species, particularly those threatened with extinction, which specifically addresses target 2 of this goal.

Goal 8: Global Partnerships for Development

The project improved and strengthened the partnership between international organisations, government ministries, NGOs, the private sector and local communities. Organic certification of honey and other hive products ensured fairness in trade and provided market advantages. Kenya Forest Service now works with the village forest management committees, started in all the project sites, and encourages communities to form community forest associations (CFAs) to support management and conservation of the forests.

Linking Conservation and Livelihoods

The linkage between livelihoods and conservation was fundamental to the conception and implementation of this project. It aimed to demonstrate the livelihood benefits of forest resources, to motivate the local communities to involve themselves in participatory forest management and conservation.

The logic is simple: conserve the forest and the natural resources to support traditional livelihood plus access to wider income; destroy it and these livelihood opportunities are destroyed with it. This logic operates at every scale, from global levels and climate change, to watersheds and landscapes, through to a single beehive on the forest edge. This logic was made fully apparent to forest-adjacent communities as a result of the tangible activities of this Commercial Insects Project. Some of the learning points that were instilled within the communities and support organisations are indicated below.

The same people were involved in bees/silk enterprise and in the Participatory Forest Management committees. The project constantly reinforced the message to communities that the CIP support was given to provide incentives for PFM and forest conservation, making it a 'mantra' at community meetings.

Location of the beehives and rearing houses close to the forest or in the buffer zone and commercialising wild silkmoths and stingless bees demonstrated the direct advantage of the forest to improving people's own livelihoods, building awareness that forests can provide high quality and quantity of honey. In Arabuko-Sokoke, it was demonstrated that honey that is collected close to the forest is double the yields and higher in quality (glucose and fructose levels) than honey collected from 3- to 5 km away (see also Technical box 18).

TECHNICAL STUDY 17:
Quality of Honey Harvested and Processed Using Traditional Methods in Rural Areas of Kenya

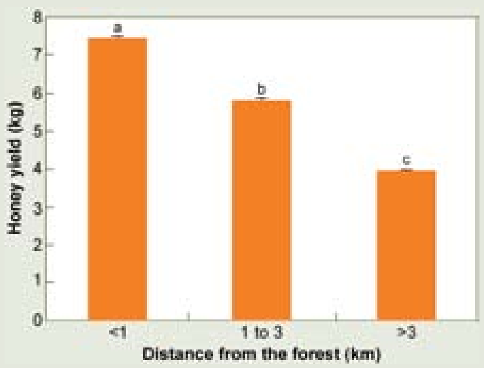
The honey consumed in most of Africa is harvested from traditional hives and processed using traditional methods. This work presents the quality characteristics of honey samples (n = 72) processed using traditional methods and on sale in various important beekeeping zones in Kenya, among them Mwingi, Mida Creek and Kakamega. The quality of the honey was compared to international standards as proposed in the Codex Alimentarius. The quality markers analysed were moisture, hydromethylfurfural (HMF), sugar content, diastase, proline content and free acidity. Moisture was determined using a honey refractometer, HMF and diastase content were determined through spectrophotometry, sugars were determined by high performance liquid chromatography (HPLC), proline was determined through spectrophotometry and free acidity was quantified by volumetry-titration technique. Average constituent values were at 16.00–21.20% (moisture); 3.70–389.36 mg/kg (HMF); 20.83–300.6 mg/kg (proline); 8.03–56.98 Schade units (diastase); 57.03–102.66% (fructose and glucose levels) and 18.00–71.85 mq/kg (free acidity). Most of the samples had constituent levels within the limits set in the Codex Alimentarius.

Traditional honey harvesting and processing methods seem not to have negative effects on the major honey constituents. However, excessive smoking during harvesting had compromised the aroma and flavour of some samples. In an effort to promote beekeeping as an eco-friendly, sustainable alternate source of livelihoods, training in best apiculture practices, improved extension services and establishment of honey marketplaces is now established to improve honey quality in Kenya.

— Courtesy E. Muli *et al.*

TECHNICAL STUDY 18:
Proximity to a Forest Ensures Better Honey Yields: Another Reason to Conserve Forests

Although tropical forest conservation is a top priority for human and environmental health, deforestation persists mainly because of food and economic needs. No community will totally give up economic activities for the sake of ecological integrity, unless it is given alternative economic activities from which to draw its livelihood. Beekeeping in the forest buffer zone instead of traditional destructive honey harvesting from forest trees is one such option at Arabuko-Sokoke Forest (ASF) in Kenya. ASF is a dry coastal forest that is home to endangered and threatened fauna and is a hotspot considered a priority for conservation. To find out whether honey quantity and quality differed at various distances from the forest we obtained samples from hives placed at varying distances from ASF in two successive years. All the honey samples met the internationally required standards, and honey yield increased with proximity to the forest. Indeed the yield almost doubled in hives <1 km from the forest compared to those >3 km. This study convincingly demonstrates to the ASF community another reason why they should conserve the forest.



Honey yields (kg per harvest) at different distances from the edge of Arabuko-Sokoke Forest. Bars bearing different letters are significantly different ($p < 0.05$). (Sande *et al.* in press)

— Courtesy of S. Sande *et al.*

Farmers who were actively involved in stingless bees reduced the number of times they went to the forest to cut trees and burn charcoal. This is because they had accepted the need of managing stingless bees in their homesteads rather than the destructive harvesting in the forest. Awareness has also been created on the importance of stingless bees in pollination of both cultivated and wild plants.

The survey carried out on the status of the stingless bees indicated there was an increase in number of colonies in the forests after the GEF project intervention. Farmers have realised the importance of stingless bees in pollination apart from honey production. The number of colonies domesticated increased as the farmers learned how to carry out colony division.

The project activities to build awareness within the communities, through training and demonstration, that bee pollination is vital to the health of agricultural crops as well as to trees stimulated the expansion of the colonies. This has enabled healthier more productive plants, and therefore has affected higher crop yields and greater income returns.

Habitat monitoring in buffer zone and core zone in the final year of the project has showed that there has been no loss of habitat in the focal project forest area. The monitoring results also indicate that the resident communities have made no new demands on the forests and no illegal encroachment was reported during the project period. Illegal activities (cutting/harvesting) in the buffer zones were shown to have reduced by 50% by the final year.

Increasing Livelihood Options and Reducing Rural Poverty

Beekeeping

Beekeeping is a relatively inexpensive activity and by generating additional or complementary income for rural households it provides an important, and often a significant, contribution to the overall household food and income security. Compared to other agriculture land-based enterprises, beekeeping requires no, or very little, land and labour. In addition to honey, there is a range of useful and marketable bee produce, such as wax, propolis, pollen, royal jelly and bee venom. Through the project, it has been found that Langstroth hives, when managed correctly, increase the volume of honey compared to traditional log hives and provide easier access for other bee products, hence enhancing the overall economic returns. It is possible to achieve on average 20 kg/harvest/hive of comb honey as opposed to 5–8 kg from traditional hives. With 1000 Langstroth hives, 70% colonisation per season, and at least two harvests per year, this gives 28,000 kg of comb honey and Kshs 2,520,000 (at Kshs 90 per kg of comb honey). When the 28,000 kg are processed, it gives 19,600 kg of liquid honey, which at Kshs 200/kg achieves Kshs 3,920,000. With a market centre in place, the honey can be packaged in glass jars of 500 g (each empty jar costs Kshs 24.75). The packaged honey in a 500 g jar is sold at Kshs 150 (Kshs 180 in Nairobi). The 19,600 kg in 39,200 jars therefore has achieved Kshs 5,880,000. Within the project period, honey production increased at all the three sites.

As part of its organic programme, *icipe* has also trained farmers to utilise their traditional hives more effectively and sustainably. *icipe* recognises the vast scale of traditional beekeeping that is already well established across Africa, and within these project areas; also the significance of these traditional systems in times of drought. Colonisation has been found to be greater in traditional hives during prolonged drought periods than in intermediate (i.e. Kenya Top-bar) and modern (Langstroth) hive systems. *icipe* is also working on adapted technologies for harvesting diversified bee products from traditional hives and adapting centrifuge processing equipment to cater for non-customary comb shapes.

Wild Silk Production

Wild silk farming offers a financial opportunity to farmers living in areas where species of wild silkmoths occur in the forests. In each of the three project sites there are unique species—in Kakamega, *Anaphe panda*, in Arabuko-Sokoke, *Argema mimosae*, *Epiphora mythimnia* and *Gonometa postica*, and in Mwingi, *Gonometa postica* and *Argema besanti*. In Mwingi, it has been shown that an acacia plant with a canopy of about 3 m can support 200 *Gonometa postica* silkworms. A farmer with 100 acacia trees can raise 16,000 live cocoons (allowing for 20% mortality). Currently, a farmer receives Kshs 200 for a kg of live cocoons (about 200 cocoons) hence the 16,000 cocoons can make 80 kg achieving Kshs 16,000. There are two silkworm seasons in a year. If the 80 kg of cocoons are converted into silk, 30 kg can make up to 200 m of silk, which can fetch up to Kshs 190,000 at the rate of Kshs 950 per meter. If further value addition is undertaken by converting the cloth into shirts and tops, it can give 95 pieces worth Kshs 247,000 (at a rate of Kshs 2600 per item).

Anaphe silk cloth from Kakamega Marketplace

TECHNICAL STUDY 19:
Effects of Boiling Time on Floss and Spun Silk Yield From Cocoons of *Gonometa postica* and *Bombyx mori* in Kenya

Silk farming (sericulture) is increasingly being considered as a livelihood option in Africa. The maximum yield of silk from cocoons is an important aspect of sericulture. This study evaluated spun silk yield from cut cocoons of *G. postica* and *B. mori* using sodium carbonate at different boiling times of 30, 60 and 90 minutes. For control, cocoons were boiled in distilled water for the same duration. Effectiveness of the boiling duration was determined by measurement of mean percentage sericin loss at the degumming level, mean floss weight from the degummed cocoons and mean weight of spun silk obtained from the floss. The results obtained indicated that for cocoon degumming, boiling cocoons with sodium carbonate for 90 minutes gave the highest sericin loss; however, this was not significantly different from the sericin loss recorded for all cocoons at 60 minutes, but significantly higher than that recorded at 30 minutes. The mean floss weight at 90 minutes was highest but not significantly different from that recorded at 60 minutes but significantly higher than that recorded at 30 minutes for *G. postica* cocoons. However, for *B. mori* cocoons, mean floss weight was not significantly different for the different boiling times. The mean spun silk weight for *G. postica* cocoons was highest at 90 minutes but this was not significantly different from the mean weight of spun silk obtained at 60 minutes but significantly higher than that obtained at 30 minutes. For *B. mori*, the highest mean spun silk weight was recorded at 90 minutes but this was not significantly different from the records at 60 and 30 minutes. In all experiments, the boiling of cocoons with sodium carbonate gave significantly higher records than those obtained with distilled water. From these results, it is concluded that for *G. postica* cocoons the 60 minutes boiling with sodium carbonate is sufficient while for *B. mori* cocoons, the 30 minutes boiling schedule with sodium carbonate is sufficient.

Mean floss weight (g) ± SE for *Gonometa postica* and *Bombyx mori* cocoons at different boiling times using sodium carbonate with distilled water as a control

Treatment	Mean floss weight (g) ± *SE*			df, *F*, *P*
	30 min	60 min	90 min	
***G. postica* males**				
Sodium carbonate	14.68 ± 0.62bA	21.42 ± 0.46aA	22.84 ± 0.98aA	2, 36.41, 0.0001
Distilled water	0.00 ± 0.00bB	1.25 ± 0.32abB	1.94 ± 0.72aB	2, 4.64, 0.0413
df, *F*, *P*	1, 568.79, < 0.0001	1, 1282.34, < 0.0001	1, 293.11, < 0.0001	
***G. postica* females**				
Sodium carbonate	16.54 ± 0.83bA	22.76 ± 0.91aA	23.67 ± 0.45aA	2, 26.44, 0.0002
Distilled water	0.00 ± 0.00bB	1.30 ± 0.39aB	2.31 ± 0.55aB	2, 8.92, 0.0073
df, *F*, *P*	1, 398.80, < 0.0001	1, 471.16, < 0.0001	1, 918.03, < 0.0001	
B. mori				
Sodium carbonate	32.79 ± 0.96aA	33.84 ± 0.43aA	33.75 ± 0.51aA	2, 0.74, 0.5034
Distilled water	0.00 ± 0.00cB	1.61 ± 0.34bB	5.60 ± 0.28aB	2, 130.03, < 0.0001
df, *F*, *P*	1, 1172.80, < 0.0001	1, 3475.71, < 0.0001	1, 2365.59, < 0.0001	

Means within a column followed by the same capital and within a row followed by the same lower case letter(s) are not significantly different (*P* = 0.05, SNK).

Continued on next page

Technical Study 19 contd.

Mean spun yarn weight (g) ± SE for *Gonometa postica* and *Bombyx mori* cocoons at different boiling times using sodium carbonate with distilled water as a control

Treatment	Mean spun yarn weight (g) ± *SE*			df, *F*, *P*
	30 min	60 min	90 min	
***G. postica* males**				
Sodium carbonate	12.83 ± 0.93bA	17.54 ± 0.37aA	17.77 ± 1.16aA	2, 9.95, 0.0053
Distilled water	0.00 ± 0.00bB	0.99 ± 0.29abB	1.51 ± 0.52aB	2, 4.97, 0.0352
df, *F*, *P*	1, 191.07, < 0.0001	1, 1232.37, < 0.001	1, 163.62, < 0.0001	
***G. postica* females**				
Sodium carbonate	14.52 ± 1.05bA	20.30 ± 0.54aA	20.53 ± 0.34aA	2, 23.10, 0.0003
Distilled water	0.00 ± 0.00bB	0.92 ± 0.23bB	1.98 ± 0.44aB	2, 11.56, 0.0033
df, *F*, *P*	1, 192.20, < 0.0001	1, 1099.49, < 0.0001	1, 1076.56, < 0.0001	
B. mori				
Sodium carbonate	31.82 ± 0.87aA	32.68 ± 0.40aA	32.83 ± 0.64aA	2, 0.60, 0.5705
Distilled water	0.00 ± 0.00cB	1.30 ± 0.28bB	4.27 ± 0.31aB	2, 82.16, < 0.0001
df, *F*, *P*	1, 1086.00, < 0.0001	1, 4150.78, < 0.0001	1, 1607.32, < 0.0001	

Means within a column followed by the same capital and within a row followed by the same lower case letter(s) are not significantly different (*P* = 0.05, SNK).

— Courtesy E. Kioko *et al.*

Mulberry Silk Production

The calculations are based on a one acre (0.4 ha) mulberry farm whose preparation is estimated at a cost of Kshs 24,000. Mulberry silkworm rearing, being completely domesticated, demands specified environmental conditions. Thus there is a need to construct a silkworm-rearing house. The cost of building a simple rearing house (25 × 20 × 10 feet) which can rear three boxes of silkworms (60,000 worms) costs Kshs 100,000, while the rearing appliances that include among others rearing beds, trays and mountages, is Kshs 50,000. The 60,000 worms can yield 75–80 kg of wet cocoons. Grade A wet cocoons sell for Kshs 300 per kilo, Grade B at Kshs 200 per kilo and Grade C at Kshs 150 per kilo. In one rearing, a community group can raise 60,000 silkworms and produce 75 kg Grade A cocoons earning a total of Kshs 22,500. The cycle of the silkworms is one month thus rearing is more effectively carried out on a monthly basis.

The community can further add value to the cocoons by reeling them into raw silk. Three kg of dry cocoons can be reeled into 1 kg of raw silk, which trades at Kshs 1500 per kilo. Further value addition can be carried out to weave and further process the raw silk into fabric of a range of textures, colours and designs. Fourteen kg of raw silk can produce 120 m of plain silk fabric, which can be sold for Kshs 90,000 at the rate of Kshs 750 per metre. Dyeing of the fabric will add more value, where a metre of plain dyed silk is sold at Kshs 850, tie dyed silk at Kshs 950 and printed silk at Kshs 1200. If the fabric is converted to garments, it can make 80 shirts worth Kshs 192,000 (Kshs 2400 per shirt).

Equal Opportunities

The introduction of the modern and intermediate hives, and the training and supervision provided by this project, have enabled women to take part in beekeeping as an income generating enterprise. Due to traditional taboos, women do not climb trees to harvest honey and are therefore excluded from traditional methods of beekeeping. As a result of the project approach and its activities the number of women interested and participating in beekeeping has increased.

All members of the communities can successfully participate in silk rearing. Further, as the rearing of silk larvae for conventional mulberry silk can be conducted close to the home and requires careful husbandry it is naturally orientated towards the traditional activities of women.

Commercial modern beekeeping and silk farming, together with the production of tree nurseries and mulberry plantations, can also be conducted by the disadvantaged members of these communities, including those with access to very small land areas. Wild silk farming and traditional beekeeping can be carried out by landless community/members and by the very poor, requiring very little external resources.

Conservation and Climate Change

Climate change is having a significant effect on land-use practices, reducing the viability of vast areas of the African continent for the provision of food and other important livelihood resources. Deepening drought cycles are leading to increasing food insecurity. Climate change, together with increasing population pressure, has already made significant negative impact on the health of land and natural resources in the three project areas.

In addition to the activities to enhance community management and long-term welfare of the forests and other natural environments, one important activity of the project has been to rehabilitate the degraded areas within the forests, including the establishment of tree nurseries. The trees planted, together with those protected within the forests, will contribute to carbon sequestration, levels of which are yet to be quantified.

Rehabilitation of degraded areas was jointly conducted between local communities and the Forest Department staff. Seedlings were raised by local community groups. In total, five (5) ha were rehabilitated in Kakamega forest, two (2) ha in Mumoni hill and three (3) ha in Nuu hill in Mwingi district. Around Arabuko-Sokoke, local communities raised tree seedlings for planting on own farms to have enough trees and hence reduce pressure on the forest. *Casuarina equestifolia* was the main species planted for commercial purposes. Mkangagani Conservation Group had successfully planted over one (1) million seedlings by the end of the project. The impact of this planting is seen as one drives along Kilifi–Malindi road. In some of the sites, the KFS staff have given permission to communities to set apiaries in the forest edge.

Organic farming has been introduced by the project in all cropping zones within the three areas to encourage communities to improve the productivity

BOX 2. Achievements in Apiculture and Sericulture

- Wild silk farming was established for different species such as *Anaphe panda* in Kakamega, *Gonometa postica* in Mwingi and *Argema mimosae* in Arabuko-Sokoke and scientific publications done. The number of farms is 24 with Mwingi having 10 sites for *Gonometa postica*, Arabuko-Sokoke 8 sites for *Argema mimosae* and *Gonometa postica,* and Kakamega 6 sites for *Anaphe panda*.
- 3980 trained in apiculture/sericulture technologies through the project support.
- Through the project 32 apiaries were established using modern hives: Mwingi groups received 200 hives in 10 apiaries, Arabuko-Sokoke 300 hives in 14 apiaries and Kakamega 150 hives in 8 apiaries. All of these apiaries are continuing to increase in size, both by the number of hives and volume of honey production at each site.
- In the course of the project, five mulberry silk rearing houses were constructed in Kakamega, and a further 2 rearing houses in Arabuko-Sokoke.
- Market centres are in operation at all three sites—Kakamega, Arabuko-Sokoke and Mwingi. Each site comprises two separate well equipped buildings; one for hive products and the other for silk products. All of the market centres are functioning well and providing value addition and good market access for the farmers/producers.
- Production has steadily increased throughout the project term, and is continuing to expand after the closure of the project.
- Prices for the products have also increased as a result of the quality improvement, the increase and dependency of supply and from the marketing support provided by the project.
- In the last year (2008) of the project Kshs 3,232,414.4 was achieved from the sale of 28,566.87 kg of honey, and 414.6 kg of wild silk, 100 kg of *B. mori* cocoons and 25.5 kg of stingless bee honey. This market return was paid in cash to farmers by September 2008.
- Through the activities of the projects in Arabuko, the farmers successfully produced 921.98 g of royal jelly. **This is the first royal jelly to be commercially produced and marketed by rural farmers in Kenya**.
- Organic certification for honey for international markets (IMO) was achieved for Mwingi district; the producers assisted under this project and the market centre. **This has resulted in Mwingi becoming the first organic certified district in Kenya, the first organic certified honey in Kenya and the first organic certified export of bee products from Kenya.**
- Government ministry management and field staff have been trained in organic certification development for small-scale producer groups and the use of the ICS (internal control system) for organic certification and supply chain development, and are keen to extend the certification to other products and other districts in Kenya.
- **Community owned and driven business has been achieved** in three distinctive parts of Kenya as a direct result of the project activities, **sustainable both in commercial and environmental terms.** These act as successful models for other communities and regions of Kenya.

of their land and increase the carbon sink. The producer group representatives, NGO trainers and government ministry management and field staff have been trained in organic certification development for small-scale producer groups and the use of the ICS (internal control system) for organic certification and supply chain development. As a result the organic certification is expanding in number of producers and geographical spread. As organic certification enables producers to achieve higher market demand (and often higher price returns), therefore greater returns, more farmer groups are demanding to be included in the scheme and willing to comply with the environmental positive requirements of these internationally recognised organic certification standards. This is another strong example of incentive-led community-driven conservation.

BOX 3: Achievements in Forest and Biodiversity Conservation

- Community forest associations (CFA) have been formed through the project activities: five in Kakamega, 3 in Mwingi and 3 in Arabuko-Sokoke are in place awaiting the formal registration by Kenya Forest Service.
- Tree nurseries have been established at each of the three forest sites.
- Improved buffer zone management has been achieved.
- Buffer zone trees have been planted from seedlings produced by the communities in the community nurseries. The communities have been trained in nursery and tree sampling management and are conducting ongoing care of these trees.
- Surveys in Arabuko-Sokoke Forest have shown that there has been no decrease in bird population, (key species include East Coast akalat and Sokoke scops owl) since the inception of the project.
- Through promotion and publicity brought about by the project, in March 2008, Mwingi and Kitui hills and valleys were recognised as important bird areas, joining 60 other such sites in Kenya.
- Through community participation in forest biodiversity monitoring and the incentives from successful business in forest products no further destruction of the forests and its biodiversity has been recorded in the three target project areas.

Langstroth hives apiary at Nguni training site, Mwingi

Development Through Partnerships

Maximising the potential for impact

Building on the clear link of these activities to poverty alleviation, and the enabling environment provided by state agencies charged with the responsibility of managing forests, the project was easily assimilated within the Ministry of Livestock (dealing with emerging livestock products) and Kenya Forest Service (handling all forest development and management in Kenya).

icipe has focused its support on enabling buffer zone communities to access information and technology, through the applied dissemination of its insect science. By supporting community groups to evolve into recognisable entities by becoming associations with by-laws and legal rights, and through business as well as technical training, *icipe* has assisted these producers to become commercial operators. As the association is based on clusters of buffer zone stakeholders, *icipe* has also provided training to the CFAs and CSOs, Kenya Forest Service staff, managers and field staff of local NGOs and CBOs.

While the IFAD support was primarily for strategic research and development of optimal insect strains of silkmoth and honeybees and market linkages of the products, the GEF support was focused on training the rural poor in sericulture and apiculture and to support inter-communal management of conservation areas through creating sound insect enterprises: In this respect the establishment of the market centres in all project sites to ensure sustainability of the ventures. To be able to guarantee the products from marketplaces and to strategically place the business aspects of the project, *icipe* liaised with the Kenya Organic Agriculture Network (KOAN) to have the honey organic certified and approved by the government authorities. This labelling programme has enabled the primary products to sell in all approved outlets both at domestic and international levels even after the project period and financial support ended in 2008.

Monitoring indicators of environmental health, a primary indicator of determining forest recovery and restoration, was the major contribution of Nature Kenya. Its approach was to collect and collate this information from site support groups, a network of community groups found across the project sites. A similar exercise was extended to the threatened species of birds and mammals in Arabuko-Sokoke. In Kakamega, the project interacted closely with the KEEP programme which focused on environmental education. Similar monitoring protocols were extended into the dry hilltop forests of Mwingi, focusing on important bird species and reptiles, such as the pancake tortoise.

BOX 4: Achievements—Collaboration, Dissemination and Training

- The project was successfully initiated, managed, implemented and completed through the collaboration and participation of multiple donors, national level development actors, government departments and the communities of the areas.
- The project has over the years prepared information for dissemination through brochures, posters and scientific publications. (See publications list.)
- *icipe* has been involved in the development of the beekeeping policy in Kenya and bee health legislation for the continent.
- The commercial insect enterprises conducted by communities living adjacent to the forests have, over the project period, received good media coverage both in the local newspapers, radio, television channels and international media.
- Some local NGOs and ministry departments have initiated the commercial insect enterprises with groups not covered under this project.
- Eight postgraduate students have been trained through the project, plus five at PhD level and three at MSc level.
- The project ran smoothly with Project Steering Committee meetings held and reported on time.
- Due to the strong organisational and management training, the farmers/producers formed and registered as a self help group to conduct their business. They are now going through the process of becoming a business association to handle their own certification and export market activities.
- Women participated in all activities of the project and comprise a large percentage of the beneficiaries, in terms of skills development and improved livelihoods.

Assessing the Impact

The CIP was designed in response to major problems that were affecting the conservation of forest resources in Kenya. These ranged from poverty among forest adjacent communities, limited technical and institutional capacities in both government and civil society organisations to address the problems as well as policy and legislative deficits that facilitated the unsustainable exploitation of the resources. The project adopted the provision of income generating incentives for communities as well as the development of value chains linking community level production systems to the market as a way of reversing resource degradation. The approach to achieving this included the recruitment of all relevant institutions including private sector entities. To ensure sustainability of the effort into the future *icipe* promoted local ownership of the programme through the introduction of simple technological interventions that could easily be adopted by community groups. The project has now been replicated at both local and regional levels and presents huge potential for up-scaling. This momentum will need to be sustained into the future.

The project has contributed to the improvement of the management and conservation of critical ecosystems in the three focus areas in Kenya. This process has resulted in increased realisation of both national and global environmental benefits. Considerable progress has been made towards the achievement of project objectives. Overall the project is rated successful.

Challenges and Lessons Learned

Important challenges and lessons have been drawn from this formative project. As the three sites are geographically, socially and bio-dynamically independent and different from each other, and from the rigorous monitoring that was undertaken throughout its term, the results of the project activities provide sound and highly informative data for all public and private sector instigated conservation and livelihood initiatives across this region of Africa.

The project has shown that clear benefits can be accrued from the implementation of its commercial insect and forest conservation activities that have direct impact on the ecological integrity of protected areas, such as forests. It has demonstrated that this is more readily assured where community groups that live adjacent to these areas are involved in the management of such areas and also realise economic and social benefits directly from them. In achieving these results the project had to overcome a series of challenges, which has included those pertaining to the prevailing climatic, social and political conditions. Most of the challenges have been overcome within the project term. For those aspects outside of the direct influence of the project, such as climate change, the resulting models from the project activities of climate change adapted livelihoods and community-driven incentive-led management of natural resources demonstrate the effectiveness of this approach to all development and political actors, as well as to community stakeholders across Africa.

BOX 5. Lessons Learned

The following lessons from this project could benefit the design and implementation of similar initiatives.

Lesson 1: Establish baseline studies at project inception: Establishment of baseline data is a key factor in monitoring biodiversity conservation. Clear benefits have been accrued from the implementation of a project. The project has established a good baseline data for key species such as wild silkmoths, honeybees and stingless bees and built on data already available for other key species such as threatened birds, plants and reptiles.

Lesson 2: Involve community groups that live adjacent to forests in management of the forests: Success in promoting the conservation and ecological integrity of protected areas, such as forests, is more readily assured where community groups that live adjacent to these areas are involved in the management of such areas and also realise economic and social benefits directly from them.

Lesson 3: Create linkages between commercial insects, income generating activities and forest and biodiversity conservation: The linkages between commercial insects, income generating activities and forest and biodiversity conservation have been a challenge. However, in this project, combined efforts by the stakeholders have been upheld in addressing these linkages and clearly bringing out that the forest biodiversity including the commercial insects and the forest adjacent communities are centrally important to improved environmental health and better livelihoods.

Lesson 4: Allow the communities to derive benefits from conservation programmes: *The project has demonstrated that there is a direct link between conservation and livelihoods.* Future projects should ensure that there is provision for local people to benefit from resources conservation programmes as this guarantees sustainability of such initiatives.

Lesson 5: Factor in the problem of unpredictability of weather: Unpredictable weather fluctuations are a major concern to projects that depend on natural population of insects and associated flora, and influence their success or failure in the short to medium term. In the face of increasing climate change it should be accepted that realistic and practical methods that bring about tangible incentives for communities to positively manage their natural resource that buffer the effects of climate change must be central to all livelihood and conservation projects.

Lesson 6: Intensive capacity building is required: Involvement of local communities in forest management can be a challenge. The communities expect quick returns from nature-based enterprises hence a lot of training is needed for proper understanding of the economics of the apiculture/sericulture technologies as well as the non-monetary benefits of conservation.

Lesson 7: Adopt participatory methods of project management to reduce costs: Biodiversity conservation programmes are inherently expensive. These costs increase if a control and command process is adopted to implement such programmes. These costs are reduced considerably with the adoption of participatory methods of project management.

Lesson 8: Project ownership at the community level is key to sustainability: The rural communities must be empowered to respond to the challenges they face. Through ownership and management of the marketplaces the communities have been empowered to have full say in their business and enhancing chances of project sustainability while creating opportunity for rural development, respect of human rights and food security.

Lesson 9: Ensure product quality and provide market linkages: A conservation project that extends economic and social benefits to community groups and the development of natural based enterprises provides means for local communities to enter into the mainstream economies of their countries. The quality of the products must be safeguarded and efficient market linkages established so that competitive prices are maintained.

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Lesson 10: Carry out comprehensive resource valuation processes: The provision of benefits from conservation to community groups pre-supposes the presence of such values in the resources to be shared. There is need for the implementation of comprehensive resource valuation processes that will help quantify the extent of benefits to be shared with community groups. This also calls for the incorporation of resource valuation processes into formulation.

Lesson 11: Sustainability through integration into the overall national development planning processes: The CIP has demonstrated that natural resources conservation cannot be conducted outside of the context of overall national development planning processes. There is therefore a need to ensure that conservation programmes are integrated into these processes.

Lesson 12: Enhance sustainability of the results by investing in the community and government personnel for in house post project support: The project was implemented over short time period and investment into community development was carried out to ensure continued institutionalisation of the results.

Lesson 13: Need for CFAs to develop strong MoUs with Government: Forest associations at village level can develop strong MoUs with Government over the management of protected areas—both buffer and core zones. However, building association capacity needs dedicated staff inputs from both forestry and social facilitators.

Lesson 14: Unexpected delays are a reality: Implementation of some project activities was delayed due to unexpected delays such as putting in place the Forest Act 2005. However, group mobilisation went on in anticipation and later this paid off.

Lesson 15: Anticipate delays in gauging the project impact: Biodiversity monitoring and income mapping requires some time before tangible results/impact can be felt across the board.

Lesson 16: Make a record of the lessons learned throughout the project life: Note down what worked well (or even what did not work well), and share it out widely.

Future Focus

The project plans to develop forest corridors to enhance survival of the commercial insects at the three forests for promoting biodiversity conservation and income of the communities living there.

The project will also focus on developing a scientific measurement to assess the adverse impacts of climate change on the crops and forest biodiversity and develop coping mechanisms based on commercial insects and crop pollination services in mitigating the worsening effects of climate change to enhance rural income. The partnership with all stakeholders will be central aspects to the attainment of this goal.

Section 4

Sustainability and Replicability

Sustainability

Progress through Partnerships

Within the four-year term, the project was able to deliver direct and quantifiable benefits at various levels. The project benefited greatly from having cultivated close collaboration with key stakeholders such as the Government of Kenya through the various ministries. The staff members from some of these government agencies were trained alongside the community members. As a result of the project design and the investment in its activities, a sound knowledge base has been developed with stakeholders at all levels, and due to the business culture that was instilled throughout this process there is positive ownership of this information, skills and enterprise development by all the stakeholders involved. These are important aspects in ensuring that the project has the capacity to move forward beyond the funding period. The realisation of both economical and social benefits from the project that do not deplete the forests will enhance the long term sustainability of the project activities.

The current Kenya Forest Service policy on Participatory Forest Management, recognises the community as key players in the management of forest resources. This is an important policy enhancement, as previously the forests were considered to be state resources under the sole management of the government. This project has brought about the broadening of livelihood options for community groups, in the face of current climate variability. Reduced exploitation of forest resources will ensure their continued productivity thereby ensuring availability of the resource over time.

The project has also opened new initiatives for rural people. Some of the groups have identified the apiculture/sericulture initiatives as projects for financing from various agencies, e.g. the Constituencies Development Fund (CDF).

Since the termination of the project, the Kenya Forestry Service has continued the activities started under this project under their own government funding. Some activities were streamlined in district government work plans.

Challenge to Sustainability

The project's achievements/sustainability may be threatened by the negative aspects of climate change, group politics and marketing policy gaps. There are also groups within the project areas who are not beneficiaries of the current project and who need to be brought to the same level of understanding for the enterprises to expand in membership and trading capacity.

Replication

The project yielded important lessons that can be considered for use in designing other initiatives. One such lesson is that success in promoting the conservation and ecological integrity of forests is assured where community groups that live in areas adjacent to these forests are involved in the management of such areas and also realise economic and social benefits from them. This experience can be up scaled and replicated in other areas.

The project in one site in Mwingi forest has been certified organic. This has put in place internal control systems, involving players from within the community and has given the products wider appreciation and demand. This certification process can be replicated at the other two sites, in Kakamega and Arabuko-Sokoke and in any other community in the country and beyond.

The project has received visitors from different parts of the continent and beyond indicating the desire of other countries to try such initiatives. *icipe* has been invited to initiate similar projects in various countries including Egypt, Yemen, The Sudan, Southern Sudan, Madagascar, Malawi and Ethiopia among others.


Reviewer at a community tree nursery


Reviewer at a community apiary


Reviewer at a silk marketplace


Reviewer listening to community views

Closing Word

"Institutional deficits and capacity limitations are a usual cause for the collapse of projects when outside support ends. It is instructive to note that CIP has established local level project management institutions that are run by community groups themselves to manage project activities. All the project sites visited demonstrated local ownership of processes with a number of communities displaying capabilities for the design and management of meetings, visitor tours and projects in general. A major feature that cut across all projects visited was the predominance of women as members and office bearers of groups. This has resulted in the empowerment of women who are now recognised for their contributions to project activities. The net effect of this is that these projects are contributing directly to the poverty reduction strategy at local level. Working with and through women also guarantees impact at household level, as women are responsible for the welfare of the household. The income that is flowing to the women was reported to be having direct household impact through increased abilities of households to fund important needs such as children's education and health delivery needs."

— External reviewer

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Postgraduate Students

PhD students

N. Mbahin. The ecology and economic potential of the wild silkmoth *Anaphe panda* (Biosduval) in the Kakamega forest of western Kenya. Kenyatta University, Kenya.

K. Okwae Fening. Biology and ecology of the major parasitoids of *Gonometa postica* Walker (Lepidoptera: Lasiocampidae) on different species of *Acacia* in Mwingi, Kenya. Kenyatta University, Kenya.

B. Ngoka. Relative abundance of the wild silkmoth, *Argema mimosae* on different food plants and behavioral host selection by parasitoids. Kenyatta University, Kenya.

S. Sande. Honeybees and forest conservation: A case study of the Arabuko-Sokoke Forest, Kenya. Kenyatta University, Kenya.

H. G. Kibogo. Molecular characterisation of honeybees, *Apis mellifera* in East Africa. Jomo Kenyatta University of Agriculture and Technology, Kenya.

MSc students

J. Macharia. Relative abundance, queen rearing and colony characterisation of stingless bees in Kakamega forest of Kenya. Jomo Kenyatta University of Agriculture and Technology, Kenya.

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Reviewer with stakeholders after project briefing

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