UNITED REPUBLIC OF TANZANIA

MINISTRY OF NATURAL RESOURCES AND TOURISM

National Beekeeping Research Master Plan I

NABERM I

(2020 - 2030)

Tanzania Forestry Research Institute

(TAFORI)

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ABBREVIATIONS AND ACRONYMS

COSTECH	Tanzania Commission for Science and Technology
FAO	Food and Agriculture Organization of the United Nations
FBD	Forestry and Beekeeping Division
FORVAC	Forestry and Value Chains Development Programme
ICT	Information Communication Technology
ITC	International Trade Centre
M & E	Monitoring and Evaluation
MNRT	Ministry of Natural Resources and Tourism
MT	Metric Tones
NABERM	National Beekeeping Research Master Plan
NSGRP	National Strategy for Growth and Reduction of Poverty
PPP	Public-Private- Partnership
TaFF	Tanzania Forest Fund
TAFORI	Tanzania Forestry Research Institute
TAWIRI	Tanzania Wildlife Research Institute
TFS	Tanzania Forest Services Agency
TZS	Tanzania Shillings
SDGs	Sustainable Development Goals
URT	United Republic of Tanzania
US$	United States Dollar

PREFACE

Beekeeping in Tanzania is a common economic activity practiced by both traditional and novice beekeepers in the production of bee products mainly honey and beeswax. There is also a window for other bee products and services that can be exploited and promoted in both domestic and international markets. The Government of the United Republic of Tanzania recognizes the importance and role of the Beekeeping Sector in development endeavors thus has found it reasonable to consolidate all research efforts that will generate scientific information to enhance the contribution of the industry to the national economy.

The Ministry of Natural Resources and Tourism (MNRT) is delighted to present the National Beekeeping Research Master Plan I (NABERM I 2020-2030). Production of NABERM I has been a mission of our beekeeping stakeholders in order to indicate areas for research in beekeeping.

The Ministry adopted a consultative process in the production of NABERM I. Multiple stakeholders were visited and field observations undertaken. The developed checklists and questionnaires were responded by beekeepers, manufacturers of bee equipment, traders of bee products, consumers of bee products, private institutions, regulatory authorities, Government and Non-Government institutions.

The NABERM I has six research themes and four support programmes. The research themes are i) Conservation of honeybees and their habitats ii) Conservation of stingless bees and their habitats, iii) Harvesting, processing and packaging of bee products, iv) Beekeeping based industries and services, v) Bee products markets and marketing systems and vi) Socio-economic, policy and extension. Support programmes are: (i) Human resources development, ii) Infrastructure development and improvement, iii) Dissemination of research findings and iv) Financing of research activities.

Realizing the goal, the document depends much on different players along the value chain. It is my sincere hope that different stakeholders in their respective nodes will be ready to contribute

in addressing the research areas identified. My expectation is that Tanzania Forestry Research Institute (TAFORI) will ensure availability of this document to all relevant stakeholders as well as instituting effective coordination to make beekeeping sector realize its full potential in contributing to the national economy.

Prof. Aldof F. Mkenda
Permanent Secretary
Ministry of Natural Resources and Tourism

ACKNOWLEDGEMENT

I am indebted to the Task Force Team on developing the National Beekeeping Research Master Plan I (NABERM I). I wish to thank the team which was composed of Mr. Liana Hassan (Chairperson), Mrs Gladness Mkamba, (Vice - Chairperson), Mr. Raymond Okick (TAWIRI - Secretary), Dr.NicephorLesio (TAWIRI - Member), Dr.SiimaBakengesa (TAFORI - Member), Mr.FelicianShayo (FBD - Member), Eng. KaiziregeCamara (Follow The Honey Tanzania - Member) and Mr.KarengiSlaa (TFS- Member) for their expertise, commitment and eventual preparation of this document.

I wish to thank all stakeholders including individuals, communities' leaders, government officials, entrepreneurs, regulatory authorities, universities and research institutes, who generously provided information relevant in putting together NABERM I. We are grateful to all for their valuable support.

I am grateful to all individuals who in one way or another were involved in the process of improving the document and securing funds to undertake this task. Specifically, I appreciate the inputs of Director of Forestry and Beekeeping Dr. Ezekiel E. Mwakalukwa and the former Assistant Director, Beekeeping Development, in the Division of Forestry and Beekeeping Mr. Allen K. Richard. I owe special thanks to the Ministry of Natural Resources and Tourism through Tanzania Forest Fund (TaFF) and Forestry and Value Chains Development Programme (FORVAC) for financial support to the development of NABERM I.

Addressing the targets of NABERM I would take the beekeeping sector to the next level. Technologies developed, innovations made and challenges addressed will provide beekeeping stakeholders with needed solutions. The TAFORI Board of Directors is looking forward for revitalised beekeeping sector through NABERM I.

Dr.Felician B. Kilahama

Chairman, Board of Directors

Tanzania Forestry Research Institute

EXECUTIVE SUMMARY

Beekeeping is a long time established traditional economic activity in Tanzania contributing to source of food, raw materials for various industries, medicine, and source of income and employment. Production potential of bee products is about 138,000 MT of honey and 9,200 MT of beeswax per annum, from estimated 9.2 million honeybee colonies in the country. The national production is reported to be 30,393 (22%) MT and 1,843 (20%) MT of honey and beeswax respectively which is far below the estimated potential.

Although the beekeeping sector has a high potential to contribute to the livelihoods of Tanzanians, it has not been fully utilized because of poor technology, insufficient information on bees and their habitats and poor infrastructure for market.

Since Tanzania is moving towards the middle income status through industrialization, there is a need to harness all potentials for economic development. The Government has realized the importance of putting in place a National Beekeeping Research Master Plan (NABERM), and has prepared NABERM I whose purpose is to put together the important research areas based on the current and future requirements of stakeholders. Its overall goal is to enhance notable and sustained contribution of the beekeeping sector to socio-economic development of Tanzania. To achieve the goal NABERM has five specific objectives aiming at generating research evidence, providing access and affordability of bee products and services, developing and promoting technologies, increase use of scientific information and strengthening institutional capacity. Strategies to achieve objectives of NABERM include collaborations with stakeholders, hire/attract renowned excellences, use of technology, promote innovations and building strong team for communication.

This endeavor is in line with National Strategy for Growth and Reduction of Poverty (NSGRP) and is expected to contribute in achieving Tanzania Development Vision 2025, Sustainable Development Goals (SDGs) and related International natural resources and environmental policies.

The NABERM I has six research themes and four support programmes. The research themes are i) Conservation of honey bees and their habitats, ii) Conservation of stingless bees and their habitats, iii) Harvesting, processing and packaging of bee products, iv) Beekeeping based industries and services, v) Bee products markets and marketing systems and vi) socio - economic, policy and extension. Support programme are i) Human resources development ii) Infrastructure development and improvement, iii) Dissemination of research findings and iv) Financing of research activities. Furthermore, the NABERM I has highlighted the roles/responsibilities of stakeholders in its implementation.

In order to achieve the objectives of NABERM I, 20 targets have been set for which TZS 30.8 billion is estimated for a period of 10 years.

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND

Beekeeping is a traditional economic activity among many communities living around or in the vicinity of forests. It is estimated that about 90% of beekeeping in Tanzania is a forest-based activity using traditional methods. From traditional beekeeping, communities obtain honey and beeswax for food and income generation. Thus, it is a typical livelihood activity that involves harnessing nature to generate food and income. It employs more than 2 million people as beekeepers, processors and retailers, from both rural and urban communities (URT, 1998).

According to URT (1998) the production potential of bee products is about 138,000 MT of honey and 9,200 MT of beeswax per annum, from estimated 9.2 million honeybee colonies in the country. FAO (2018) reported the national production to be 30,393 (22%) MT and 1,843 (20%) MT of honey and beeswax respectively which is far below the estimated potential. To date there is no study that has shown variation from the above facts. There is a need for further study to understand number of honeybee colonies, production potential and actual production.

Apart from honey and beeswax there are several other bee products such as pollen, propolis, royal jelly, brood and venom with high value but not yet exploited economically in the country. It is also estimated that 90% of all honey produced in Tanzania is consumed within the country as food or input for making brews, medicine and other multiple products (ITC, 2015). There are views that the total demand for honey in the country is much more than supply.Beekeeping sector generates about US$ 2.5 million from export of honey and beeswax annually (MNRT, 2019).

The beekeeping sector is profitable industry and worth rewarding investment. It plays an important role in achieving sustainable development as it offers livelihood opportunities and generates income at the bottom of the pyramid while contributing towards poverty alleviation,

food security and conservation of biodiversity. NABERM is expected to guide generation of the required information for sustainable beekeeping and hence contribute to achieving Tanzania Development Vision 2025, National Strategy for Growth and Reduction of Poverty, Sustainable Development Goals and related National and International natural resources and environmental policies.

1.2 RATIONALE OF NATIONAL BEEKEEPING RESEARCH MASTER PLAN

The climate and environmental conditions favour the survival of bees and bee fodder across the country. In addition, there are trained experts in beekeeping, novice and traditional beekeepers. Unfortunately, the current production of bee products is still low, caused by long standing challenges. These include use of inappropriate equipment and materials, improper harvesting and handling of bee products, poor apiary management and inadequate products diversification. In addition, the sector is faced by inadequate organized markets and marketing systems for both domestic and international markets, inaccessibility to financial credit, lack of understanding of the role of bees in pollination services and environmental changes that have led to disappearance of habitats for bees.

Despite of these challenging problems the opportunities for beekeeping sector have continued to grow due to increasing market demand for honey, beeswax and other bee products for food, medicine and ingredients in manufacturing industries. These opportunities have motivated local communities, both public and private institutions to promote and indulge in beekeeping activities. Effective management and utilization of bee resources for economic development cannot take place in the absence of scientific information and knowledge. Thus, within the foregoing scenario, there is a need for demand driven researches in beekeeping.

Empirical evidence from the literature indicates presence of researches conducted in beekeeping industry as an attempt to provide solutions to the challenging problems of beekeeping sector in the country. Unfortunately, many of the researches appeared to end up with situation analysis of beekeeping at various levels rather than developing practical-based solutions to the observed problems. In this scenario, for the country to benefit from the emerging commercial potentials in

beekeeping, the problems need to be addressed systematically and properly. Addressing the problems will enable quick transformation of the sector for more gains to beekeeping practitioners and country at large. This will be achieved through comprehensive and innovative research in beekeeping to improve productivity that is streamlined in the prevailing national development agenda. Since there was no master plan for beekeeping research in the country and research priorities were not identified, beekeeping research did not fully address the needs of beekeepers and other stakeholders in the beekeeping value chain. Therefore, development of NABERM is a prerequisite to enable proper and systematic research aiming at eliminating standing challenges in the beekeeping sector. NABERM provides an in depth analyzed and prioritized areas for research with immediate and long term development impacts for the sector. The importance and need for research in beekeeping has been emphasized in the National Beekeeping Policy of 1998 and National Beekeeping Programme of 2001 for productive beekeeping practices. Hence, NABERM provides roadmap to ensure long-term contribution of beekeeping sector to the national development.

CHAPTER TWO

2.0 GOAL, OBJECTIVES AND STRATEGIES

2.1 GOAL

An enhanced, notable and sustained contribution of the beekeeping sector to socio - economic development of Tanzania.

2.2 OVERALL OBJECTIVE

To provide a research framework for development, conservation and management of beekeeping resources and services in order to strengthen sector contributions to socio-economic development of Tanzania.

2.2 SPECIFIC OBJECTIVES

i. To develop sustainable mechanisms for ensuring safety of bees and habitat for improved quantity and quality of bee products and services;
ii. To increase access to and affordability of products from beekeeping industry;
iii. To develop and promote technologies, including ICT, that improves productivity and quality along the value chain in the beekeeping industry;
iv. To increase use of scientific information in formulating and advocating policies, and strengthening coordination of beekeeping related research activities; and
v. To strengthen institutional capacity of Tanzania Forest Research Institute.

2.3 STRATEGIES

In order to achieve the objectives of NABERM I as stated in Section 2.2, the views of beekeeping research institutions and other stakeholders involved in beekeeping research were used to develop strategies aimed at conducting beekeeping research activities. The strategies put forward include:

i. Foster national, regional and international collaborations in key strategic research areas;
ii. Hire/attract experienced and renowned experts to stimulate research excellence;
iii. Use technologies to compensate for capacity gaps and increase productivity;
iv. Promote innovation along the value chain in beekeeping industry; and
v. Build a strong research communications team to ensure uptake.

CHAPTER THREE

3.0 STRATEGIC TARGETS

Objective 1

To develop sustainable mechanisms for ensuring safety of bees and habitat for improved quantity and quality of bee products and services.

Targets

i. Appropriate bee hives and relevant accessories for sustainable beekeeping industry developed by 2030;
ii. Management regimes/practices that ensure conservation of honeybees and stingless bees, their habitats, and increased quantity and quality of bee products developed by 2030;
iii. Beekeeping resources to maximize their utilization assessed by 2030;
iv. Equitable mechanisms for utilizing beekeeping resources in all forms of land use explored by 2030; and
v. Safety of bees ensured by 2030.

Objective 2

To increase access to and affordability of products from beekeeping industry.

Targets

i. Appropriate bee hives and relevant accessories for sustainable beekeeping industry promoted by 2030;
ii. Technologies for harvesting, processing, packing and handling of bee products promoted by 2030;
iii. Industries for sustainable supply of beekeeping equipment, related goods and services supported by 2030; and
iv. Markets and marketing systems of bee products and equipment promoted by 2030.

Objective 3

To develop and promote technologies, including ICT, that improves productivity and quality along the value chain in the beekeeping industry.

Targets

i. Technologies for harvesting, processing, packaging and handling of bee products developed by 2030;
ii. Technologies for sustainable supply of beekeeping equipment and bee related products developed by 2030;
iii. Value added bee products developed by 2030;
iv. Technologies for monitoring bees and bee colonies established by 2030; and
v. Bee pollination services in forest and farm lands evaluated by 2030.

Objective 4

To increase use of scientific information in formulating and advocating policies, and strengthening coordination of bee related research activities

Targets

i. Coordination of research communication improved by 2030;
ii. Scientific information to support sector related policy processes provided by 2030; and
iii. Availability and accessibility of research findings increased by 2030.

Objective 5

To strengthen institutional capacity of Tanzania Forest Research Institute

Targets

i. Coordination of research activities improved by 2030;
ii. Human resource capacity to conduct and coordinate beekeeping research in order to meet the National and International obligations strengthened by 2030; and
iii. Infrastructure and working environment in research institutes supported by 2030.

CHAPTER FOUR

4.0 RESEARCH THEMES

4.1 CONSERVATION OF HONEYBEES AND THEIR HABITATS

4.1.1 Background and Justification

The forests found in Tanzania are the principal habitats for known and yet to be known colonies and taxa of honeybees. It is known that flowering plants (angiosperms) evolved together with bees because of their pollination relationship. In this revolutionary relationship, honeybees collect nectar and pollen as their main food. In so doing, they effect cross pollination needed by the angiosperms to ensure quality seeds that will generate naturally to sustain the plant communities. Beekeeping, if done properly, works to maintain this evolutionary partnership between plants and the honeybees.

Tanzanian beekeeping is to a large extent, natural forest dependent. The three interdependent partners (bees, forests and beekeepers) have co-existed for many years. Similarly, beekeeping methods used in these forest stands, involving mainly traditional hives have not changed significantly over the years and have inherent disadvantages in conservation of both bees and their habitats. Traditional hives allow minimum management of bee colonies which involve only hive siting and honey harvesting. During harvesting, in these fixed comb hives both honey and brood combs are harvested by the beekeeper and thus killing the broods which are the future bees.

Studies for improving beekeeping methods and equipment have been conducted around the world. However, focus on tropical bees has been little and lacking coordination between research projects. As a result, the development of tropical beekeeping has been hampered by inadequate knowledge on how to manage honeybees and maximize income and other benefits from conservation. Currently appropriate methods of managing tropical honeybees are based on information generated from researching honeybees and beekeeping in the temperate regions. Thus, it is utmost important to establish fundamental parameters concerning the biology and behavior of African honeybees, review the effectiveness and sustainability of existing

beekeeping methods and develop effective low-cost beekeeping equipment and methods that ensure conservation of both the honeybees and their habitat in Tanzania.

Tanzania is estimated to have about 9.2 million honeybee (*Apismellifera*) colonies. Currently, there are three (3) races of honeybees namely *Apismelliferascuttellata* (the savanna race), *Apismelliferalitorea* (the coastal race) and *Apismelliferamonticola* (the mountain race). There is need to understand different honeybees which are present in the country and their respective distributions. During field study, it was observed that there are many types of honeybees with different behaviours in different ecological zones which have not been studied. Field observations indicated that honeybees are affected by changes in climate which results in change in productivity, beekeeping calendar and emerging pests, predators and diseases. The well-known potential productivity is challenged by current field data. There is need to carry out research on honeybee classifications, honeybee colony carrying capacity (number of colonies per unit area) and their different adaptations including understanding their pests, predators and diseases.

Beekeeping has been carried out in forest, game and beekeeping reserved lands. However, assessment of these reserves is required to establish their capacity on beekeeping activities, especially their colony carrying capacity, apiary site locations and layout. The Ministry of Natural Resources and Tourism through its institutions manages reserved lands which is about 32.5% of the total country land. These include national parks (22), game reserves (24), game controlled areas (27), forest reserves (462), nature reserves (17), plantation forests (23), Ngorongoro Conservation Area (1) and Ramsar Site area (4). All these are potential and provide good habitat for honeybees. However, the potential for undertaking beekeeping and different benefit sharing arrangement has not been fully explored, though beekeeping is carried out in forest reserves and game reserves under gentleman agreements.

Apart from reserved lands, agricultural land also provides potential habitat for beekeeping. Honeybees contribute significantly to crop production through pollination. They increase crop yield of agricultural crops and hence contributes to industrial economy. Without honeybees as pollinators, agricultural production could be at stake. However, the contribution of bees as

pollinators has not been evaluated. Furthermore, the pollination requirement of various food and cash crops has not been determined in the different climatic zones. There is need to collect sufficient scientific evidence to demonstrate that honeybees help increase crop yield through pollination process.

Increasing land productivity requires several interventions including good farm husbandry and the use of farm implements such as fertilizers and pesticides. Unfortunately, careless use of pesticides has brought about foes and challenges worldwide. Pesticide residues are not only undesirable in food production including honey, but also they are detrimental to both bees and their habitats. As the country moves on to increase productivity in agriculture and encourage api-agroforestry, efforts must be made to ensure safety to pollinators, their habitats and the produced food. Therefore, research on these intricate issues is required in order to generate scientific information that will assist in management and conservation of honeybees in reserved, non reserved and agricultural land.

4.1.2 Proposed Research Activities

4.1.2.1 Activities on bee hives and accessories:

i. Establish bee hive standards (type, size, entrance size and position);
ii. Design bee hives and accessories suitable for production of bee products other than honey and beeswax;
iii. Identify locally available tree species and other materials suitable to bees for making hives; and
iv. Carry out studies on traditional beehives aiming at conserving bees and their habitats.

4.1.2.2 Activities on honeybee colony management

i. Carry out colony manipulation to increase their number, acquire desired traits and achieve optimal yield;
ii. Conduct studies on baiting materials, height of hive from the ground, hive entrance direction in different ecological zones to increase hive occupancy rate;

iii. Undertake studies on migration, swarming and absconding behavior of bees in different areas;
iv. Develop beekeeping calendar specific to vegetation zones in the wake of climate change;
v. Study beekeeping adaptation practices in the face of climate and land use changes;
vi. Establish methods for controlling pests, predators, diseases and disorders;
vii. Study effects of shifting bee colonies between ecological zones on bees and beekeeping;
viii. Develop colony management techniques for harvesting different bee products (other than honey and beeswax);
ix. Examine commonly used fuels for bee smokers, their effect on bees and bee products; and
x. Carry out cost-benefit analysis of different beekeeping models.

4.1.2.3 Activities on data base on beekeeping resources:

i. Map beekeeping potential areas;
ii. Study the carrying capacity of bee colonies in a specified vegetation area;
iii. Identify different types of honeybees in different ecological zones;
iv. Study indigenous knowledge in beekeeping industry (hive making, siting, inspection, harvesting, processing, storage and use of bee products);
v. Carry out surveillance of occurrence of invasive species and their effect on beekeeping industry; and
vi. Carry out inventory on beekeepers, apiaries, bee colonies and productivity of hives.

4.1.2.4 Activities on beekeeping in different forms of land uses:

i. Identify important factors in arranging Joint Management of protected areas and other forms of Public Private Partnership (PPP) with reference to beekeeping;
ii. Undertake studies on equitable mechanisms for joint beekeeping activities in agricultural, protected areas, open areas and private owned lands (different ecological zones);
iii. Carry out studies on socio-economic and ecological contribution of beekeeping in protected areas;
iv. Examine the use of pesticides and their effects in beekeeping industry;
v. Determine and promote plant species suitable in api-agroforestry systems; and

vi. Carry out studies on pollination requirements of various plant species by bees in farmland and forest areas.

4.2 CONSERVATION OF STINGLESS BEES AND THEIR HABITATS

4.2.1 Background and Justification

Management of stingless bees (also known as Meliponiculture) is famous for producing high valued medicinal honey which is gaining popularity in different parts of Tanzania. These bees are widely distributed in most tropical or southern subtropical regions of the world such as Australia, Africa, Southeast Asia, and in some parts of South America including Mexico, Brazil, Peru, Venezuela, Paraguay, Bolivia and Costa Rica (Michener 2007; Camago and Pedro, 2012; Chidi and Odo, 2017). Previous studies show that in Africa there are six genera of stingless bees, namely, *Dactylurina*, *Meliponula*, *Plebeina*, *Hypotrigona*, *Liotrigona* and *Cleptotrigona* (Eardley, 2004). Apart from producing high quality honey, the stingless bees are excellent pollinators of a wide range of flowers due to their small bodies compared to the honeybees. Furthermore, stingless bees are suitable for pollinating crops which are grown in residential areas such as backyard gardens.

Despite of the known benefits of the stingless bees, studies on their types and behaviour in order to effectively manage and conserve them have not generated sufficient information. The current taxonomic status and value of stingless bees in pollination of forest and agricultural vegetation, and biodiversity conservation in Africa including Tanzania is not sufficiently known (Eardley and Kwapong, 2013). The scant literature available with regard to their biology, behaviour and management is based on studies from South America which is considered to be the centre of diversity for stingless bees, and meliponiculture is practiced extensively (Eardley, 2004). Inadequate knowledge to manage the species found in Tanzania such as suitable hives, harvesting, storage and packaging facilities for honey calls for further research in order to maximize their productivity and utilization.

The impact of transferring stingless bee colonies from their natural environments for stocking hives sited at homesteads has not well been assessed and documented. Procedures for harvesting

honey and other bee products have not been standardized. Despite of its popularity for its high medicinal value, analysis of honey to determine chemical composition in different geographical areas of the country at different seasons of the year has not been done.

Conservation of the stingless bees pose a challenge as they are threatened by chemical poisoning (especially pesticides) and land clearing for habitation, agricultural and industrial developments which kill the honeybees themselves, destroy their natural habitats and nesting sites. Therefore, research is required to generate adequate information that will enhance equitable conservation and utilization of these bees so that they contribute adequately to the national economy.

4.2.2 Proposed Research Activities

i. Develop standards for stingless bee products;
ii. Identify species of stingless bees and their distribution;
iii. Carry out studies on biology and behaviour of stingless bees;
iv. Develop and promote use of suitable hives and their siting methods;
v. Develop suitable colony management regimes in different areas;
vi. Identify important fodder/forage resources for stingless bees;
vii. Study the impact of transferring colonies from natural nests to artificial nests; and
viii. Carry out studies on occurrence of pests, predators and diseases including control methods.

4.3 HARVESTING, PROCESSING AND PACKAGING OF BEE PRODUCTS

4.3.1 Background and Justification

Harvesting of bee products is a crucial activity in the calendar of beekeeping. It is a process of taking or removing bee products from the hive by the beekeeper. The most common traditional methods of beekeeping involve siting log or bark hive high up on trees in locations which are far from residential areas. Therefore, harvesting involves climbing trees to harvest honey at the hive position or to descend the hive so that harvesting is done on the ground. Whether harvesting is done high up on the tree or on the ground the activity involves lighting fire in order to generate smoke to calm down the aggressive bees or fire glow to get rid of them by burning, which risks

the life of the honeybees or even staring forest fires. Occasionally honey is also contaminated by the smoke making it of low quality.

Efforts to introduce modern equipment for harvesting bee products such as bee suits, bee smokers and the like to traditional beekeepers have not been successful. In most cases harvesting is done during night when the colony is calm and visibility for the honeybees is difficult. This makes the whole activity difficult to be conducted properly and maintain high quality products.

After harvesting, honey is obtained by squeezing it out of the combs. Some beekeepers even heat the produce to reduce viscosity to ease honey extraction. Due to lack of means for temperature control, the honey may become overheated, therefore further spoiling the quality. Beeswax is rendered after squeezing out honey from the combs. Empty combs are also harvested and rendered into beeswax. The commonly used method of rendering beeswax is soaking the combs in water overnight then boiling it and filtering it through a sack.

Modern methods of processing honey and beeswax have been introduced but majority of beekeepers do not afford the prices and the technology. It is fundamentally important that the existing methods are assessed in order to develop affordable equipment and technology for processing including packaging of bee products to meet requirements of the beekeeping industry. Apart from honey and beeswax, other profitable bee products include propolis, pollen, bee venom and royal jelly. However, harvesting of these products has not been explored and promoted in the country. This calls for research and developing affordable technology of harvesting, processing, storage and packaging of bee products.

4.3.2 Proposed research activities

i. Assess factors of importance that influence consumer preferences;
ii. Assess efficiency and effectiveness of existing collection and processing facilities;
iii. Develop suitable and affordable harvesting, processing and storage technology that ensure quality bee products;
iv. Carry out post-market surveillance for bee products; and

v. Carry out studies on appropriate packaging materials, packaging design and handling of bee products;

4.4 BEEKEEPING-BASED INDUSTRIES AND SERVICES

4.4.1 Background and Justification

Beekeeping-based industries are those involved in manufacturing of equipment used for pursuing various beekeeping activities and utilize bee products as raw materials. Equipment manufactured for supporting beekeeping activities include hives, hive accessories, bee protective gears and colony management equipment. Other materials are harvesting, processing, storage and packaging containers. In addition, some industries utilize bee products as raw materials to manufacture nutritional, pharmaceutical, cosmetic and electronic goods. Beekeeping industry also provides pollination and tourism related services.

Bee equipment of various types found in the field include hives, hive accessories, protective gears, smokers, hive tools, honey press and bee brush manufactured in different areas of the country by Government Institutions, Non-Governmental Organizations and few skilled and innovative individuals in varying qualities. Some of the same beekeeping equipment, also of varying qualities, are imported mostly from China. Field observation has shown presence of more than 10 honey and beeswax processing plants, their raw materials requirement has not been satisfied. Pollen, propolis, royal jelly and bee venom are scantly harvested and industries requiring them for materials have not been established.

Beekeeping based industries are important in both urban and rural areas because they produce important equipment for beekeeping activities and play vital role in marketing of bee products. In addition, the industries contribute to the economy of the country through creation of employments, investment opportunities, foreign exchange earnings and market for primary bee products and services. However, the contribution of the industries to national development in terms of products, export earnings and employment has not been fully exploited.

There are challenges regarding beekeeping based industries and services. Field observations indicate that the public is not adequately aware of the existence of opportunities for establishing beekeeping based industries. Research results that uncover opportunities for investment including location and size of plants and industries based on need for equipment and raw materials are required for the beekeeping industry to contribute adequately in the national economy. Other constraints include inappropriate technology, unreliable supply of raw materials and limited information on the utilization of bees for pollination and api-tourism services. Therefore, research is required to generate adequate information that will establish necessary information important for development of beekeeping based industries and services.

4.4.2 Proposed research activities

i. Assess the existing beekeeping based industries;
ii. Carry out study on suitable beekeeping equipment in different ecological zones;
iii. Develop various secondary bee products;
iv. Analyze nutritional and medicinal values including api – therapy services;
v. Identify and promote unique api-tourist attractions; and
vi. Identify traditional values and myths in beekeeping for tourist attraction.

4.5 BEE PRODUCTS MARKETS AND MARKETING SYSTEMS

4.5.1 Background and Justification

Beekeepers have a focus on high production and sales of bee products for profitable income generation. Availability of a good market for sales of the bee products stimulates more production through expansion of beekeeping activities by existing players and new ones joining the industry. Market is found at every stage node of the chain. The chain involves producers, processors, dealers, packaging and sales group and consumers interconnected by transporters. However, marketing of the bee products in Tanzania have had challenges in information network (i.e. producers may not know where to find a buyer while on the other hand a buyer has shortage of product and does not know where to get some more). Therefore, there is a need to assess the existing marketing system in order to improve it for satisfaction at each node in the value chain.

Consumer taste and satisfaction in bee products has been a challenge in the market for a long time. This is due to changing physical characteristics caused by vegetation nature of the product and seasonal variation within a year. Therefore, this calls for continuous research on factors influencing marketing of honey. Apart from honey, harvesting of other bee products such as pollen, propolis, royal jelly and bee venom is a new innovation in different parts of Tanzania. In addition to this product diversification, innovation in value addition to bee products is in increase, necessitating investigations on the source of products as raw materials on one hand and market for finished products on the other.

Currently, there is weak establishment of markets and marketing systems to ensure smooth transactions of the business along the value chain. Therefore, research to strengthen establishment of such systems is inevitable.

4.5.2 Proposed research activities

i. Examine existing players and their roles in the bee products value chain;
ii. Assess market forces/factors that determine prices of bee products along the value chain;
iii. Assess bee products and determine their properties;
iv. Map bee products based on their geographical, botanical origin and physicochemical properties;
v. Conduct studies on market potential of bee products;
vi. Identify important factors in determining location of collection and processing centers for bee products; and
vii. Develop financing mechanism for different nodes along the beekeeping value chain;

4.6 SOCIO-ECONOMIC, POLICY AND EXTENSION

4.6.1 Background and Justification

The goal of the National Beekeeping Policy of 1998 is to enhance the contribution of the beekeeping sector to the sustainable development of Tanzania and the conservation of her natural resources for the benefit of present and future generations. With this sectoral goal, one of the objectives of the policy is to enhance national capacity to manage and develop the beekeeping

sector in collaboration with other stakeholders. Inadequate coordination with other related sectors like Wildlife, Agriculture and Lands limits efforts of beekeeping development. Cross-sectoral policy issues related to beekeeping sector have significant influence on decision towards beekeeping development either individually or collectively. However, Tanzania beekeeping sector development is hampered by limited extension services. Extension services conducted in the country are fragmented and sectoral based with un-harmonized and conflicting messages. Capacities for the extension personnel as well as facilities are inadequate for effective delivery and user benefits. There is poor communication and absence of coordination in planning and execution of extension services (URT, 2001).

Socio-economic and extension issues influence the establishment, management and utilization and ultimately conservation of bee resources. There has been little attention on socio- economic and extension issues despite of their significant influence. Many beekeeping socio-economic programmes have performed dismally due to the reluctance of the communities to constructively participate in such programmes. Reasons behind this reluctance are not fully understood as few researches have been done in this direction. Therefore, the success in beekeeping development and management will depend on our accurate understanding of complex factors related to socio-economic, policy and beekeeping extension.

4.6.2 Proposed research activities

i. Identify existing gaps in policy, legislations and law enforcement in beekeeping;
ii. Undertake studies on the effect of various relevant policies, and international conventions and agreements on the management of bee resources;
iii. Assess the effects of different policy options on taxes, tariffs and subsidies;
iv. Assess impact of regulatory framework to beekeeping industry;
v. Undertake studies on gender and youths involvement in beekeeping;
vi. Conduct a study on effectiveness of different extension services and dissemination of research findings on beekeeping management;
vii. Study the impact of various technologies and beekeeping programmes/projects to local communities' livelihoods; and
viii. Examine enabling environment for investment in beekeeping.

CHAPTER FIVE

5.0 IMPLEMENTATION, COORDINATION, MONITORING AND EVALUATION ARRANGEMENTS

Implementation, coordination, monitoring and evaluation of NABERM I will be carried out by various stakeholders. However, overall coordination, monitoring and evaluation is vested to TAFORI.

5.1 IMPLEMENTATION

NABERM 1 is providing roadmap for execution of beekeeping research in the country. Implementation will be done by various stakeholders adhering to relevant regulations and procedures laid down by the Government. Roles and responsibilities of key stakeholders are presented in Table 1.

Table 1: Roles and responsibilities of key stakeholders

SN	Stakeholder	Role/responsibility
1	MNRT	Overall custodian of NABERM I Support research activities Use and promote research findings Communicate research findings
2	PO-RALG	Use and communicate research findings Provide required information for research Support research activities
3	Sector ministries	Collaborate and support research activities Use and promote research findings
4	COSTECH	Overall coordination and promotion of research activities

		Finance research activities Register and promote innovations
5	Research institutions	Conduct research Use and communicate research findings
6	Academic institutions	Conduct research Use research findings Train researchers
7	Development partners	Expertise and financial support
8	International communities	Expertise and financial support User of research findings
9	Private sector	Collaborate in research activities Finance and support research activities User of research findings
10	NGOs	Finance and support research activities Use and Communicate research findings
11	Media	Communicate research findings
12	Regulatory authorities	Collaborate with researchers in setting and supervising standards Users of research findings Ensure standards, protocols and procedures are maintained
13	Beekeepers and farmers	Provider of information User of research findings Support and collaborate in research activities

5.2 COORDINATION

Coordination and regulation of NABERM I activities will involve but not limited to;

i. Identifying and soliciting funds from various sources to support NABERM I;

ii. Receive research proposals, evaluate and recommend them for further actions;
iii. Monitoring and evaluation of research activities in the field;
iv. Collect, synthesize and deposit published research materials ;
v. Organizing research fora such as conferences, workshops, seminars, symposia;
vi. Set and review regularly beekeeping research priority areas through consultations with stakeholders; and
vii. Prepare and publish newsletters, policy briefs and extension materials.

5.3 MONITORING AND EVALUATION

Monitoring and Evaluation (M & E) is a management tool used to follow up or find out if the plan is being implemented accordingly. M & E will be carried out progressively and reports submitted to TAFORI Board of Directors.

In order to appraise stakeholders on the progress made and the overall performance of NABERM I, annual Review workshops will be held. Comments given during Stakeholder's review workshops will be incorporated when preparing annual reports.

For the purpose of evaluating NABERM I in terms of relevance, effectiveness, efficiency and impact, two evaluations missions will be conducted; mid-term and final evaluations. Mid-term evaluation will take place after five years to assess progress of NABERM I. Final evaluation will take place after 10 years to assess the implementation of NABERM I. Evaluation reports will be the base for formulation of NABERM II.

CHAPTER SIX

6.0 SUPPORT PROGRAMME

6.1 HUMAN RESOURCES

6.1.1 Background and Justification

Capacity to do effective research depends on the investment on human resources. Research Institutions, companies and organizations dealing with beekeeping need well trained, skilled and experienced researchers, technical and supporting staff. Since staff with such attributes are scarce, Research Institutions need to effectively plan how to recruit, train and retain them by preparing sustainable human resource development programmes.

As stated in the National Beekeeping Programme (URT, 2001), the roles of beekeeping research and training institutions in producing trained and skilled manpower is critical in order to ensure that all beekeeping and related industries are professionally managed. Currently, the human resource capacity in beekeeping sector is not adequate.

In order to strengthen the capacity of beekeeping research institutions to conduct and manage beekeeping research, the following activities need to be undertaken by research institutions in order to meet the above objective:

6.1.2 Programme activities

i. To undertake manning levels by replacement and recruitment of new staff;
ii. To develop and coordinate training programmes based on Institution's training needs assessment;
iii. To establish National and International institutional linkages in order to diversify training and research opportunities and sabbatical attachments to researchers; and
iv. To review and improve scheme of service for researchers and supporting staff in order to motivate, promote and retain them.

6.2 INFRASTRUCTURE

6.2.1 Background and Justification

To ensure conducive working environment, Beekeeping Research Institutions need to have well equipped and accredited laboratories, field equipment, transport facilities, collection points and centers, processing facilities, and well equipped offices with internet services. To ensure efficient use and undue duplication of equipment and facilities, efforts to share and coordinate the availability of these facilities to different Research Institutions need to be worked out.

6.2.2 Programme activities

i. To plan and construct new infrastructure based on Institution's current and future needs;
ii. To assess and institute routine maintenance of infrastructure;
iii. To acquire new equipment and facilities and
iv. Establish a culture of sharing research facilities.

6.3 PUBLICATIONS AND DISSEMINATION OF RESEARCH FINDINGS

6.3.1 Background and Justification

Research outputs need to be published and disseminated to end users or end beneficiaries. While in Tanzania researchers are free to publish and disseminate research results through various outlets, such information needs to be available at one source. Therefore, it is high time that TAFORI establishes and hosts a national depository and library of all beekeeping research outputs.

6.3.2 Programme activities

i. Researchers motivated to publish research findings in reputable and retrievable sources;
ii. Annual review workshops held for presenting research findings;
iii. Beekeeping research institutions participate actively and disseminate research results in National and International Scientific Conferences, Trade fairs, ApiExpo and Agricultural shows;
iv. World Bee Day promoted and research institutes participate actively;

v. Local journals facilitated to publish and disseminate research findings regularly;

vi. Research findings disseminated using ICT facilities.

6.4 RESEARCH FINANCING

The main sources of funding for beekeeping research in Tanzania include: the Government, Development partners, Private sector and internal revenue generation. Considering the central role of research in the development of beekeeping and allied natural resources, the Government is expected to continue funding beekeeping research because it has been receiving little funding despite of its potential to contribute to the national development. Beekeeping research projects should be given funding priority by COSTECH and Tanzania Forest Fund (TaFF).

Development Partners have been supporting beekeeping research in Tanzania over the past 40 years. This has somehow strengthened beekeeping research capacity in terms of human resource and infrastructure. The contribution of private sector has not been adequate in beekeeping researches. It is expected that under NABERM I, the private sector will be motivated to participate on 'win-win' arrangement through Public-Private-Partnership (PPP) by linking research and investment in beekeeping related industries.

6.5 COSTING

Since TAFORI is the overall in charge of coordinating, monitoring and evaluation of NABERM I, budget for implementing it is estimated to be TZS 30.8 billion (Table 2).

Table 2: Estimated costs for implementation of NABERM I

SN	TARGETS	ESTIMATED COST (TZS, 000,000)
1	Appropriate bee hives and relevant accessories for sustainable beekeeping industry developed by 2030	1,000
2	Management regimes/practices that ensure conservation of honeybees and stingless bees, their habitats, and increased quantity and quality of bee products developed by 2030	1,000
3	Beekeeping resources to maximize their utilization assessed by 2030	1,000
4	Equitable mechanisms for utilizing beekeeping resources in	300

	all forms of land use explored by 2030	
5	Safety of bees ensured by 2030	700
6	Appropriate bee hives and relevant accessories for sustainable beekeeping industry promoted by 2030	500
7	Technologies for harvesting, processing, packing and handling of bee products promoted by 2030	300
8	Industries for sustainable supply of beekeeping equipment, related goods and services supported by 2030	500
9	Markets and marketing systems of bee products and equipment promoted	300
10	Technologies for harvesting, processing, packaging and handling of bee products developed by 2030	600
11	Technologies for sustainable supply of beekeeping equipment and bee related products developed by 2030	600
12	Value added bee products developed by 2023	500
13	Technologies for monitoring bees and bee colonies established by 2030	500
14	Bee pollination services in forest and farm lands evaluated by 2030	300
15	Coordination of research communication improved by 2030	500
16	Scientific information to support sector related policy processes provided by 2030	300
17	Availability and accessibility of research findings increased by 2030	700
18	Coordination of research activities improved by 2030	1,000
19	Human resource capacity to conduct and coordinate beekeeping research in order to meet the National and International obligations strengthened by 2030	10,000
20	Infrastructure and working environment in research institutes supported by 2030	10,200
	GRAND TOTAL	**30,800**

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