Production-to-Consumption Systems: A Case Study of the Bamboo Sector in Kenya

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Cover Photo: Mrs. Margaret Nangekhe selling dried bamboo shoots in Kitale town

INBARs Bamboo and Rattan Development Programmes.

The application of bamboo and rattan in enhancing the economic and ecological well being of resource-dependent communities in Asia has been extensive. Systematic studies of the potential of bamboo and rattan, previous and current uses, and the social, cultural and political perspectives of these resources have been invaluable in promoting development through innovative and sustainable use of bamboo and rattan. The International Network for Bamboo and Rattan (INBAR) has played a pivotal role in advancing the bamboo and rattan sector in this region. INBAR has facilitated and coordinated research (including action-research) on biodiversity and genetic conservation, production systems, processing and utilisation and socio-economics and policy, while promoting capacity building at the national level. A number of rural development programs are being implemented in the region. INBAR has also been instrumental in promoting technology transfer and information exchange between network partners.

The replicability in Latin America and Africa of the success stories from South and South-east Asia is yet to be assessed, despite the immense interest from the private sector, non-governmental organizations and government institutions in using bamboo and rattan to fuel rural development in the region. The dearth of information on the bamboo and rattan sector has been the main constraint to the development of systematic and sustainable development programs.

In order to do this INBAR has commissioned national studies from selected countries in Africa and Central and South America. These national studies will provide a thorough review of the current state and future potential of the bamboo and rattan sectors in each country. Certain standard indicators will be documented in these studies to allow regional comparisons while other information will be country-specific. The national studies will help the experts decide the priority areas of study at the local, national and regional levels. This in turn will help INBAR clearly define its role within these countries as a facilitator and coordinator.

INBAR has developed an outline for these national studies. The outline serves two purposes. Firstly, it is meant to facilitate the data collection process and secondly, it should assist in the formulation of case study reports. The framework also guarantees that comparable information is provided in each national study. Information covered includes; general information on the country (geographical, topographical, climate, demography, political, environmental); the bamboo and rattan sector (biodiversity, production, utilisation, socio-economics, marketing, legislation); the institutional capacity at the national and local level; previous, ongoing and upcoming research and development interventions in the bamboo and rattan sector; and finally conclusions and recommendations.

After defining priority areas, case studies are undertaken in a number of carefully chosen, highly representative, locations within the country to collect raw data on all aspects of the present state of the bamboo and/or rattan sectors in those locations. The case studies investigate the Production-to-Consumption system of the resource. This involves the entire chain of activities to which the bamboo or rattan is subjected, from the production of raw materials (including the input market, where one exists) through the various stages of intermediate sales and processing, to the consumer of

the final product. The system includes the technologies used to process the material as well as the social, political and economic environments in which these processes operate. These are all covered in the case study.

Once the raw data has been collected, it can then be analysed. It is classified into two focus areas; constraints and opportunities. Possible options that could address the constraints or take advantage of the opportunities and thereby promote development are identified, and a plan for development formulated. This plan is then developed into an action-research project, which is actually a micro- or mini-level rural development project. It is effectively a trial project, and is intended both to test whether the interventions suggested by the study are appropriate and to obtain feedback from the local population on all aspects of the program. The methodology and development options (interventions) of these projects would be finalized at a stakeholders meeting in the country prior to the start of the project.

If an impact analysis study towards the end of the action research project indicates that the project is successful, and the community agrees, this would then form the basis for developing similar programs that could be multiplied in scope and applied in similar situations throughout the region or nation. In this way we go from fully tested small-scale trial project to multiple projects with large impact in a short time. At this national or regional level, these programs would attract investment from donors interested in poverty alleviation and rural development.

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Table of contents

List of figures

List of tables

List of plates

Summary

The bamboo case study was conducted in various parts of the country with the aim of obtaining information on the bamboo production to consumption systems. Data was collected from primary and secondary sources. The data covered aspects such as social and demographic factors of the various local communities, policy and legal issues, stakeholders' analysis, constraints, employment and income opportunities from bamboo and its related activities.

It was established that bamboo has many uses. The main uses are in fencing (estimated at 2.4 million culms per annum), construction (142 000 culms), props in the flower industry (634 000 culms), bamboo shoots (38 000 shoots), and toothpicks and skewers (27 000 culms). The other products produced from bamboo are incense sticks (7 000 culms per annum), baskets (12 000 culms) and handicrafts (1 000 culms). The current ban on the utilisation of bamboo, lack of alternative resources, low processing technology and lack of awareness on the importance of bamboo production strategies have affected the effective utilisation of bamboo.

It was noted that many local people who live in urban, peri-urban and rural areas derive their income from the various activities of the bamboo production to consumption system. These activities include harvesting and assembling, transportation, processing, packaging and marketing. Toothpick production is one enterprise that is growing very fast in this country but it uses very small quantities of bamboo. Most of the raw materials are obtained from natural forests.

To develop and sustain a vibrant bamboo sector in the country the following interventions are proposed:

- *create awareness on the economic potential of bamboo resource to resource managers and policy makers so as to catalyse policy and legislative reforms;*
- *implementation of KEFRI guidelines on management of bamboo;*
- *improve quality of products through training and use of efficient technologies;*
- *improve marketing of products through establishment of market information system; and*
- *encourage bamboo growing on-farms or on government land through leases.*

List of acronyms

GOK	Government of Kenya
INBAR	International Network for Bamboo and Rattan
KEFRI	Kenya Forestry Research Institute
MENR	Ministry of Environment and Natural Resources
PCS	Production-to-Consumption System
DFO	District Forest Officer
Ksh.	Kenyan Shilling: (National currency). 100 Ksh. = 1.2 US$

CONTEXTS

Kenya in East Africa straddles the equator and extends between 34^0 and 43^0 East. It has 3, 446 km of land boundaries and is bordered by Uganda (933 km) in the east, by Ethiopia (830 km) and Sudan (232 km) in the north, by Tanzania (769 km) in the south and by Somalia (682 km) in the west. It has 536 km of coastline in the southeast. Kenya covers a total area of 582, 650 sq km, of which 569, 250 sq km is land and 13, 400 sq km is water.

TOPOGRAPHY

The highest point in Kenya is Mount Kenya in the west at 5, 199 m. From here the land slopes down to the sea in the southwest and down to about 1000 m altitude in much of the rest of the country. The central highlands and Great Rift Valley occupy much of the western central part of the country. Kenya has few rivers: The main ones are the Galana, formed from the confluence of the Athi and Tsavo and which flows out to sea at Malindi, the Tana which arises in the central highlands and flows out to sea near Lamu and the Turkwel which flows into Lake Rudolf. Lake Rudolf is in the north of Kenya and is the largest lake. Part of Lake Victoria in the west belongs to Kenya. Natural resources include fluorspar, gold, limestone, rubies, salt barites and soda ash.

LAND USE

Only 7% of the land is used for arable crops. 37% is permanent pasture, 1% is down to perrenial crops. Kenya has about 1.24 million ha. of closed canopy indigenous forests left (2.1% of the total land area), out of a possible 6.8 million ha (Wass, 1995). Most of these are distributed in the moist central highlands where human population and agricultural settlement are also concentrated. In the extensive arid and semi-arid areas, forests are mainly found on isolated hilltops as island forests and in discontinuous narrow bands along some permanent and seasonal rivers. The country's forests consist of a variety of vegetation communities determined principally by rainfall, altitude and soil type. These forests are mixtures of many tree species interspersed in places with glades. Large areas of bamboo are common in some highland forests.

Progressive reductions in forest cover have occurred since the turn of the century. Presently, the rate of reduction is estimated at 5 000 ha per year, caused mainly by clearing for agriculture, grazing and excisions. It is estimated that over 2.9 million people, representing about 530 000 households, live within 5 km of forest areas and a further 10 000 households live in these closed-canopy forests (MENR, 1994; Wass, 1995).

These forests are facing many threats from increasing demands from the growing population and unsustainable management and utilisation practices. The demand for wood is growing while the capacity to produce it has become increasingly constrained by the need to conserve existing forest resources and the need for expansion of agricultural and settlement land. For example, about 90 % of Kenya's population depends on wood energy for cooking. It is estimated that about 71 % of the

energy consumed annually come from wood in addition to provision of wood for construction, and paper (MENR, 1994). Forests provide a wide range of goods and services, including medicinal plants, honey, thatching grass and fodder besides playing crucial roles in soil and water conservation, particularly in regulation of water flow, control of floods and erosion, and conservation of biodiversity.

BAMBOO RESOURCES.

The dominant species of bamboo in Kenya is the indigenous *Arundinaria alpina (K.Schum)*, locally known as *Mirangi* (Kikuyu), *Techani* (Pokot), *Tegek* (Kips.), *Tekek* (Sebei), *Modi* (Luo) and *Mianzi* (Kiswahili). *A. alpina* grows to 20 m tall in ideal conditions, but at high altitudes, the culms are relatively slender and short. Culms are thick-walled and branches emerge at the upper nodes. Shoots are produced during the rainy season and culms live for between seven and fourteen years. Flowering is thought to occur at forty-year intervals in the Aberdare ranges and at fifteen-year intervals in the Mt. Elgon range. Gregarious flowering is not known in *A. alpina*.

Arundinaria alpina K.Schum. occurs between 2290 and 3360 m above sea level (a.s.l.) and covers about 150 000 ha either as pure or mixed stands. Estimated coverage in the Timboroa plateau is about 31 000 ha, 65 000 ha in the Aberdare ranges and 51 000 ha in the Mount Kenya, Mt. Elgon and Mau ranges. The species is found mainly in areas of high agricultural potential where competition for land is intense. *A. alpina* is receiving attention from the government especially for catchment rehabilitation, regulation of water-flow and erosion control where it is a vitally important species.

Most of the bamboo resources in Kenya are found within government forests and in trust-lands and farmlands, which were once within the Government forests but have since been degazetted. Another small proportion is found domesticated by farmers with *Bambusa vulgaris* as the dominant species. The Kenya Forestry Research Institute (KEFRI) has introduced other bamboo species from Asian countries within forest areas and on farmlands on an experimental basis (Table 1).

Table 1: Major species of bamboo in Kenya (local and introduced)

Scientific name	Source
Arundinaria alpina	High altitude areas of Kenya - *(Indigenous)*
Bambusa brandisii	Malaysia
Bambusa vulgaris var. *striata*	India
Bambusa bambos	Thailand
Bambusa tulda	India
Dendrocalamus membranaceous	India
Dendrocalamus strictus	India & Burma
Dendrocalamus brandisii	India
Gigantochloa aspera	Java (Indonesia)
Oxytenanthera abyssinica	Zimbabwe
Phyllostachys pubescens	China

Thyrsostachys siamensis	Thailand

KEFRI has carried out research on selection and growth of bamboo species in collaboration with Asian Research and Development Institutions since 1986. Through this research initiative, over twenty Asian bamboo species have been introduced into the country. Some of these are successfully growing in the field and on-farms in western, central and coastal Kenya. These are Kakamega, Vihiga, Yala (Siaya District), Kaptagat (Eldoret), Muguga (Kiambu District), Gede and Jilore (Malindi District). Some of the species trialled in Kenya include: *Bambusa brandisii, B. vulgaris* var. *striata, B. bambos, B. tulda, Dendrocalamus membranaceous, D. strictus, D. brandisii, Gigantochloa aspera, Oxytenanthera abyssinica, Phyllostachys pubescens* and *Thyrsostachys siamensis.*

PEOPLE

The population of Kenya is 30, 339, 770 and is estimated to be growing at 1.53% per annum. Forty three percent of the population is under 15 years of age and 54% between 15 and 64 years old. The male/female ratio between ages 15-64 years of age is 1.01. The predominant ethnic groups are the Kikuyu (22%), Luhya (14%), Luo (13%), Kalenjin (12%) and the Kamba (11%). Other groups include the Kisii and Meru. Thirty eight percent of the population is Protestant and 28% Roman Catholic and seven percent Muslim. Twenty six percent adhere to indigenous beliefs. The official languages are English and Kiswahili but there are many other indigenous languages. Seventy percent of the female population and 86% of the male population over 15 years of age are literate.

THE BAMBOO-PEOPLE INTERACTION

In the past, there has been indiscriminate harvesting of the indigenous bamboo species. The remaining bamboos are found in the mountainous areas and are important in the protection of water catchments. A government ban on cutting bamboo was proclaimed in 1982 to control further indiscriminate cutting and to allow the over-cut areas to regenerate to their full potential (MENR).

However, local farmers, small enterprises and the horticultural industry use bamboo under controlled licensing. The Aberdare ranges and Mt. Kenya are two areas where bamboo resources are plentiful and exploitation is going on to some extent. These areas are close to the cities of Nairobi and Naivasha which are major bamboo processing and consumption centres.

Bamboo provides raw materials for many industries such as the production of incense sticks, toothpicks, food and forage, water harvesting, medicine, props for commercial flower growing, tea picking baskets and making handicrafts. These activities provide job opportunities and entrepreneurship for the rural poor. Furthermore, bamboo is used for fencing and construction and constitutes a potentially vital source of raw material for the pulp and paper industry.

There are some constraints to the development of the bamboo sector in Kenya. According to the Forestry Department, bamboo is classified as a minor forest product. This has slowed the recognition and development of this resource. Other factors affecting the development of the bamboo resource include; the ban on harvesting, lack of awareness on its potential, production of unprocessed or semi-processed products, poorly developed marketing structures, lack of information on availability of planting materials, lack of information on the methods of propagation, establishment, crop management and harvesting (Kigomo, 1995; Kigomo, 1988).

Although some farmers have adopted cultivation of bamboo species, and controlled cutting is still allowed in natural forests under special license, detailed information on quality, quantity, and types of uses and characteristics of the users is unavailable to enable development of a vibrant and sustained bamboo enterprise sector in the country. The importance of the bamboo sector in Kenya needs to be more clearly understood from the above perspectives.

ISSUES

This study was designed to determine the type and extent of uses of the bamboo resources, and processing, pricing and marketing of the products. The findings of this study will be used to promote the development of on-farm bamboo plantations, natural forest management programmes and bamboo cottage industries in the country. Mechanisms for stimulating and enhancing the involvement of the small-scale manufacturers in urban and peri-urban centres were sought. These included integrating production, utilisation, processing and marketing, and improved efficiency through the use of new technologies.

1. METHODS

1.1 **The production to consumption system (PCS).**

Bamboos are one of the most important Non-Timber Forest Products (NTFPs). They are renewable, yield annually and are readily accessible to rural peoples. As a resource they have enormous potential to fuel rural development and this has long been recognized in many parts of the world. However any bamboo development program exists within the context of the society in which it is implemented and is subject to pressures and limitations (constraints) from many factors within that society not apparently directly related to growing, processing and selling bamboo. In order to develop a successful development program an understanding of all these factors (their effects, their magnitude and their potential (beneficial or detrimental)) is required. This necessitates investigations far more detailed than can be conducted at country or regional level.

Carefully focussed case studies do allow such detailed analyses to be made and can be very useful if they are chosen to be truly representative. Such case studies are often based in specific geographical locations, primarily due to the nature of the bamboo resource. However because of the huge variety of raw material-management systems and processing techniques to which bamboos are subjected, and end products into which they are made, it is necessary to use a reliable and standardized tool for analyzing all the processes involved, and all the factors impacting upon them. Thus the International Network for Bamboo and Rattan adopted the concept of the Production-to-Consumption System (PCS) (Belcher, 1995). This involves the entire chain of activities to which the bamboo is subjected, from the production of raw material (including the input market, where one exists) through the various stages of intermediate sales and processing, to the consumer of the final product. The system includes the technologies used to process the material as well as the social, political and economic environments in which these processes operate. These are all covered in the case study.

Subsequently analysis of the PCS enables identification of all the constraints limiting bamboo management and use, and highlights opportunities that, if taken, would promote bamboo-based de-

velopment. Development programs can then be planned which utilize and develop the opportunities whilst circumventing, or even eliminating, the constraints. In ideal environments these programs may be limited to the bamboo PCS itself. In less favorable environments they may include policy shifts, infrastructural changes and even legal changes (for example relating to land tenure). In all cases, the emphasis is on community-led development (by the community, for the community) with the maximum possible benefit remaining within the community. The production to consumption system analytical framework utilized for this study is based on that explained in INBAR working paper Number 4 (Belcher, 1995).

1.2 MAIN OBJECTIVES

The study analysed the production-to-consumption system (PCS) of the bamboo sector in Kenya and identified potential development interventions for the improvement of the livelihoods of the local people.

1.3 SPECIFIC OBJECTIVES

The specific objectives of the study were:

i. To provide detailed background information on the bamboo sector and in particular the socio-demographic profile of the communities growing bamboo in Kenya;

ii. To develop a comprehensive understanding of the production-to-consumption systems (PCS) of bamboo in the country;

iii. To identify potential development interventions that will serve to minimise bottlenecks, problems and inefficiencies in the bamboo PCS and improve the livelihood of rural stakeholders;

iv. To identify policy, legal issues, management constraints and opportunities; and

v. To produce fully costed activity models for selected potential interventions.

2. METHODOLOGY OF THE PCS FIELD STUDY

2.1 Brief description of study area

The study was carried out in areas where bamboo production, processing and utilisation are common. These are Mt. Kenya, and the surrounding towns of Nyeri and Nanyuki; and the Aberdare mountain ranges including Nairobi and Naivasha towns. Other study centres included the Mau mountain ranges, the towns of Siaya, Kisumu and parts of Homa Bay district, the Cheranganyi hills, Mt. Elgon, Nakuru, Kitale, Malindi and Mombasa (see Fig.1). Individuals and groups selected from institutions and local communities involved in the production-to-consumption channels were interviewed. Farmers who produce bamboo both as a resource and products were also interviewed.

The average forest cover per district in the study areas was about 9.6 %, which is above the national average of 2.4 % (Fig. 2).

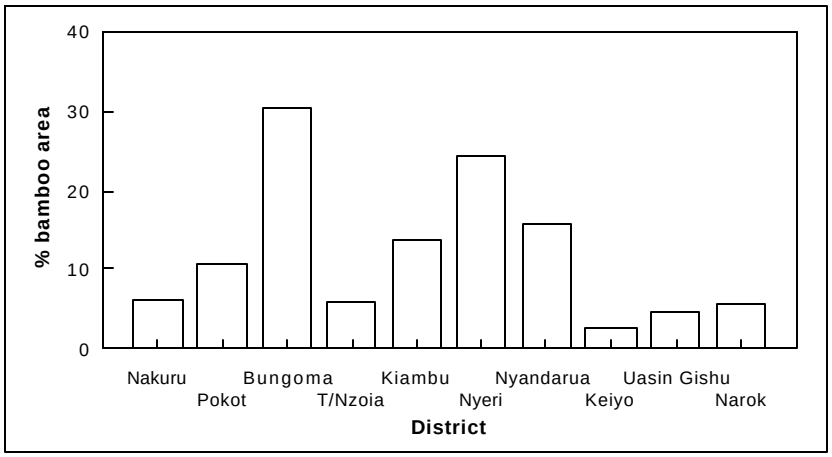

Fig. 1: Bamboo as a percentage of forest area in different areas
Source: Susan Minae (1989).

The average per cent bamboo cover within the forest was about 11.0 % with a range of 0 to 30 % (Fig. 2) which compares well with previous studies which estimated the cover at 10 % (Kigomo, 1995). The apparent increase in the proportion of bamboo within the forest could be as a result of a decrease in the area of forest cover due to excisions and not actual increase in acreage. The highest bamboo cover was in higher altitudes close to the main mountains in the country (Table 2).

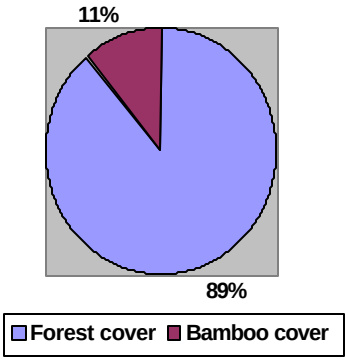

Fig. 2: Mean relative area of bamboo (Source: MENR, 1994).

Table 2: Bamboo cover (hectares) in different study areas

District	Total Area (ha)	Forest cover (ha)	Bamboo area (ha)	% bamboo cover in forest	No of culms per hectare
Nakuru	576 200	137 391	8 565	6.23	11 000
West Pokot	910 000	20 857	2 223	10.66	12 000
Mt. Elgon	254 900	49 383	10 250	20.76	13 500
Trans-Nzoia	246 800	48 058	2 827	5.88	9 000
Kiambu	245 100	41 369	5 723	13.83	7 500
Nyeri	216 200	103 651	25 133	24.25	10 250
Malindi/Kilifi	1 200 300	41 765	n.a	0.43	n.a
Nyandarua	352 800	57 306	9 060	15.81	12 540
Keiyo-Marakwet	305 300	49 625	1 265	2.55	6 500
Uasin Gishu	321 800	21 414	960	4.48	8 500
Narok	1,611 500	72 354	4 207	5.81	14 000
Kakamega	296 300	19 649	n.a	0.13	n.a
				Mean: 10.34	**Mean: 10480**

n.a no data available
Source: MENR (1994)

2.2 Demographic profile and socio-economic activities within the study areas

The population density within the study areas varied significantly, ranging from 36 to 790 person per Km^2 with an average of 220 persons per Km^2 (Table 3).

2.3 Parameters for data collection

The primary data were collected from field surveys and informal interviews with a selected sample of raw bamboo producers, collectors, processors and consumers. A structured questionnaire was designed for the study (Appendix 1a-f). A team of scientists assisted by locally trained interviewers who doubled as interpreters administered the questionnaire. Interviews involved several visits to host villages and collection centres and major processing, manufacturing and market centres in Kenya. Secondary data were gathered from literature on previous work on bamboo.

Table 3: Socio-economic information for the surveyed villages

District	Village	Pop. (1998)*	Number of households	Male	Female	Area (sq. km)	Density Person/Km^2
Malindi	-Msabaha	5 859	867	2 797	3 062	20	293
	-Madunguni	2 977	378	1 361	1 617	20	149
	-Dabaso	15 211	2 305	7 788	7 423	58	262
Nyandarua	-Geta	5 597	1 038	2 697	2 899	28	200
	-Makumbi	4 901	854	2 334	2 568	10	490
West Pokot	-Kapsait	2 448	421	1 193	1 246	47	52
	-Kapkanyar	3 808	801	2 099	1 939	100	38
Trans-Nzoia	-Endebess	36 123	6 333	18 227	17 896	383	94
	-Ndalu	9 972	1 436	4 987	4 985	58	172
Nakuru	Nakuru Munic.	209 911	55 059	112 851	97 060	266	789
	-Olenguruone	29 354	5 084	14 604	14 749	168	175
Uasin-Gishu	-Ainabkoi	1 886	330	1 004	882	53	160
	-Timboroa	9 007	1 500	4 418	4 589	88	36
Kiambu	-Kamae	5 151	925	2 538	2 613	37	102
	-Gathangari	6 509	1 328	3 236	3 273	11	139
Mt. Elgon	-Chebyuk	1 2 281	1 848	6 176	6 105	46	592
Vihiga	-Jeptulu	8 015	1 203	3 769	246	7	267
Average							211.16

* *Projections based on the 1989 Government of Kenya Population Census Report.*

2.3.1 Production

To understand the production to consumption process, an assessment of resource availability in the country, raw bamboo collection/harvesting, characteristics of the collectors, types of processing technologies used, collection/financing arrangements; stock management systems and resource input requirements were carried out. Local institutions, customs, traditions and informal rules of stock management, government policies (quotas, licenses, extraction fees, royalty, taxes and tenure laws); local prices, different qualities of raw bamboo; and monthly earnings of collectors/harvesters were also considered.

2.3.2 Processing.

Data on inputs (labour, raw resource, capital, and prices), raw bamboo processing, socio-demographic characteristics of proprietors, employees and apprentices were collected. Information was also collected on the technologies used, financing arrangements, transportation from harvest site and storage. Interactions among collectors, transporters and end-users of raw bamboo were considered. Prices for intermediate goods, purchase terms, spot purchases, contracts, stage-wise value-addition and monthly income of handicraft operators were considered.

2.3.3 Consumption / utilisation

Analysis of the product range, pricing and mode of payments were undertaken. Other parameters considered were volume of sales income and profits of handicraft operators, projected

sales and future outlook, and trade restrictions, royalties, taxes, and other fiscal and regulatory measures.

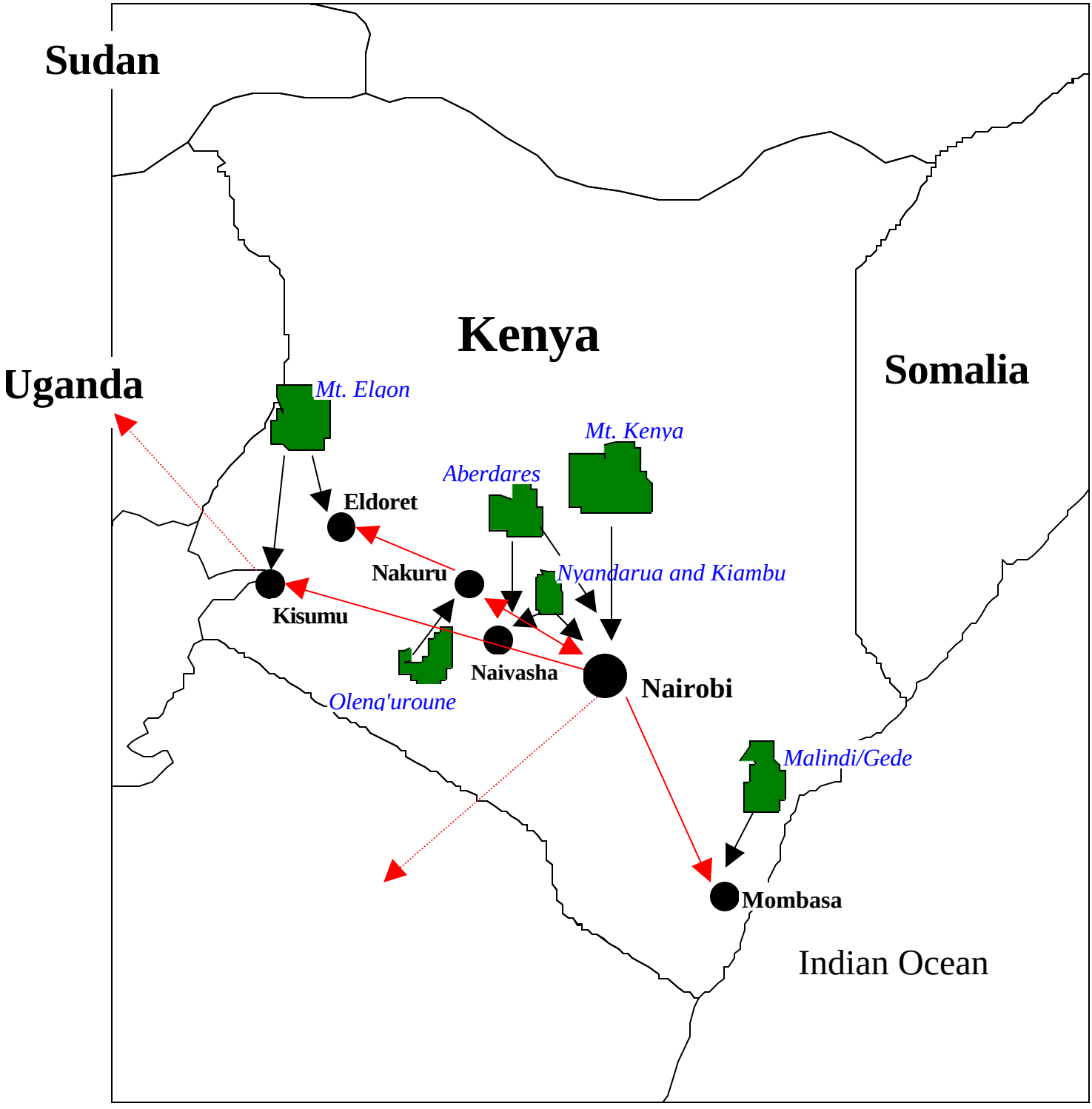

Fig. 3: Movement of raw bamboo from major sources to main processing and utilisation centres.

● Major towns/processing & consumption centres

2.4 Sampling Technique

A quota sampling technique was used to select the bamboo collectors and processors in all the study sites. Harvesting, collection, and processing individuals in rural and urban towns were selected based on relative distribution patterns of target stakeholders in the various parts of country. Since the precise distribution of all bamboo collectors and processors was unknown beforehand, the actual survey was done following the initial interviews with key informants in urban areas and forest stations. A total of 339 respondents were interviewed with some respondents being interviewed in more than one category. The distribution of the interviewees was as follows (Appendix 2):

- Bamboo producers (34 villages):- A total of 65 individuals interviewed;
- Collectors/harvesters (13 villages/farms):- A total of 25 individuals interviewed;
- Primary processors (22 villages/rural towns): - A total of 59 respondents interviewed;
- Retailers and consumers (market centres in urban towns/cities):- A total of 133 individuals interviewed;
- Policy making institutions (urban towns/cities)-Discussions conducted with relevant government officials and stakeholders. A total of 57 respondents were interviewed (Appendices 1a and 2).

2.5 Data analyses

Data analyses were done using Lotus and Excel computer packages. Descriptive statistics were mainly used in the analysis. Frequency tabulation was used to present the collected information on the various aspects of the PCS. The three principles that guided the tabulations were:

- Natural exclusivity of qualities or values;
- Internal logic and order of tabulations;
- Careful selection of the class intervals for quantitative variables.

Where appropriate, the distributions were summarised, using measures such as mean, mode and median. Percentages were used to compare frequencies and to express qualitative variables in a numerical format.

3. RESULTS

Plate 1: *Bambusa vulgaris* var. *striata* at a farm in Gede, Malindi

Plate 2: Bamboo assembling point at Timboroa

The survey established that bamboo growing was mainly confined to areas unsuitable for agriculture waterways and gorges. Outside the forest areas, it was found that about 3.4 % of households had bamboo on their farms, occupying about 1.6 % of the total land holding in the study areas. Most respondents were aware of the potential benefits of bamboo but are reluctant to increase the acreage of bamboo on their farms because of uncertainty in marketing and management because of the present ban and competition from other land-uses.

In all the study areas, it was established that *A. alpina* in natural stands had an average stem length of 10.2 m and a diameter of 7.5 cm. Bamboos from farmlands were on average found to be smaller, with an average length of 9.6 m and diameter of 6.2 cm. Tables 4a and 4b give a summary of officially recorded quantities extracted in different study areas over the last three years. In some areas, larger sizes of bamboo were found in the more inaccessible, higher altitude, regions. Stocking levels were found to be higher in natural forests than on the farmlands. The average number of culms per hectare in forest areas was 10 480. According to Kigomo (1988) and Kant *et al*. (1992) there are about 10 000 to 17 000 stems per hectare in undisturbed stands of *Arundinaria alpina*.

Table 4a: Bamboo culms collected from natural forests in ten districts

District	1997	1998	1999
Nakuru	28 548	66 983	42 455
West Pokot	1 395	780	2 110
Mt. Elgon	5 478	11 260	16 035
Trans-Nzoia	6 948	1 945	15 687
Kiambu	86 783	39 542	91 560
Nyeri	41 165	21 740	85 025
Nyandarua	79 348	91 304	59 075
Keiyo-Marakwet	8 557	11 130	6 783
Uasin Gishu	15 478	28 357	22 652
Narok	73 435	15 390	94 045

Source: MENR Annual Reports (1997-1999).

Table 4b: Bamboo culms harvested in different villages

Village	1997	1998	1999
Msabaha	160	200	135
Madunguni	100	250	150
Dabaso	90	190	150
Geta	5 800	3 300	4 770
Makumbi	3 500	5 900	6 611
Kapsait	100	450	280
Kapkanyar	1 250	550	320
Endebess	90	65	110
Ndalu	130	60	90
Nakuru Munic.	30	65	50
Olenguruone	15 500	12 800	10 600
Ainabkoi	3 300	1 800	2 800
Timboroa	3 580	2 550	3 200
Kamae	9 200	10 200	7 890
Gathangari	150	120	80
Chebyuk	1 500	1 850	950

Jeptulu	650	900	640

Source: Estimates from the study

3.1. Production systems

The study established that the main sources of bamboo are government forests on which about 99.4 % of the total are produced. The remaining 0.6 % is produced on farmlands. Most of the bamboo produced on farms is used locally for fencing and construction, as well as for shade and ornament. Some farmers have retained some natural stands of bamboo on their farms where excision of forestland and subsequent settlement have taken place. This was observed in Geta-Aberdares, Olenguruone-Mau forest area, Kapsokwony-Mt. Elgon and Lelan-Cherangani Hills. Bamboo on state forests are protected and conserved, although controlled harvesting is allowed in some areas. The estimated amount of bamboo collected from state forests within the study areas varied considerably due to variation in demand (Table 4a). Because of the ban on bamboo harvesting in 1982, the figures given in the tables show extraction under special license arrangement. These figures do not necessarily reflect the national total and are found in records only.

Quantities of bamboo culms collected from natural forests are believed to be higher than those reported here because of illegal harvesting. In all the natural forests visited, there existed no formal management system for bamboo. This is because of the current ban on the exploitation and the classification of bamboo as minor forest produce.

Production of bamboo from the farms varied and depended mainly on demand from other users or immediate households. No consistent pattern of production was evident. The average land size per household in the study areas was about 3.26 hectares (Table 5). Out of these, bamboo occupied about 3.28 %.

Table 5: Estimated size of land holding in the study areas

Village	Average size of holding (hectares)	Total area under bamboo per village (hectares)	Mean bamboo area per farmer (hectares)	Households with bamboo on-farm (%)
Msabaha	5.0	2.1	0.05	4.8
Madunguni	3.8	2.3	0.15	4.0
Dabaso	5.0	3.5	0.06	2.4
Geta	1.2	20.0	0.11	5.3
Makumbi	1.8	10.1	0.23	5.0
Kapsait	6.1	1.5	0.10	3.6
Kapkanyar	6.0	8.1	0.27	3.7
Endebess	2.0	3.1	0.03	1.7
Ndalu	2.2	1.8	0.06	2.1
Nakuru Munic.	0.3	0.6	0.03	0.0
Olenguruone	5.8	87.4	0.34	5.0
Ainabkoi	3.2	10.6	0.23	3.6
Timboroa	4.5	4.7	0.14	5.0
Kamae	1.6	0.9	0.10	5.0
Gathangari	1.0	4.6	0.04	1.9
Chebyuk	3.1	3.5	0.18	1.4
Jeptulu	2.8	3.5	0.23	1.2
Total	**55.4**	**168.3**	**2.35**	**55.7**

Mean	**3.26**	**9.9**	**0.14**	**3.28**

Source: Estimates from the study

There were farmers in Gede-Coast and Vihiga-Western regions who had established a few clumps of exotic bamboo on their farms that are occasionally harvested for use in fencing and minor construction work. *Bambusa vulgaris* was more popular in the province of Coast due to its large size and strength. Lack of developed marketing systems for bamboo products and land size were cited by the farmers as the main constrains in development of on-farm planting bamboo planting.

Kaimosi Tea Estate in the Western region has shown interest in growing bamboo for making tea picking baskets, furniture and for water-catchment protection. They have planted about one thousand seedlings, although the survival is low. In Madunguni area at the coast, one farmer has established about two acres of bamboo mainly for fencing and for interior decoration. In Malindi, also at the coast, one farmer has established about half a hectare of bamboo.

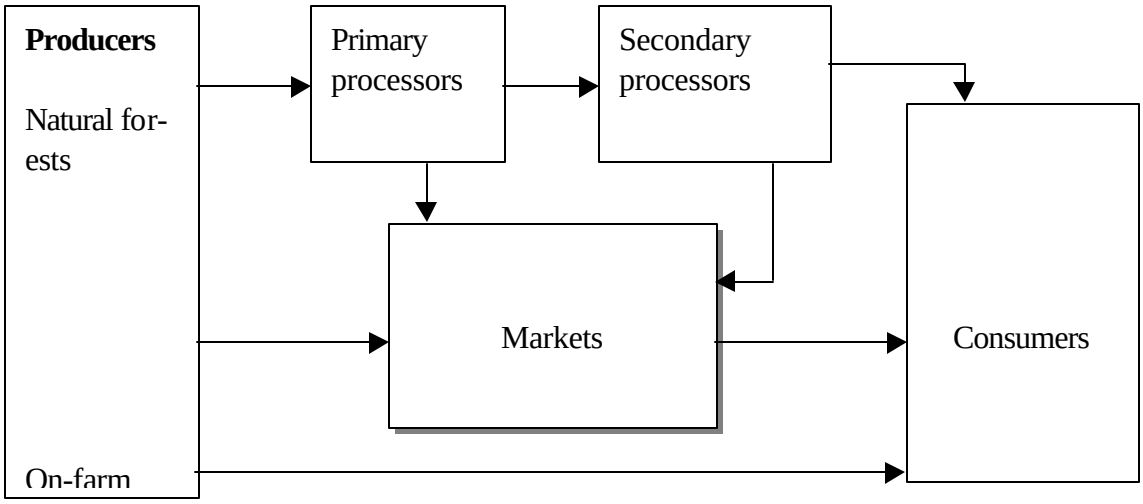

Fig. 4: Bamboo production to consumption in Kenya
Source: Modified from the Philippines PCS case study.

3.2. Processing/Manufacture

Most of the processing and manufacturing activities involving bamboo are very basic and use simple technologies. The different stages of the bamboo PCS are carried out independently in most cases, except at KAPI Ltd, which carries its own harvesting and processing of final products.. KAPI Ltd is an enterprise established in 1964 in Nakuru town that uses bamboo for the production of incense sticks. This company uses between 7 000 to 8 000 bamboo canes annually for incense stick production and more recently "fancy" items production for export markets. The company has acquired slitting machines for cutting bamboo into small pieces but finishing is still carried out manually using knives.

Apart from toothpicks, basketry, incense sticks, and fancy items which undergo basic processing and finishing, other bamboo products such as flower props and fencing materials are processed by splitting and cutting to size using machetes and knives. Faster and more efficient processing

technologies are therefore lacking and need to be developed to enable diversification and value addition of the products.

In the production of toothpicks and incense sticks women were mainly involved in secondary processing whereas men are involved in primary processing, harvesting and transportation for example. The male to female proportion of involvement in these bamboo activities was 72 : 28. In most of the areas visited the local people use alternative materials such as cypress off-cuts and *withies* for fencing. Napier grass and papyrus reeds provided alternative raw materials for the making of baskets and mats.

Plate 3: Processed flower supports in Naivasha

Plate 4: Processing of toothpicks in a Nairobi estate

3.3 Consumption / Utilisation

Bamboos are used on a small scale as plant supports in the horticulture industry, especially the flower industry around Lake Naivasha, as a raw material in the handicraft industry, and in the construction industry for fencing and interior decorations. They are also used as partitioning materials. Fencing uses about 74 % of all the bamboo harvested in the study areas, the flower industry 20 %, the construction industry 4 % and the rest of the sectors use about two percent. Table 6 shows the preference ranking of the different bamboo products.

Table 6: Preference ranking of different bamboo uses in different regions of Kenya.

Region	Fencing	Basketry	Bamboo shoots	Flower props	Toothpicks
Aberdares	1	3	5	2	4
Mt. Kenya	1	3	5	2	4
Mt. Elgon	1	3	5	2	4
Cherangani	1	2	4	5	3
Kiambu	2	4	5	1	3
Coast	1	2	5	4	3
Naivasha	2	4	5	1	3
Nairobi	1	4	5	2	3
Total	10	25	39	19	27
Overall rank	1	3	5	2	

*1 - Highest rank (most prevalent use); 5 - Lowest rank - (Least prevalent use)

In some areas such as Mt. Elgon, the local people use young bamboo shoots as vegetables and the processing is simple; by smoking and drying. The processing of these shoots has not attained the level of sophistication observed in imported canned shoots available in food stores in Nairobi and Mombasa. Toothpick production from bamboo is a well-established cottage industry in Nairobi and the surrounding area. The toothpicks normally find their way into other townships through middle-men. Most of the processing activities are done manually. Toothpick production uses small quantities of bamboo compared to other forms of use. The various uses of bamboo are shown in figure 4.

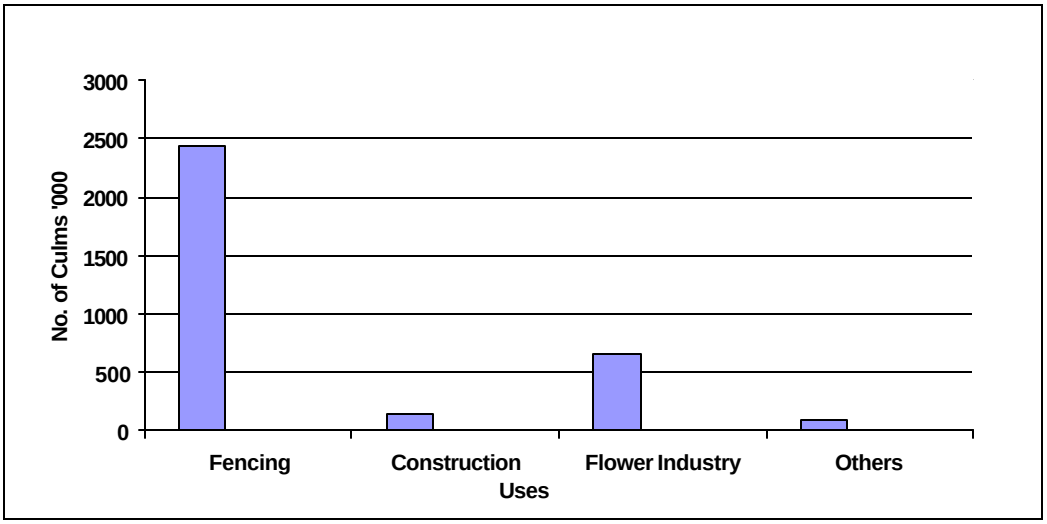

Fig. 5 Bamboo consumption for various uses
Source: Estimates from the study.

3.4 Costs and returns for selected bamboo processing activities

Table 7: Average daily wage rates (labour) prevalent in the study areas

District	Peak season	Low season	Average
Nakuru	150.00	120.00	135.00
West Pokot	80.00	60.00	70.00
Mt. Elgon	80.00	50.00	65.00
Trans-Nzoia	100.00	80.00	90.00
Kiambu	150.00	150.00	150.00
Nyeri	150.00	120.00	135.00
Malindi/Kilifi	120.00	110.00	115.00
Nyandarua	100.00	100.00	100.00
Keiyo-Marakwet	90.00	75.00	82.50
Uasin Gishu	120.00	100.00	110.00
Narok	80.00	60.00	70.00
Kakamega	120.00	110.00	115.00
Homa Bay	110.00	100.00	105.00
Siaya	100.00	100.00	100.00
Average	110.71	95.36	103.04

Source: Estimates from the study

3.4.1 Basketry

Baskets are used by the local communities for picking tea and for transporting it to factories. The baskets measure 2.5 feet in height with a basal diameter of 2 feet. Baskets are also used on a small scale in homes for storage. Basket production on a large scale was observed in Oleng'uruone and Kiambu districts and to a lesser extent in Nyeri District. Most of the individual basket makers did the weaving on their own. There were four basket producers in Oleng'uruone and seven in Kiambu. Three individuals were interviewed in Kiambu and one individual in Oleng'uruone area. Bamboo culms were purchased from the neighbours while individuals living close to natural forests could obtain the culms free by stealing. To make basket 3 culms, metal sheet for support are required. The basket maker also incurs costs of transport to the market. Each bamboo culm cost Ksh. 10 from the neighbours/farmers and Ksh.17 from the forest department. Forest department records indicate that an estimated total of 7 630 and 4 200 culms are used annually for basket production in Kiambu and Oleng'uruone districts respectively. Table 8 gives the financial analysis of a typical basket producer.

Table 8: Inputs and outputs analysis for a typical basket processor

Item	Amount – Ksh
Annual production capacity (no)	750
Annual income from bamboo	75 000
Purchase of culms	10 920
Annual costs on tools and materials	4 110
Labour	23 400
Total costs per year	38 430
Profit per year calculated on annual income from bamboo	36 570

Source: Estimates from the study

Plate 5: Tea picking baskets made out of bamboo in Kiambu

Basket makers do not cost most of the inputs in the enterprise. As a result of this, their production costs were estimated at 51 % of the total income from basketry. Labour has been estimated for 260 days at a rate of Ksh. 90 per day. Due to the difficulties involved in the acquisition of raw materials, especially bamboo culms, only a few people are employed in this sector. Most enterprises were comprised of family members, and each basket maker had, on average, a family of ten. Men dominate basket making, except for the occasional involvement of women in marketing. The main tools needed are knives of various sizes and a sharpener. Production is estimated at 750 baskets per year per producer made from 1,100 culms. Each basket retails at Ksh. 120 in Oleng'uruone and Ksh. 100 in Kiambu. The baskets are mainly sold at the point of production.

3.4.2. Toothpicks production

Toothpick production is mainly carried out around Nairobi and other major towns such as Eldoret, Kitale and Kapenguria. Most of the individuals involved in toothpick production do it on a part-time basis.

The process of toothpick production is manual. Production starts with crosscutting the culms and removal of nodes. Thereafter, the pieces are debarked, split, cut to size, sharpened and packed in bundles of either 100 or 200 using rubber bands, after which they are dispatched for sale. Packaging is carried out using manila and nylon papers.

The other products made besides toothpicks include skewers, chopsticks, ice cream pallets and bamboo spatula. These are made in relatively small quantities compared to toothpicks and are made to order. One toothpick enterprise reported production of 9 000 packets of 100 pieces of toothpicks, 4 400 packets of 50 pieces of skewers, 350 packets of 50 pieces of chopsticks and 350 packets of 50 pieces of ice cream pallets annually.

An average, toothpick production enterprises engage two full-time employees and five part-time employees. Full time employees earn about Ksh. 2 600 per month while part time employees earn Ksh. 1 800 per month. For some proprietors, part time employees are paid on a piecework basis i.e. Ksh. 3.00 for 100 toothpicks and Ksh. 7.00 for 100 skewers. Each toothpick producer uses about 1 800 bamboo culms per year. An estimated 27 000 bamboo culms per year are used countrywide in production of toothpicks and allied products. In Nairobi bamboo culms are purchased in various Hardware Stores. Prices per culm range from Ksh. 45 to Ksh. 60.

The toothpick producers preferred bamboo to other materials because of strength, durability and availability at affordable prices. The peak period for toothpick production is July - November (tourist season) while January - March is the off peak period. The profit margin for tooth pick producers is about 30 %. Most of the toothpick producers are un-registered as most of them operate in their backyards.

The main problems in toothpick production are mainly associated with the crude technology used for production. Manual operations are tedious, slow and often result in a lot of variation in quality of the products. This is a possible area for intervention to improve production capacity through acquisition of appropriate technology and improved quality of the products. Acquisition of culms through middlemen was found to increase the costs of production significantly (about 8 %), thus reducing the profit margins for the toothpick producers. It is necessary for the producers to acquire the culms directly from the forests or planters. More information on costs and benefits are presented in Table 9.

Table 9: Inputs and outputs analyses for toothpicks production

Item	**Amount – Ksh**
Income from bamboo	441 227
Cost	
Labour	127 868
Purchase of culms	90 837
Transport	18 013
Rent	45 200
Loans repayment	28 750
Marketing costs	6 752
Incentives to staff	4 000
Annual costs on tools and materials	3 678
Overheads	11 800
Total costs per year	323 730
Profit per year calculated on income from bamboo	117 495

3.4.3. Use of bamboo in the horticulture industry

Most of the horticulture companies are located in and around Naivasha town where 15 companies use bamboo to support a variety of flowers and vegetables in their greenhouses. Annual consumption is estimated at 663 750 culms, which is about 20 % of all the bamboo used in all the study areas. Use of bamboo in the horticulture industry has been declining in the last two or three years as the companies have switched to alternatives such as *withies* and plastics. The change to alternative materials is partly explained by the current ban on the use of bamboo and subsequent problems associated with the acquisition of special licenses. At the same time there has been a lot of pressure from conservationists that the companies use alternative materials.

Each company uses an average of 44 250 culms per year. The demand for use of bamboo in horticulture is expected to increase as the industry develops in other towns such as Eldoret, Kitale, Kericho, Nanyuki, Nairobi and Kiambu are expected to increase the demand for bamboo. Most of them have not started using bamboo at the moment.

Most of the bamboo collectors are landless and most have an average family of three. The collection process involves cutting, de-limbing and assembling at the point of collection. Twenty five per cent of the collectors reported earning less than Ksh. 1 000 per year, 25 % earned between Ksh. 1 000 and 3 000 while 50 % earned Ksh. 3 001 to 5 000. There were 30 collectors in the Aberdares forest alone of whom one half are involved in bamboo collection on a part time basis.

Plate 6: Bamboo supports in a flower farm at Naivasha

Culms are harvested and transported to the assembly point at a cost of Ksh. 5 per culm. In all cases, lorries are used for delivery to the companies in Naivasha. A lorry carries an average of 1 000 culms per trip and costs Ksh. 28 700 inclusive of royalty, transport charges, loading and off-loading costs and other fees. A financial capital of about Ksh. 19 million per year is required to meet the demand of all the flower companies. Most of these costs (about 90 %) are spent on purchase and transportation of culms. Bamboo culms are delivered to the company yard where tallying and processing are carried out. Each individual processes an average of 100 culms per day (crosscutting, splitting and finally tying in bundles as required) and earns Ksh. 1 800 per month. Table 10 shows costs and benefit of a typical supplier of culms to the horticulture industry.

Table 10: Cost and benefit analysis for a bamboo culms supplier

Item	**Amount Ksh**
Annual consumption (culms)	663 750
Sales – Ksh	19 912 500
Royalty	11 283 750
Lorry hire	4 646 250
Harvesting and assembly charges	2 655 000
Other expenses	464 625
Total expenses	19 049 625
Profit	862 875

3.4.4. Bamboo shoots

Production and consumption of bamboo shoots is mainly found in the Mt. Elgon area of Western Kenya. Bamboo shoots are sold in the surrounding towns such as Kitale and Kimilili as well as other market centres such as Chwele, Lwakhakha and Cheptais. Collection of bamboo shoots is carried out in May and June. On collection the shoots are sun-dried or smoked after which they are stored. Smoked and sun-dried shoots have a storage life of two years. There is normally stiff competition for bamboo shoots in the forest between humans and wild animals. On the average, 1,200 shoots are consumed annually in each of the market centres and towns. Selling price is on average Ksh. 12 per three shoots.

3.4.5. Fencing and construction

Fencing and construction use the largest number of bamboo culms annually compared to other uses. Fencing is predominantly used on farms for cattle paddocks and delineating farm boundaries and homesteads (Appendix 3). Bamboo for construction is mainly for interior design, building huts and granaries. In addition, institutions such as Kenya Army Barracks and Agricultural Society of Kenya use about 15 lorries annually. Bamboo fences are replaced once every three years. About 20 % of the forests adjacent households in Cherangani-Mt. Elgon and Timboroa-Nabkoi areas use bamboo in fencing and construction. On average 250 bamboo culms could fence an acre of land at a cost of Ksh. 2500. (at Ksh 17 per culm. In the Mt. Elgon, Kitale, Nabkoi and Timboroa areas, about 79 400 culms, 47 640 culms and 45 000 culms are used for the construction of huts, granaries and interior decoration respectively.

Plate 7: A newly constructed bamboo fence at Timboroa

3.4.6. Vertical integration in the bamboo sector.

Most bamboo processors are not integrated in their operations with the exception of KAPI Ltd, which specialises in the production of incense sticks. This company is currently diversifying its products to include "fancy" items for export markets. The rest of the other groups/individual specialise in the production of only one item. This can be dangerous if there is competition. Apart from the farmers who could produce baskets using bamboo from their own farms the rest of the other companies do not own their own bamboo plantations. Kaimosi Tea factory has is in the process of raising bamboo plantations for producing bamboo for tea picking baskets and furniture.

3.5. Marketing of the Bamboo Products

The bamboo products sold in the market include bamboo culms, bamboo shoots, toothpicks, meat skewers, baskets and incense sticks. In most of the study areas market forces determined the prices of raw bamboo. The Coastal region reported the highest prices of Ksh. 350 per culm. In Mt. Elgon area the price was Ksh. 5 for 3 pieces of bamboo shoots. Table 11 gives the summary of price variation among the identified bamboo products. The price was high along the

coastal region because of the Hotel industry. The royalty by the Forest Department for a culm of bamboo was Ksh. 17 in all the forest stations countrywide at the time of the survey.

Most respondents reported that about 75 % of the stems on every clump could be marketed. The rest were used for firewood because of poor quality. The number of clumps on the farms was varied but there is potential for growth if markets could be developed

Table 11: Price variation of selected bamboo products

Product	**Nairobi**	**Mombasa**	**Nakuru**	**Kisumu**	**Eldoret**	**Nyeri**
Culm	50.00	350.00	30.00	n.a	n.a	30.00
Toothpicks (100 pcs)	8.50	15.00	12.00	12.00	15.00	15.00
Baskets (1 unit)	120.00	n.a	120.00	n.a	n.a	100.00
6" Skewers (50 pcs)	25.00	25.00	22.00	22.00	n.a	n.a
Incense sticks (50 pcs)	30.00	45.00	50.00	50.00	30.00	40.00
Shoots (1 piece)	n.a	n.a	n.a	n.a	5.00	n.a

n.a – No data available

Source: Estimates from the study.

The major buyers of bamboo products are individuals small-scale users and hotels for interior design, flower industry for props, incense sticks industry and some are used as fishing rods, navigation tools, fish traps and racks.

3.6 Policy and Legal Considerations.

Utilisation of bamboo and bamboo products in Kenya has in the past seventeen years been mainly constrained by policy considerations. The survey carried out showed that most respondents were aware of the selective ban on exploitation of bamboo. The current ban on exploitation of bamboo seems to have outlived its usefulness. The resource only needed time to regenerate after which controlled exploitation could continue on a sustainable basis. Implementation of the government ban has resulted in conditions, which has encourage graft and corruption, making the bamboo resource available only to influential people and disadvantaging resource poor entrepreneurs.

Although government policies (ban on extraction and classification as a minor product) have hampered development of the bamboo sector, demand for bamboo products has ensured continuation of some activity within the sector. While influential users have continued using bamboo, no interests or efforts has been directed towards management of the resource despite existence of guidelines developed by KEFRI. Few people know of the existence of these guidelines. Since this ban is still in force, it will be important for alternative ways of producing bamboo to be developed. This could be done on the farms while waiting for a review of the ban. Establishment of on-farm bamboo plantation will be possible because some farmers in Nyandarua, West Pokot, Kiambu and Gede are already planting the resources on their farms.

Bamboo has immense potential and if harnessed can improve the livelihood of the rural poor and thereby enhance the contribution of the sector to the economy. The bamboo resources in both state forests and on individual farms are currently not managed properly. If the technical guidelines on the bamboo management developed by KEFRI are implemented, policy reviewed and awareness created, bamboo has a potential to contribute substantially to the welfare of Kenyans.

Insecurity and poor accessibility in some bamboo growing areas, encroachment of forestland by the forest adjacent communities are other factors that required proper policy and legislation. Re-classification of bamboo as a major forest product as opposed to the present classification as a minor forest product requires forest policy review.

The rules and regulations affecting bamboo harvesting are indicated in Box 1.

Box 1: Rules and Regulations for bamboo extraction from State forests

- There is no subletting or sub-contracting once a license has be granted;
- Road side bamboo and bamboo on protection sites should not be cut;
- Only mature bamboo should be cut on selective basis;
- Payments should be made before removal;
- Cutting and removal should be carried out during government working days/hours;
- Registration numbers of vehicles to be used in transporting bamboo should be provided to the Forester in advance;
- Authorising letter for the removal of bamboo is subject to scrutiny by the police and any other authorised officers;
- Movements permits should be issued by the District Forest Officer (DFO) or Forester and his deputy only;
- Bamboo should be removed only for the purpose stated in the authority letter;
- The authority is valid for six month only from the date of issue. The permit or authority becomes invalid after six months.

Source: MENR (1994).

ANALYSIS

CONSTRAINTS AND OPPORTUNITIES

The bamboo sector in Kenya is much more advanced than in the neighbouring countries Tanzania and Uganda. There are large natural stands of bamboo and there is a strong demand for fencing on cattle ranches and for poles in the flowering industry. Other users are craftsmen manufacturing basketry, and the tooth pick industry. Compared to most Asian countries Kenya's bamboo sector is still very young. A number of constraints are hampering a steady development of the sector:

- A current ban on the exploitation of bamboo resource
- classification of bamboo as a minor forest product
- lack of organisation among the various user groups
- lack of recognition of the sector in the national economy
- lack of awareness on the potentials of bamboo
- production of semi-processed or unprocessed products
- poorly developed marketing structures
- lack of information on availability of planting materials
- lack of information on propagation, establishment, crop management and harvesting methods
- poor infrastructure in bamboo growing areas
- lack of appropriate technologies in processing.

The Forestry Department has issued a ban on the exploitation of bamboo since 1982, allowing only bamboo harvesting from state forests with a special license. However, there are no indications of an overall depletion of bamboo resources that could justify a total ban on bamboo. Moreover, most of the actual bamboo cutting is illegal. A rough calculation of the figures of the actually-used bamboo and the officially-harvested bamboo shows a difference of 88%, which means that a large part of the bamboo used in Kenya is illegally harvested. Therefore, a gradual easing of the ban could have a positive effect on the development of the bamboo sector. It should be replaced by a general management plan for bamboo resources in the country that takes into account the growth rate of bamboo and the fact that regular cutting stimulates the growth and increases productivity. Simultaneously, a program that stimulates on-farm bamboo planting should be put in place in order to increase the supply of bamboo from private land and gradually evolve towards bamboo plantations on a community level.

The majority of the bamboo is used for fencing and the poles are used without proper treatment and, consequently, fences need to be replaced after an average lifetime of only three years. Thus, a basic treatment of the bamboo culms could improve durability and the added-value could improve the relatively low incomes of the collectors (they earn an average of 12 US$ from bamboo annually). At the same time, the higher costs of treated bamboo for buyers would be compensated by the extended durability of the bamboo poles and fences.

KEFRI has developed management guidelines both for natural stands of bamboo and on-farm bamboo planting but these have not been applied. This may be due to lack of quantitative information on costs and benefits in bamboo production. Lack of established commercial value attached to bamboo in some areas is also a major reason for the non-utilisation of the management guidelines developed by KEFRI. Field observations indicated that no management regimes (propagation, establishment, management and proper harvesting techniques) are applied in bamboo production. The application of the guidelines will enhance sustainable utilisation of the resource and may help ease the ban on bamboo harvesting.

Most of the products are made manually e.g. toothpicks. It is important to introduce technologies aimed at improving the production capacity. One area where this could be done is in the toothpicks industry where processes like splitting cross cutting and finishing could be done by machine to improve production and add value to the products.

The user groups need to be organised and educated on the importance of bamboo processing and marketing. The manufacturers/users could be organised into groups based on their localities for better marketing of their products. For example, raw bamboo is directly delivered to the flower companies rather than processed products. Basket producers make and market their products individually. Some of the manufacturers get free bamboo from the wild while others buy their raw materials from neighbours to make baskets. The basket makers, who steal raw materials, sell their end products cheaply and thus under cut, the genuine basket makers who buy their raw materials.

Bamboo shoots are collected in Western Kenya around Mt Elgon and used as a vegetable. The shoots are sun-dried and smoked, but the finished product does not have the same quality as the canned shoots sold in Nairobi and Mombasa. Therefore, improving the processing of the shoots could upgrade quality and enable this national product to compete with the imported shoots. The existence of a market for shoots opens opportunities for Kenyan shoots to become a new sector that generates income for the people (mainly women) involved in their harvesting, smoking and trading.

POTENTIAL ACTIVITY MODELS

The recommended interventions include technical training to all stakeholders to sensitise them over the potentials of bamboo, introduce of incentives (loans, subsidies, etc), lift the ban on bamboo from state forests and instead carry out extraction on a sustainable basis, and establishment of demonstration or model bamboo growing households and enterprises to improve on supply, improve markets and provide market information and improve roads in bamboo growing areas, sensitise the communities on the benefits of integrated production systems to maximise markets.

These interventions should initially target farmers who already have some experience and exposure in bamboo production. In so doing it is also important to take cognisance of the fact that bamboo production forms only part of the income generating activities by the farmers. Appendix 4 gives the logical framework for Kenya.

- Awareness creation and training of stakeholders on the potentials of bamboo, need to encourage on-farm bamboo plantations, improve on roads, make budgetary allocations to manage bamboo resource. An investment appraisal of on-farm bamboo establishment indicates that the investment has an internal rate of return (IRR) of 25 % and a cost benefit ratio (CBR) of 2.47 under local conditions. This support the view that on-farm bamboo growing can be viable intervention (See appendix 5);

- Policy and legislative reforms to lift the ban, improve management regimes, classify bamboo as a major product need to be put in place;

- Dissemination of KEFRI guidelines to improve on propagation, establishment, management, and harvesting techniques. This will involve both the farmers and government staff charged with the responsibility of managing natural bamboo stands;

- Establishment of on-farm bamboo plantation for supply of bamboo shoots, fencing and construction materials to alleviate the current short supply from natural forests. This will involve facilitating the farmers to achieve this goal;

- Technology improvement in the handicraft (artisan) industry: fancy items, toothpicks, and baskets. This involves importing machines or working closely with informal sector to produce the necessary machines. Investment appraisals of toothpicks and basketry model enterprises indicate that the investments have respectively IRR of 46 %, 100% and CBR of 2.55, 2.09 under local conditions. This supports the view that the two enterprises are viable interventions likely to have a positive impact on improving the livelihoods of the local entrepreneurs (See appendix 5 and 6).

- Organising the bamboo collectors and other bamboo users especially those supplying the Flower (Horticulture) industry with a view to improving income realised from bamboo sales and harvesting - Naivasha Case study.

CONCLUSION AND RECOMMENDATIONS

Estimates for the total bamboo area in Kenya are a total of 150,000 ha of *Arundinaria alpina* concentrated in the highlands of which 70, 000 ha are pure stands. The consumption of bamboo requires the cutting of only a few thousand hectares per annum and can not cause a threat for depletion considering the rapid growth rate of bamboo. Most of the bamboo stands are in state forests with adjacent communities depending directly or indirectly on this resource for their livelihoods i.e. subsistence and income. Most of the bamboo collected from both state forests and farms is used for fencing (74%) and in the flower industry for flower poles (20%). Naivasha town is the center of horticulture companies and consumes 20% of all the bamboo in Kenya. The remaining commercial utilisation of bamboo is concentrated in the production of toothpicks and incense sticks.

A major constraint for the development of the bamboo sector is the short supply of bamboo from state forests as a result of the government ban on the utilisation of the resource. Other problems are the poor infrastructure, poor processing techniques, poorly developed marketing structures and lack of alternative sources.

The following interventions have thus been recommended in the short run: establishment of on-farm bamboo plantations, provision of new technologies for toothpick producers and provision of financial support to the basket producers through credit facilities. It is expected that these interventions will bring about efficient utilisation of the bamboo resource, financial empowerment to the local communities, improved supply of raw material and introduction of improved technology.

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Appendix 1a: Bamboo collectors

Date of Interview:.....
Interviewed by:.....
Checked by:.....

GENERAL:

1. Name:.....
2. Address:.....
3. Educational Attainment [<Std VII] [Std VII] [Form IV] [>Form IV]
4. Gender [M] [F]
5. Household size: .....
6. Number and gender of household members involved in bamboo collection

Task>				
Male				
Female				
Children > 10 yrs				
Children < 10 yrs				

7. Type of activities engaged in by each (See table above)
8. Annual income from bamboo collection [< 1000] [1000 - 1999] [2000 - 2999] [3000 -4999] [>5000]
9. Other sources of income (specify) [SALARY] [FARMING] [DAIRY] [BUSINESS]
10. Total area of land owned [< 5 ACRES] [5 - 10 ACRES] [10 - 15 ACRES] [> 15 ACRES]
11. Do you have bamboo in your farm? [Y] [N]. If yes, Proportion of land covered by bamboo:
12. Is there any cultivation/management of the wild resource?
    If so, describe:
13. Who owns the land from where bamboo is harvested [STATE] [COMMUNITY] [PRIVATE]
14. Do you pay royalty, commission, or tax on the area harvested? [Y] ..... [N]
    How much was paid per year, and to whom? [Kshs. .....] [To. .....]
    What is your opinion of the level of payment?: .....

COLLECTION:

15. Number and duration of collection trips in a month: .....
16. Mode of transportation: .....
17. Cost and source of finance for wild bamboo collection: Cost.....Source.....
18. How far from the point of assembly is the bamboo found?: .....km
19. Average number of persons in the collection team:.....
20. Describe the bamboo collection process: .....
21. What tools and inputs are required for bamboo collection?

Item/Input	QTY	Unit cost	Total amount	Remarks
Panga				
Saws				
File (Sharpener)				
Others (specify)				

22. Season/months when bamboo collection is carried out: .....

23. Quantity of raw bamboo collected per trip (No. of culms).....
24. Cost of cutting and de-limbing per culm:.....
25. Cost of transport to the assembly point per culm; Ksh.....
26. What are the species/varieties of bamboo collected?: .....
27. State the average length [.....].diameter[.....] and wall thickness [....] of bamboo culms collected.
28. How much of the bamboo must be rejected at the point of assembly?(No. of culms):.....
    For what reasons? [IMMATURE] [DAMAGE] [SIZE]
29. Is any of the raw bamboo collected used for your household?: [Y] [N]
    How much? (No. of culms):.....
    How is it used?.....
30. What are main factors affecting the volume of bamboo harvested?:.....

COSTS/ REVENUES:

31. Distance from site to point of delivery.....km.....m
32. Transportation cost to/from site: To site.....From site.....Total.....
33. Food costs:.....
34. Tools/other inputs: (Table below)

Item/Input	QTY	Unit cost	Total amount	Remarks
Panga				
Saws				
File (Sharpener)				
Others (specify)				

35. Payment to hired help/field guides: Kshs.....
36. Fees, access taxes, royalties, commissions, etc. per collection trip: Ksh.....
37. Miscellaneous expenses Ksh.....
38. How much does each raw bamboo culm sell for? Ksh.....
    Who are the buyers?.....
    Where? (be sure to specify all locations, with geographic directions if necessary)
    .....
39. How much income do you make per trip from sales of raw bamboo? Ksh.....
40. What is your opinion of the income you realise through bamboo collection?:.....

PROCESSING:

41. Do you carry out any processing activities on the raw bamboo? [Y] [N]
    If yes, specify type and describe process.....
42. What are the inputs and tools required for this processing?.....
43. What are the costs incurred for this processing ? (per culm). Ksh.....
44. How much does the processed bamboo sell for? (per culm) .....
    To whom?.....
    Where? (be sure to specify all locations, with geographic directions if necessary)
    .....….
45. How much income do you make per trip from sales of processed bamboo?: Ksh.....
46. What are the end products made from the bamboo that you harvest?.....
47. Where are they sold? (specify all locations, with geographic directions if necessary).....
48. Who are the buyers?:.....

Appendix 1b: Bamboo planters

Date of Interview:.....
Interviewed by:.....
Checked by:.....

(I). GENERAL:

1. Name:.....
2. Address:.....
3. Educational Attainment [<Std VII] [Std VII] [Form IV] [>Form IV]
4. Gender:
5. Household size:
6. Number and gender of household members involved in bamboo plantation activities

Task>				
Male				
Female				
Children > 10 yrs				
Children < 10 yrs				

7. Type of activities engaged in by each: (Table above)
8. Annual income from bamboo plantation activities: Ksh.....
9. Other sources of income (specify below):

Source	Income (Ksh.)
1.	
2.	
3.	
TOTAL	

10. Total area of arable land in your farm:.....
11. Percentage of arable land covered by bamboo plantation:.....
12. Proportion of bamboo plantation that is harvested each year:.....
13. Area of bamboo plantation that is established each year:.....
14. Time required for bamboo to reach harvestable maturity:.....
15. Describe how the bamboo is cultivated/managed in the plantation:.....
16. What are the tenurial arrangements on the harvested bamboo land ?
    [PRIVATE] [LEASED] [SQUATTER]
17. How long is the period of contract?:.....
18. Do you yourself own any of the bamboo under plantation? [Y] [N]
    If yes, state area owned:.....
    If no, do you pay any royalty, commission, or tax on the area harvested? [Y] [N]
    How much is paid per year, and to whom?.....
    What is your opinion of the level of payment?.....

19. Costs:

NURSERY PHASE

Activity	**No. units**	**Price/unit**	**Total cost**	**Comment**
Seed procurement				
Seed treatment				
Potting soil				
Maintenance: Watering Fertiliser Pesticide Weeding				
Infrastructure				
Tools/equipment				
Other (specify)				
Sub-total				

PLANTATION PHASE

Activity	No. units	Price/unit	Total cost	Comment
Surveying/ blocking				
Land preparation strip clearing ring weeding holing				
Planting/sampling Inventory/ replanting				
Maintenance: Watering Weeding Fertiliser Pesticide				
Infrastructure				
Tools/Equipment				
Other (specify)				
Sub-total				

HARVESTING PHASE

Activity	No. units	Price/unit	Total cost	Comment
Labour				

Tools/equipment				
Other				
Sub-total				

20. Revenues from bamboo plantation

Product	No. units produced	Sale price /unit	Total reve-nue	Comment
Raw bamboo culms				
Other (specify)				
Sub-total				

21. What is your opinion of the income you realise through bamboo plantation?:.....
.....
22. What is the annual (allowable) cut?:.....
How well is this enforced?:.....
23. Distance from cutting area to settlement area:.....
Distance from cutting area to point of assembly:.....
24. Method of transportation of bamboo from cutting area to assembly point [MANUAL] [BICYCLE] [TRUCK] [OTHERS]
volume transported per trip (No of culms):.....
amount spent per trip (Ksh.):.....
25. Who are the planters? [FOR FAMILY] [FOR ORGANISATIONS] (delete one)
Number of members:.....
Number of non-members:.....
Number of female planters. What kind of activities?.....
Number of children involved. What kind of activities?.....
27. Season/month of the year when harvesting is at its lowest
[WET SEASON] [DRY SEASON] Months:.....
28. Are quotas given to the planters? [YES] [NO]
If yes, how much (in Ksh. equivalent)?: Ksh.....
29. What are the main factors affecting the volume of bamboo production? List.....
30. Describe how the bamboo is harvested:.....
31. What tools are used?:

Tool	Purpose(s)

32. How much bamboo ends up being rejected? (No. of culms):.....
For what reasons? [IMMATURE] [DAMAGE] [SIZE]
33. How much of the bamboo ends up being used for your home? (No. of culms):.....

34. If possible, would you choose to invest in a bamboo plantation? [YES] [NO]
    If yes, where would you get the necessary capital?:.....
[Bank loan]
[Rural co-operative society]
[Borrow locally]
[Own savings]
[other sources]
    If no, why?.....
35. What are some of the problems encountered in a bamboo plantation?:.....
36. How are the prices for the raw bamboo determined?:.....
37. To whom and where do you sell the raw bamboo? (be sure to specify all locations, with geographic directions if necessary):.....
38. Do you have any marketing contracts with the buyers of your raw bamboo? [YES] [NO]
    If so, what are the terms?:.....
39. What are the end products made from the bamboo that you harvest?:.....
40. Where are they sold? (be sure to specify all locations, with geographic directions if necessary)
    Who are the buyers?:.....

PROCESSING:

41. Do you carry out any processing activities on the raw bamboo? [YES] [NO]
    If yes, specify type and describe process:.....
42. What are the inputs and tools required for this processing?:.....

Tools/other inputs:

Item/Input	QTY	Unit cost	Total amount	Remarks
Panga				
Saws				
File (Sharpener)				
Ropes				

43. What are the costs incurred for this processing?: Ksh.....
44. How much does the processed bamboo sell for?: Ksh.....
    To whom?:.....
    Where? (be sure to specify all locations, with geographic directions if necessary)
45. How much income do you make per culm?: Ksh.....

What are the end products made from the bamboo that you harvest?:.....

Who are the buyers and their locations? (be sure to specify all locations, with geographic directions if necessary):.....

Appendix 1c: Processors/manufacturers

Date of Interview:
Interviewed by:
Checked by:

Questions for Labour Force

GENERAL:

1. Name
2. Address
3. Educational Attainment: [<Std VII] [Std VII] [Form IV] [>Form IV]
4. Gender: [M] [F]
5. Household size:
6. Number and gender of household members involved in bamboo processing

	M	F	Children <10
Cutting			
De-limbing			
Carrying			
Arranging			

7. Type of activities engaged in by each:
8. Monthly/daily remuneration:
9. Primary source of income:
   Estimated monthly income
10. Position in the company:
11. Nature of employment [APPRENTICE][CONTRACTUAL][CASUAL][PERMANENT]
12. When were you employed?:
13. Employment terms (specify below)

Weeks/month		No. months	Wage/month
	Full-time		
	Part-time		
	Sub-contract		
	Piece-wise		

14. Does your employer provide any other benefits?: [Y] [N]
    If yes, state:

LABOUR INPUT

15. Hours worked per day:
16. Number of days/week that processing/manufacturing takes place:
17. When is processing/manufacturing at its peak?: Its low point?
18. What are the tools/equipment used?

Tool	Purpose(s)

19. Where did you train in the processing techniques?:
    For how long?:

Were you an apprentice?:

Did your master contractually employ you afterwards?:

20. How long does it take to become independently established?:

Appendix 1d: Questions for proprietors

GENERAL:

1. Name
2. Address
3. Age
4. Gender [M] [F]
5. Estimated total annual income (from all sources):
6. Estimated annual income from bamboo processing:
7. Is the enterprise registered? [Y] [N]

If so, with whom?

8. Type of product made and volume of production (specify below):

Product	Low volume	Medium	High

9. Labour employed:

	Number of employees	Wage paid
Full-time		
Part-time		
Sub-contract		
Piece-wise		

10. Sources of inputs:

Name of supplier	Location of supplier	Volume of purchase	Unit price paid	Method of payment

11. Input cost structure (examine income statement of the enterprise if possible)

	Activity:	Activity:	Activity:	Activity:
Raw materials, with unit cost				
Labour cost				
Land/Workshop rent				
Transportation cost				
Equipment, list with unit cost				
Interest on loans				
Taxes, overheads				
Other fees/levies paid				

12. Where do you obtain your capital investments?

Name of source	Location of source	Amount of principal	Interest rate	Repayment period

13. Outputs from processing/manufacturing:

Product	Quantity	Price received	Sold to	Location of buyer

14. Have you encountered problems in processing/manufacture bamboo products?: [Y] [N]
    If yes, specify:
15. Has the enterprise ever had a need for technical assistance?: [Y] [N]
    If so, where do you go?:
    How much do you pay?:
16. Pricing scheme:
    Who sets the price?:
    What is considered in price setting?
17. Are women involved in the enterprise?:
    If so, in what capacity?:
    How do they perform compared to their male counterparts?:
18. Do you involve children?: [Y] [N]. If so, in what capacity?
19. What are the problems encountered in the following activities:

Procurement:
Problems solutions

Processing:
Problems solutions

Marketing:
Problems solutions

Appendix 1e: Bamboo product retailers (in market centres)

Date of Interview:
Interviewed by:
Checked by:
GENERAL:

1. Name
2. Address
3. Educational Attainment [<Std VII] [Std VII] [Form IV] [>Form IV]
3. Gender [M] [F]
4. Number and gender of household members involved in bamboo retailing

	M	F	Children <10

5. Annual income from bamboo product sales:
6. Other sources of income (specify)
7. How long have you been selling bamboo products?
8. Which bamboo products do you sell?:
9. What other non-bamboo products (used as alternatives) do you sell?:
10. Supply/costs of bamboo products:

Product	Quantity purchased	Supplier	Location of supplier	Unit cost of product	Terms of purchase

Do you have any special arrangements with the suppliers of your bamboo products?

11. Sales/revenue of bamboo products:

Product	Quantity sold	Type of buyer (household, business, bulk, tourist)	Sales price of product	Revenue from product	Comment

12. What proportion of your total sales are from bamboo products?:
13. How do bamboo products compare to other products in profitability?:
14. What is the consumer's perception of the quality of bamboo products?:
15. What comments do you have on the quality of bamboo products?:
16. What trends have you observed in:
    Demand for bamboo products:
    Cost:
    Type of bamboo products being made:
17. What other bamboo products do you think could be produced?:
18. What problems are there in selling bamboo products?:
19. Are you involved in any other stage in the production/processing/transportation of bamboo products?: [y] [n] If yes, what stage?.

Appendix 1f: Consumer of final bamboo products

1. What bamboo products have you purchased recently?:

2. What bamboo products do you have in your home?:

3. What do you use bamboo for?:
4. How do bamboo products compare to similar products not made from bamboo?:
   In quality:
   In price:
   In length of useful life:
   In attractiveness:
5. Do you feel that you get good value for the price that you pay for bamboo products?:
   [Y] [N]:
   If no, please explain.

6. What other products would you like to see made from bamboo?:

7. As a consumer, what improvements in bamboo products do you think would be beneficial?

Appendix 2: Names of villages and number of individuals interviewed

Region	Village/location	Managers	Producers*	Collectors	Processors 1*	Consumers*	Total
Coast	Gede	5	9	2	10	11	
	Malindi	_	2	_	3	6	
	Mombasa	1	1	_	2	7	
	Mazeras	_	2	_	0	2	
	Kibwezi	2	2	_	2	2	
	Muthinaini	_	1	_	0	1	
	Sub-total	8	17	2	17	29	73
Western	Kakamega	1	0	2	0	2	
	Kaimosi	1	1	_	2	1	
	Vihiga	1	1	_	0	1	
	Secheno	1	2	_	2	2	
	Sub-total	4	4	2	4	6	20
Mt. Elgon	Kitale	3	3	1	3	3	
	Kimothon	1	2	3	2	3	
	Kimilili	_	1	_	1	2	
	Kapsokwony	5	5	3	3	3	
	Chepyuk	_	0	2	2	2	
	Saboti	1	1	_	0	1	
	Sosio	3	3	_	1	3	
	Sub-total	13	15	9	12	23	72
Cherengani	Kapenguria	2	2	0	2	2	
	Makutano	_	0	0	0	1	
	Kapcherop		2	0	2	2	
	Lelan	1	1	3	4	7	
	Eldoret	1	1	_	0	9	
	Iten	1	1	_	0	1	
	Kessup	1	1	_	0	0	
	Timboroa	1	2	1	1	2	
	Nabkoi	1	1	_	0	2	
	Sub-total	8	11	4	9	26	58
Mau	Bomet	1	1	_	0	1	
	Elburgon	2	2	_	0	2	
	Nyangores	1	1	_	0	1	
	Nakuru	1	1	_	4	15	
	Olenguruone	2	1	_	1	1	
	Sub-total	7	6	0	4	21	38
Nyanza	Maseno	1	1	_	0	1	
	Kisumu	_	0	_	0	4	
	Nyabeda	_	1	_	0	1	
	Siaya	1	1	_	1	3	
	Homa Bay	2	2	_	2	4	
	Sub-total	4	5	0	3	13	25
Central	Naivasha	_	0	2	9	12	
	Geta	1	7	_	_	_	
	Kiandogoro	2	_	3	_	_	
	Gathiuru	2	_	1	_	_	
	Githunguri	_	_	1	1	3	
	Kamae	1	_		_	_	
	Nyeri	1	_	_	_	_	
	Ol kalau	2	_	_	_	_	
	S. Kinangop	4	_	1	_	_	
	Subtotal	13	7	8	10	15	53
Total		57	65	25	59	133	339

Note: Some respondents appear in more than one stage (*) of bamboo PCS, all supermarkets have been categorised as consumers. Processor 1 refer to primary processors while processor 2 refer to secondary processors

Appendix 3: Reported uses of bamboo

No.	Uses	Area
1	Fencing	All
2	Construction (Trusses)	Malindi,
4	Forage	Timboroa, Cherangani
5	Basket making	Oleng'uruone, Kiambu and Nyeri
6	Firewood	All
7	Tooth picks and skewers	Nairobi, Kakamega, Cherangani & Eldoret
8	Gutters for water collection	Cherangani and Aberdares
9	Making beds	Cherangani and Mt. Elgon
10	Smoking bees	Cherangani
11	Medicine for malaria	Cherangani, Mt. Elgon and Mau
12	Lighting	Cherangani
13	Bee hive making	Cherangani
14	Stakes	Mt. Elgon, Mt. Kenya and Aberdares
15	Incense sticks manufacture	Nakuru
16	Shoots for food	Mt. Elgon
17	Roofing	Aberdares
18	Breakfast set and curtain roller	Nakuru
19	Wine glass and pipe	Malindi
20	Pencil holders	Nakuru
21	Bread rack	Nakuru
22	Fish trap	Malindi
23	Interior decoration	Nakuru, Malindi and Nairobi
24	Fishing rod	Malindi
25	Nursery beds	Aberdares, Mt. Kenya, Timboroa
26	Flute	Mt. Kenya
27	Arrow sticks	Mt. Kenya and Oleng’uruone
28	Making granaries	Cherangani and Mt. Elgon
29	Making huts	Cherangani, Aberdares and Mt. Kenya
30	Water catchment conservation	All
31	Ornamental	Malindi, Nairobi, Vihiga & Siaya
32	Bird traps	Malindi
33	Lamp shades	Malindi
34	Drumstick	Kakamega
35	Wind break	Malindi, Kakamega, Vihiga & Siaya
36	Shade	Malindi, Kakamega, Vihiga & Siaya
37	Rugby goal posts	Malindi
38	Poll vault poles	Malindi
39	Butterfly traps	Malindi
40	Butterfly cages	Malindi
41	Navigation pole in Dhows	Malindi
42	Cleaning pole for dams and pools	Kibwezi
43	Ship carvings	Nairobi

44	Ice cream pallets	Nairobi
45	Chop sticks	Nairobi
46	Bamboo Spatula	Nairobi
47	Ash trays	Nairobi
48	Chairs	Nairobi
48	Sugar dishes	Nairobi

APPENDIX 4: BAMBOO LOGICAL FRAMEWORK IN KENYA

Activity	Findings (Indicators)	Constraints	Causes	Interventions	Output
Production (cultivation)	99.4% of bamboo found on state forest (150 000 Ha)	Shortage of raw materials	Policy (ban on harvesting of bamboo from public forests)	Demonstration of good management of bamboo resource	Increase in supply of bamboo from natural stands
				Encourage on farm bamboo production	Increase in supply of bamboo from farms
	Only 0.14 ha under bamboo per household in study areas	Limited land size	Policy and population	Leasehold arrangements with the government	More on-farm bamboo resource
	Poor state of natural stands	Lack of management guidelines for natural stands of bamboo	Classification of bamboo as minor forest product (Institutional)	Create awareness on the importance of bamboo to resource managers and policy makers	Improved state of natural stands
	Only 0.6 % of bamboo on farms	Lack of financial resources to support on farm production	Low income level	Encourage formation of local bamboo growers associations Establish credit fund for bamboo production	Increased on farm bamboo
	Poor state of harvested stands	Poor harvesting techniques	Education, financial and Institutional factors	Provide training and supervision Improve efficiency in harvesting	Improved harvesting practices
Processing	All operations manual	Lack appropriate technology	Technology not available locally	Avail appropriate processing technology(Technology transfer) Exposure tour for selected processors Improve efficiency in processing	Improved product quality and output
	Lack of business records	Lack appropriate skills	Educational (Apprenticeship)	Training on apprenticeship skills	Available records
	Processing at point of use	Lack of value addition at point of production	Lack of appropriate tools and equipment	Awareness creation for value addition and diversification of products Provide financial Support	Processed products at source
	Existence of temorary sheds	Lack of permanent business premises	Financial	Provide credit facilities for construction/ improvement of business premises	Permanent sheds available
Marketing	Localised consumption patterns of bamboo products e.g. baskets	Lack of marketing information	Institutional Lack of entrepreneurship skills	Establish Marketing information system Train on business skills e.g. costing Create awareness through market reports	Widened markets and Increased sales

Appendix 5 PCS farm model

APPENDIX 5: **INBAR PCS Farm Model**

Country name: **Kenya**
Model title: **On-farm bamboo plantation**

A. PARAMETERS

Local currency unit: Ksh

		unit time
Interest rate - working capital (without project)	10%	years
- working capital (with project)	22%	years
- fixed capital (without project)	10%	years
- fixed capital (with project)	22%	years
Loan period (months) - working capital (without project)	12	months
- working capital (with project)	36	months
- fixed capital (without project)	12	months
- fixed capital (with project)	36	months

B. FIXED CAPITAL

		WITHOUT PROJECT			WITH PROJECT																				
		Y1-Y7			Y1			Y2			Y3			Y4			Y5			Y6			Y7		
Item	unit	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total
Land																									
Lease	Ha			0	1	10,000	10,000	1	10,000	10,000	1	10,000	10,000	1	10,000	10,000	1	10,000	10,000	1	10,000	10,000	1	10,000	10,000
						0				0		0			0	0		0	0		0	0		0	0
Tools/machinery																									
Jembes	No.			0	2	200	400			0			0			0			0			0			0
Panga	No.			0	2	150	300			0			0			0			0			0			0
Saw	No.			0	1	150	150			0			0			0			0			0			0
Total				0			10,850			10,000			10,000			10,000			10,000			10,000			10,000
							0			0			0			0			0			0			0
Average operating life	5																								

C. OPERATING COSTS

		WITHOUT PROJECT			WITH PROJECT																				
		Y1-Y7			Y1			Y2			Y3			Y4			Y5			Y6			Y7		
Item	unit	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total
Labor																									
Slashing/removing debris/burning	Ha			0	1	2,000	2,000			0			0			0			0			0			0
Land preparation	Ha			0	1	5,500	5,500			0			0			0			0			0			0
Weeding	Ha			0	1	1,500	1,500	1	1,500	1,500	1	1,500	1,500			0			0			0			0
				0			0			0			0			0			0			0			0
Raw materials																									
Seedlings	No.			0	400	45	18,000			0			0			0			0			0			0
DAP	No.			0	5	1,200	6,000			0			0			0			0			0			0
CAN	No.			0				5	1,200	6,000	5	1,200	6,000			0			0			0			0
Total				0			33,000			7,500			7,500			0			0			0			0

D. REVENUE

		WITHOUT PROJECT			WITH PROJECT																				
		Y1-Y7			Y1			Y2			Y3			Y4			Y5			Y6			Y7		
Item	unit	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total
Culms	Culm			0			0			0			0	2,400	20	48,000	3,600	20	72,000	3,600	20	72,000	2,400	20	48,000
																0			0			0			0
Total				0			0			0			0			48,000			72,000			72,000			48,000
																0			0			0			0

E. CASH FLOW PROJECTIONS

thousand currency units

	WITHOUT PROJECT	WITH PROJECT						
	Y1-Y7	Y1	Y2	Y3	Y4	Y5	Y6	Y7
INFLOW								
Sale revenues	0.00	0.00	0.00	0.00	48.00	72.00	72.00	48.00
INBAR - fixed capital		8.68						
- working capital		26.40	-1.00					
Loan - fixed capital	0.00	2.17						
- working capital	0.00	6.60	-0.25					
Enterprise contribution	0.00	0.00	8.75	17.50	10.00	10.00	10.00	10.00
Total inflow	0.00	43.85	7.50	17.50	58.00	82.00	82.00	58.00
OUTFLOW								
Fixed capital	0.00	10.85	10.00	10.00	10.00	10.00	10.00	10.00
Operating costs	0.00	33.00	7.50	7.50	0.00	0.00	0.00	0.00
Total outflow	0.00	43.85	17.50	17.50	10.00	10.00	10.00	10.00
Cash flow before financing	0.00	0.00	-10.00	0.00	48.00	72.00	72.00	48.00
Debt service								
Loan repayment - fixed capital	0.00	0.72	0.72	0.72	0.00	0.00	0.00	0.00
- working capital	0.00	6.60	-0.25	0.00	0.00	0.00	0.00	0.00
Interest on - fixed capital	0.00	0.48	0.48	0.48	0.00	0.00	0.00	0.00
- working capital	0.00	4.36	-0.17	0.00	0.00	0.00	0.00	0.00
Total debt service	0.00	12.16	0.79	1.20	0.00	0.00	0.00	0.00
Cash flow after financing	0.00	-12.16	-10.79	-1.20	48.00	72.00	72.00	48.00
Retained for investment	0.00	8.75	17.50	10.00	10.00	10.00	10.00	
Disposable income	0.00	-20.91	-28.29	-11.20	38.00	62.00	62.00	48.00

F. FINANCIAL ANALYSIS

Return on total capital employed								
Income from sales	0.00	0.00	0.00	0.00	48.00	72.00	72.00	48.00
Cash outflow	0.00	50.45	17.25	17.50	10.00	10.00	10.00	10.00
Net cash flow	0.00	-50.45	-17.25	-17.50	38.00	62.00	62.00	38.00
Internal rate of return		25%						
Discounted cash inflow			225.79					
Discounted cash outflow			91.29					
Net Present Value		134.50						
Benefit/Cost ratio		2.47						

ASSUMPTIONS REGARDING FINANCING

INBAR:
80% of fixed capital (1st year)
80% of working capital (1st year)
80% times 50% (working capital plus fixed capital) (2nd year)

Loan:
20% of fixed capital (1st year)
20% of working capital (1st year)
20% times 50% (working capital plus fixed capital) (2nd year)

ASSUMPTIONS REGARDING CALCULATIONS IN THE MODEL

One hectare will yield 12 000 marketable culms as from four years
Harvesting plan will 20%, 30%, 30% and 20 % at year four, five , six and seven respectively
Farmers whoo reside near sate forests will be allowed to lease land
The farmers will sell their culms at a commercial rate of Ksh. 20 which is slightly higher than the current governments rates of Ksh. 17

Retained for investment (borrowers contrib):
50 % (working capital + fixed capital) (1st year)
100% (working capital + fixed capital) (subsequent years)

Appendix 6: Basketry Model

APPENDIX 6: INBAR PCS Farm Model

Country name **Kenya**
Model title **Basketry Model**

A. PARAMETERS

Local currency unit: Ksh

		unit time
Interest rate - working capital (without project)	10%	year
- working capital (with project)	22%	year
- fixed capital (without project)	10%	year
- fixed capital (with project)	22%	year
Loan period (months) - working capital (without project)	12	months
- working capital (with project)	48	months
- fixed capital (without project)	24	months
- fixed capital (with project)	48	months

B. FIXED CAPITAL

		WITHOUT PROJECT			WITH PROJECT																		
		Y1-Y7			Y1			Y2			Y3			Y4			Y5			Y6			Y7	
Item	unit	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total
Buildings																									
Sheds				0	1	15,000	15,000			0			0			0			0			0			0
Rent				0	12	4,000	48,000	12	4,000	48,000	12	4,000	48,000	12	4,000	48,000	12	4,000	48,000	12	4,000	48,000	12	4,000	48,000
																0			0			0			0
							0			0			0			0			0			0			0
Tools/machinery																									
Cutting knife	no	2	60	120			0			0			0			0			0			0			0
Splitting knife	no	2	100	200			0			0			0			0			0			0			0
Total				320			63,000			48,000			48,000			48,000			48,000			48,000			48,000
																0			0			0			0
Average operating life	1																								

C. OPERATING COSTS

		WITHOUT PROJECT			WITH PROJECT																		
		Y1-Y7			Y1			Y2			Y3			Y4			Y5			Y6			Y7	
Item	unit	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total
Labor																									
Weaving	labour/yr.	480	90	43,200	480	90	43,200	480	90	43,200	480	90	43,200	480	90	43,200	480	90	43,200	480	90	43,200	480	90	43,200
																0			0			0			0
Raw materials																									
Culms	no	2,200	10	22,000	2,200	10	22,000	2,200	10	22,000	2,200	10	22,000	2,200	10	22,000	2,200	10	22,000	2,200	10	22,000	2,200	10	22,000
																0			0			0			0
Metal sheet	kg	320	25	8,000	320	25	8,000	320	25	8,000	320	25	8,000	320	25	8,000	320	25	8,000	320	25	8,000	320	25	8,000
Transportation																									
Haulage cost	culm	2,200	3	6,600	2,200	3	6,600	2,200	3	6,600	2,200	3	6,600	2,200	3	6,600	2,200	3	6,600	2,200	3	6,600	2,200	3	6,600
Utilities (water, energy, etc)				0																					
Miscellaneous				0																					
Total				79,800			79,800			79,800			79,800			79,800			79,800			79,800			79,800
																0			0			0			0

D. REVENUE

	WITHOUT PROJECT	WITH PROJECT						
	Y1-Y7	Y1	Y2	Y3	Y4	Y5	Y6	Y7

Item	unit	quantity	rate	total		quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total
Baskets	no	1,500	100	150,000		1,500	100	150,000	1,500	100	150,000	1,500	100	150,000	1,500	100	150,000	1,500	100	150,000	1,500	100	150,000	1,500	100	150,000
				0				0			0			0			0			0			0			0
Total				150,000				150,000			150,000			150,000			150,000			150,000			150,000			150,000

E. CASH FLOW PROJECTIONS

thousand currency units

	WITHOUT PROJECT	WITH PROJECT						
	Y1-Y7	Y1	Y2	Y3	Y4	Y5	Y6	Y7
INFLOW								
Sale revenues	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00
INBAR - fixed capital		42.21						
- working capital		53.47	10.65					
Loan - fixed capital	0.00	20.79						
- working capital	79.80	26.33	5.25					
Enterprise contribution	0.00	0.00	63.90	127.80	127.80	127.80	127.80	127.80
Total inflow	229.80	292.80	229.80	277.80	277.80	277.80	277.80	277.80
OUTFLOW								
Fixed capital	0.32	63.00	48.00	48.00	48.00	48.00	48.00	48.00
Operating costs	79.80	79.80	79.80	79.80	79.80	79.80	79.80	79.80
Total outflow	80.12	142.80	127.80	127.80	127.80	127.80	127.80	127.80
Cash flow before financing	149.68	150.00	102.00	150.00	150.00	150.00	150.00	150.00
Debt service								
Loan repayment - fixed capital	0.32	5.20	5.20	5.20	0.00	0.00	0.00	0.00
- working capital	79.80	26.33	5.25	0.00	0.00	0.00	0.00	0.00
Interest on - fixed capital	0.00	4.57	4.57	4.57	0.00	0.00	0.00	0.00
- working capital	7.98	23.17	4.62	0.00	0.00	0.00	0.00	0.00
Total debt service	88.10	59.28	19.64	9.77	0.00	0.00	0.00	0.00
Cash flow after financing	61.58	90.72	82.36	140.23	150.00	150.00	150.00	150.00
Retained for investment	0.00	63.90	127.80	127.80	127.80	127.80	127.80	
Disposable income	61.58	26.82	-45.44	12.43	22.20	22.20	22.20	150.00

F. FINANCIAL ANALYSIS

Return on total capital employed								
Income from sales	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00
Cash outflow	159.92	169.13	133.05	127.80	127.80	127.80	127.80	127.80
Net cash flow	-9.92	-19.13	16.95	22.20	22.20	22.20	22.20	22.20
Internal rate of return		100%						
Discounted cash inflow			1326.41					
Discounted cash outflow			635.82					
Net Present Value		690.59						
Benefit/Cost ratio		2.09						

ASSUMPTIONS REGARDING FINANCING

INBAR:
67% of fixed capital (1st year)
67% of working capital (1st year)
67%times 50% (working capital plus fixed capital) (2nd year)

Loan:
33% of fixed capital (1st year)

33% of working capital (1st year)
33% times 50% (working capital plus fixed capital) (2nd year)

Retained for investment (borrowers contrib.):
50 % (working capital + fixed capital) (1st year)
100% (working capital + fixed capital) (subsequent years)

ASSUMPTIONS REGARDING THE MODEL CALCULATIONS
A shed will be required for basket production purposes
Rent will be paid for an outlet/show room to be situated in the nearest shopping centre
Four hundred and eighty labour days will be required per year and this will be provided by two people
One thousand five hundred baskets will be produced per year

Appendix 7 Toothpicks Model

APPENDIX 7: INBAR PCS Farm Model

Country name: **Kenya**
Model title: **Toothpicks production model**

A. PARAMETERS

Local currency unit: Ksh

		unit time
Interest rate - working capital (without project)	10%	year
- working capital (with project)	22%	year
- fixed capital (without project)	10%	year
- fixed capital (with project)	10%	year
Loan period (months) - working capital (without project)	12	months
- working capital (with project)	36	months
- fixed capital (without project)	12	months
- fixed capital (with project)	36	months

B. FIXED CAPITAL

		WITHOUT PROJECT			WITH PROJECT																				
			Y1-Y7		Y1			Y2			Y3			Y4			Y5			Y6			Y7		
Item	unit	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quan-tity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total
Buildings																									
Rent	month	12	4,000	48,000	12	4,000	48,000	12	4,000	48,000	12	4,000	48,000	12	4,000	48,000	12	4,000	48,000	12	4,000	48,000	12	4,000	48,000
Tools/machinery																									
Hack saw	no	2	150	300			0			0			0			0			0			0			0
Grinding stone	no	1	120	120	2	150	300			0			0			0			0			0			0
Sharpening knife	no	4	60	240	1	120	120			0			0			0			0			0			0
Saw blade	no	50	15	750	4	60	240			0			0			0			0			0			0
Ruler	no	4	20	80	50	15	750			0			0			0			0			0			0
Splitting knife	no	1	120	120	4	20	80			0			0			0			0			0			0
Scissors	no	1	180	180	1	120	120			0			0			0			0			0			0
Cross cut saw	no			0	1	180	180			0			0			0			0			0			0
Splitting machine	no			0	1	45,000	45,000			0			0			0			0			0			0
Total				49,790			94,790			48,000			48,000			48,000			48,000			48,000			48,000
Average operating life	7																								

C. OPERATING COSTS

		WITHOUT PROJECT			WITH PROJECT																				
			Y1-Y7		Y1			Y2			Y3			Y4			Y5			Y6			Y7		
Item	unit	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quan-tity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total
Labor																									
Processing	labour/yr.	48	2,600	124,800	24	2,600	62,400	24	2,600	62,400	24	2,600	62,400	24	2,600	62,400	24	2,600	62,400	24	2,600	62,400	24	2,600	62,400
Harvesting	Culms	1,800	5	9,000	3,000	5	15,000	3,000	5	15,000	3,000	5	15,000	3,000	5	15,000	3,000	5	15,000	3,000	5	15,000	3,000	5	15,000
Raw materials																									
Manila paper	bundle	1	750	750	1	750	750	1	750	750	1	750	750	1	750	750	1	750	750			0	1	750	750

Polythene	bundle	1	500	500	1	500	500	1	500	500	1	500	500	1	500	500	1	500	500			0	1	500	500
culms	no	1,800	17	30,600	3,000	17	51,000	3,000	17	51,000	3,000	17	51,000	3,000	17	51,000	3,000	17	51,000	3,000	17	51,000	3,000	17	51,000
Transportation	culms	1,800	10	18,000	3,000	10	30,000	3,000	10	30,000	3,000	10	30,000	3,000	10	30,000	3,000	10	30,000	3,000	10	30,000	3,000	10	30,000
Utilities (water, energy, etc)																									
Electricity	kWh			0	2,000	6	12,000	2,000	6	12,000	2,000	6	12,000	2,000	6	12,000	2,000	6	12,000	2,000	6	12,000	2,000	6	12,000
Miscellaneous																									
Labels	no/year	1	600	600	1	600	600	1	600	600	1	600	600	1	600	600	1	600	600	1	600	600	1	600	600
Marketing cost		1	14,000	14,000	1	14,000	14,000	1	14,000	14,000	1	14,000	14,000	1	14,000	14,000	1	14,000	14,000	1	14,000	14,000	1	14,000	14,000
Gift voucher		4	2,000	8,000	3	2,000	6,000	3	2,000	6,000	3	2,000	6,000	3	2,000	6,000	3	2,000	6,000	3	2,000	6,000	3	2,000	6,000
Overheads	no/year	1	12,000	12,000	1	12,000	12,000	1	12,000	12,000	1	12,000	12,000	1	12,000	12,000	1	12,000	12,000	1	12,000	12,000	1	12,000	12,000
Total				218,250			204,250			204,250			204,250			204,250			204,250			203,000			204,250

D. REVENUE

		WITHOUT PROJECT			WITH PROJECT																				
			Y1-Y7		Y1			Y2			Y3			Y4			Y5			Y6			Y7		
Item	unit	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total	quantity	rate	total
Toothpicks	pkt	9,000	5	45,000	18,000	5	90,000	18,000	5	90,000	18,000	5	90,000	18,000	5	90,000	18,000	5	90,000	18,000	5	90,000	18,000	5	90,000
Skewers	pkt	4,400	16	70,400	8,800	16	140,800	8,800	16	140,800	8,800	16	140,800	8,800	16	140,800	8,800	16	140,800	8,800	16	140,800	8,800	16	140,800
Chop sticks	pkt	350	48	16,800	700	48	33,600	700	48	33,600	700	48	33,600	700	48	33,600	700	48	33,600	700	48	33,600	700	48	33,600
Ice cream pallets	pkt	350	30	10,500	700	30	21,000	700	30	21,000	700	30	21,000	700	30	21,000	700	30	21,000	700	30	21,000	700	30	21,000
Total				142,700			285,400			285,400			285,400			285,400			285,400			285,400			285,400

E. CASH FLOW PROJECTIONS thousand currency units

	WITHOUT PROJECT	WITH PROJECT						
	Y1-Y7	Y1	Y2	Y3	Y4	Y5	Y6	Y7
INFLOW								
Sale revenues	142.70	285.40	285.40	285.40	285.40	285.40	285.40	285.40
INBAR - fixed capital		758.32						
- working capital		163.40	62.50					
Loan - fixed capital	0.00	18.96						
- working capital	218.25	40.85	15.63					
Enterprise contribution	0.00	0.00	126.13	252.25	252.25	252.25	251.00	252.25
Total inflow	360.95	1266.93	489.65	537.65	537.65	537.65	536.40	537.65
OUTFLOW								
Fixed capital	49.79	94.79	48.00	48.00	48.00	48.00	48.00	48.00
Operating costs	218.25	204.25	204.25	204.25	204.25	204.25	203.00	204.25
Total outflow	268.04	299.04	252.25	252.25	252.25	252.25	251.00	252.25
Cash flow before financing	92.91	967.89	237.40	285.40	285.40	285.40	285.40	285.40
DEBT SERVICE								
Loan repayment - fixed capital	49.79	6.32	6.32	6.32	0.00	0.00	0.00	0.00
- working capital	218.25	40.85	15.63	0.00	0.00	0.00	0.00	0.00
Interest on - fixed capital	0.00	1.90	1.90	1.90	0.00	0.00	0.00	0.00
- working capital	21.83	26.96	10.31	0.00	0.00	0.00	0.00	0.00
Total debt service	289.87	76.03	34.15	8.22	0.00	0.00	0.00	0.00
Cash flow after financing	-196.96	891.86	203.25	277.18	285.40	285.40	285.40	285.40
Retained for investment	0.00	126.13	252.25	252.25	252.25	251.00	252.25	
Disposable income	-196.96	765.74	-49.00	24.93	33.15	34.40	33.15	285.40

F. FINANCIAL ANALYSIS

Return on total capital employed								
Income from sales	142.70	285.40	285.40	285.40	285.40	285.40	285.40	285.40

Cash outflow	486.29	339.89	267.88	252.25	252.25	252.25	251.00	252.25
Net cash flow	-343.59	-54.49	17.53	33.15	33.15	33.15	34.40	33.15

Internal rate of return	46%	
Discounted cash inflow		3240.11
Discounted cash outflow		1269.89
Net Present Value	1970.22	
Benefit/Cost ratio	2.55	

ASSUMPTIONS REGARDING FINANCING

INBAR:
80% of fixed capital (1st year)
80% of working capital (1st year)
80%times 50% (working capital plus fixed capital) (2nd year)

Loan:
20% of fixed capital (1st year)
20% of working capital (1st year)
20% times 50% (working capital plus fixed capital) (2nd year)

Retained for investment (borrowers contrib.):
50 % (working capital + fixed capital) (1st year)
100% (working capital + fixed capital) (subsequent years)

ASSUMPTIONS REGARDING THE MODEL CALCULATIONS

Employees will reduce from four to two when machines are introduced
100 % improvement in the production capacity through use of machines
Efficiency on raw material by 50 % through use of machines