World Organisation for Animal Health

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WOAH Collaborative Centre Reports Activities 2024

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CENTRE INFORMATION

***Title of WOAH Collaborating Centre**	Bee Health in Africa
***Address of WOAH Collaborating Centre**	International Centre of Insect Physiology and Ecology (ICIPE)
***Tel:**	+254-20 863 20 00
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***Name Director of Institute (Responsible Official):**	Dr. Abdou Tenkouano, CEO and Director General
***Name (including Title and Position) of Head of the Collaborating Centre (WOAH Contact Point):**	Dr Subramanian Sevgan, Principal Scientist and Head, Environment Health Theme, icipe
***Name of the writer:**	Subramanian Sevgan

TOR 1 AND 2: SERVICES PROVIDED

1. Activities as a centre of research, expertise, standardisation and dissemination of techniques within the remit of the mandate given by WOAH

Category	Title of activity	Scope
		1) Evaluating antibacterial and antioxidant

Disease control (true)	Evaluation of antimicrobial properties of insect-based products	properties of sericin recovered from cocoons of Bombyx mori, Gonometa postica and Samia ricini in Kenya: This work focused on evaluating antibacterial and antioxidant capacity of sericin recovered from cocoons of domesticated (Bombyx mori, Samia ricini) and wild (Gonometa postica) silkworms in Kenya. Kanyora, M. G., Kegode, T. M., Kurgat, J., Kibogo, H., Asudi, G., Tanga, C. M., ... & Ndungu, N. (2024). Evaluating antibacterial and antioxidant properties of sericin recovered from cocoons of Bombyx mori, Gonometa postica and Samia ricini in Kenya. PloS one, 19(12), e0316259. 2) Bio-functional properties and phytochemical composition of selected Apis mellifera honey from Africa this study aimed to characterise the bio-functional properties and the phytochemical composition of 18 Apis mellifera honeys from Kenya, Uganda, and Cameroon in comparison to the popular and commercially available Manuka 5+ honey from New Zealand. Ndungu, N. N., Kegode, T. M., Kurgat, J. K., Baleba, S. B., Cheseto, X., Turner, S., ... & Nganso, B. T. (2024). Bio-functional properties and phytochemical composition of selected Apis mellifera honey from Africa. Heliyon, 10(10).
		1) Comparison of Semi-Parametric Shared Frailty Models for Bees' Survival This study evaluates the performance of semi-parametric shared frailty models (gamma, inverse normal, and positive stable-in comparison to the traditional Cox model using bees' survival data). The shared gamma frailty model provided a better fit to the data in comparison with the other models. Therefore, when focusing on regression parameters, the gamma frailty model is recommended. This research underscores the importance of tailored survival methodologies for accurately analyzing time-to-event data in social organisms. Isiaho, P., Salifu, D., Mwalili, S., & Tonnang, H. E. (2024). Comparison of Semi-Parametric Shared Frailty Models for Bees' Survival. Journal of Data Analysis and Information Processing, 12(2), 267-288. 2) Managed honey bee colony losses and causes

Epidemiology, surveillance, risk assessment, (true)	Surveillance of key pest and health risks associated with bees in Africa and their management practices	during the active beekeeping season 2022/2023 in nine Sub-Saharan African countries This study reports for the first-time managed honey bee colony loss rates and associated risk factors during the active beekeeping season 2022/2023 in nine Sub-Saharan African countries, namely Kenya, Ethiopia, Rwanda, Uganda, Benin, Liberia, Nigeria, Cameroon and Democratic Republic of the Congo. Overall, this comprehensive survey sheds light on the complexities and challenges beekeepers faced in Sub-Saharan Africa, pointing to the need for targeted interventions and sustained research to support the resilience and growth of the apicultural sector. Nganso, B. T., Ayalew, W., Wubie, A. J., Assefa, F., Belayhun, L., Ndungu, N. N., ... & Subramanian, S. (2024). Managed honey bee colony losses and causes during the active beekeeping season 2022/2023 in nine Sub-Saharan African countries. bioRxiv, 2024-04. 3) Large-Scale Survey of Colony Losses in Sub-Saharan Africa Reveals Climate Impacts on Honey Bees This study focused on monitoring the honey bee colony loss in Kenya and the factors associated with it. Sibaja Leyton et al.2024. Large-Scale Survey of Colony Losses in Sub-Saharan Africa Reveals Climate Impacts on Honey Bees. Available at SSRN 4830469. 4) Best practices for colony management: a neglected aspect for improving honey bee colony health and productivity in Africa This review analyzed the best colony management practices for maintaining an effective and stable bee colonies in Africa and for effective management of Bee pests and diseases. Nganso et al. (2024). Best practices for colony management: a neglected aspect for improving honey bee colony health and productivity in Africa. Journal of Apicultural Research, 1-18.
		1) More than 39888 youth and women entrepreneurs in Ethiopia trained on improved beekeeping, Bee product development, processing and marketing through the MOYESH program funded by Mastercard foundation. https://moyesh.icipe.org/ 2) more

Training, capacity building (true)	Building capacity of beekeepers, entrepreneurs, farmers, researchers and members of non-governmental organizations on improved bee farming and product development.	than 150 farmers in Kenya trained on honey bee and stingless bee farming and health management practices through the support of BMZ/GIZ and icipe's core funds. 3) A first bee and honeybee farming training facility has been established in Kakamega, Kenya. https://www.icipe.org/news/icipe-reinvigorates-support-conservation-kakamega-forest-ecosystem 4) More than 10 members of the Food for the Hungry trained on Bee and stingless bee farming and pest management techniques in Kakamega Kenya.
		1) Chemosensory function of Varroa gnathosoma: transcriptomic and proteomic analyses In this study, we evaluated the role of the gnathosoma (mouthparts) in chemosensing of the most devastating honeybee parasite, Varroa destructor mite through transcriptomic analysis. Nganso, B. T., Eliash, N., Mani, K., Sela, N., Villar-Briones, A., Osabutey, A. F., ... & Soroker, V. (2024). Chemosensory function of Varroa gnathosoma: transcriptomic and proteomic analyses. Experimental and Applied Acarology, 1-19. 2) Black queen cell virus detected in endemic African stingless bees (Apidae: Meliponinae) We tested for the presence of honeybee pathogens in nine stingless bee species in Kenya across a gradient of sites with different degrees of conservation status. We sampled colonies in meliponaries in Nairobi at the icipe Duduville campus and at Kakamega forest in Western Kenya. We screened for seven common honeybee viruses and the microsporidian parasite Nosema spp applying molecular diagnostic methods. Black queen cell virus (BQCV) was the only honeybee diseases detected in four stingless bee species (Hypotrigona gribodoi, Meliponula bocandei, M. togoensis, and M. lendiliana). Nkoba, K., Nelly, N. U., Pozo, M. I., Lattorff, H. M. G., Jaramillo, J., & Hundt, B. (2024). Black queen cell virus detected in endemic African stingless bees (Apidae: Meliponinae). International Journal of Tropical Insect Science, 1-7. 3) Electroantennography Responses of African Meliponine Bee Species (Hymenoptera: meliponini) to Hetero-Specific Trail Pheromones: Glandular Sequestration of

Diagnosis, biotechnology and laboratory (true)	Undertake advanced research on diagnosis and treatment of major pest and diseases of Bees in Africa.	Terpenyl Esters Preliminary studies of electroantennographic responses of African meliponine bees to trail pheromones were performed using four meliponine species; Hypotrigona gribodoi, Meliponula ferruginea (black), Meliponula ferruginea (reddish brown) and Melipona bocandei. Bobadoye, B., Nganso, B., & Kiatoko, N. (2024). Electroantennography Responses of African Meliponine Bee Species (Hymenoptera: meliponini) to Hetero-Specific Trail Pheromones: Glandular Sequestration of Terpenyl Esters. bioRxiv, 2024-03. 4) Multi-pronged abundance prediction of bee pests' spatial proliferation in Kenya This study sought to determine factors that in fluence the abundance and spatial proliferation of bee pests in Kenya. Abundance data on Varroa destructor, Oplostomus haroldi, Galleria mellonella and Aethina tumida were collected from apiaries in Kenya during the wet and dry seasons. The abundance data were fitted to non-conflating human footprint datasets, satellite derived vegetation phenological, topographical and bioclimatic variables. The results indicated a significant ($p \leq 0.05$) seasonal influence on bee pests' abundance, while precipitation was the most relevant on most bee pests' abundance prediction models. Topographic and vegetation phenological influence varied across the landscapes while anthropogenic influence was comparatively low. High seasonality in bioclimatic variables influenced the projected (year 2055) spatial and abundance risk levels of bee pests across the study area. The V. destructor and A. tumida prediction models for current and future epochs ranked excellent in their performance, while O. haroldi and G. mellonella were ranked good and fair, respectively. Due to their precision, this study concluded that these models could reliably be used to establish bee pests' high-risk areas for management and mitigation purposes. Makori, D. M., Abdel-Rahman, E. M., Odindi, J., Mutanga, O., Landmann, T., & Tonnang, H. E. (2024). Multi-pronged abundance prediction of bee pests' spatial proliferation in Kenya. International Journal of Applied Earth

		Observation and Geoinformation, 128, 103738.
		1) 1) Evaluation of volatiles from ethnobotanical plants as attractants for the honeybee swarms in Kenya To identify traditional plant-based bee attractants, an ethnobotanical survey was carried out in Kenya to gain an in-depth understanding of traditional apicultural practices used for hive baiting to attract swarms. Additionally, the volatile composition of traditional plants used as swarm lures was examined using gas chromatography–mass spectrometry (GC–MS), and their effectiveness in catching swarms was evaluated in comparison to beeswax in the field. The survey results revealed that Ocimum kilimandscharicum, Cymbopogon nardus and Elaeodendron buchananii are the three commonly used traditional plants for baiting, chosen based on their aroma, abundance, ease of processing and durability. Notably, the volatiles emitted by O. kilimandscharicum plus beeswax attracted significantly two and half-fold more bee swarms than the control (beeswax alone). Our findings suggest that adding O. kilimandscharicum to beeswax may significantly enhance bee swarm catches in the field. Ochola, J. B., Nganso, B. T., Subramanian, S., & Nkoba, K. (2024). Evaluation of volatiles from ethnobotanical plants as attractants for the honeybee swarms in Kenya. Journal of Applied Entomology, 148(8), 938-947. 2) When size matters: effectiveness of three endemic African stingless bees as watermelon pollinators Our study aimed at determining how bee body size, visitation rate, and bee-flower size matching ratio affect pollen deposition. We calculated the bee-flower size matching ratio, the relationship between the bee size, and the flower measurement to gauge the effectiveness of each bee species on pollen deposition and distribution among the three watermelon stigmatic lobes. Our findings elaborate on how the different sizes of various bee parts majorly impacted the amount of pollen deposited. Besides, the number of visits, probing time, and bee behaviour when handling the flower also played a role. Kasiera,

Food security (true)	Harnessing of pollination for enhanced food production and food security in Africa	W., Pozo, M. I., Toroitich, K., Karanja, R., Odhiambo, M., Jaramillo, J., ... & Nkoba, K. (2024). When size matters: effectiveness of three endemic African stingless bees as watermelon pollinators. Apidologie, 55(4), 48. 3) Co-occurrence and abundance of pollinators and pests in horticultural systems in Africa using an integrated Earth observation-based approach This study focused on investigating the influence of cropping patterns on the spatial distribution of pollinators (Apis mellifera, Hymenoptera other than A. mellifera, and Syrphidae), flower visitors (Calliphoridae), and pests, i.e. fruit fly (Bactrocera dorsalis) and false codling moth (Thaumatotibia leucotreta) of the avocado, a pollinator-dependent crop. Cropping patterns, earth observation data and relevant environmental variables were used as the predictor variables for modelling the potential distribution and abundance of avocado pollinators, flower visitors and pests in one of the leading regions in avocado production in Kandara, Maragua, and Gatanga sub-Counties in Murang'a County, Kenya. In specific, species distribution modelling (SDM) and species abundance modelling (SAM) techniques, i.e. the maximum entropy (MaxEnt) model (presence-only data) and negative binomial (NB) distribution in a generalized linear model (GLM) (abundance data) were used, respectively. Additionally, the spatial distribution probability of the co-occurrence of the pollinators, flower visitors and pests was also analysed. This study revealed that cropping patterns was the most consistent influential predictor variables for the distribution of avocado pollinators, flower visitors and pests. Our study revealed that SDM and SAM modelling outputs can be used to inform decision making for the implementation of sustainable management efforts regarding pollinators, flower visitors, and insect pests. Aduvukha, G. R., Abdel-Rahman, E. M., Mudereri, B. T., Sichangi, A. W., Makokha, G. O., Lattorff, H. M. G., ... & Dubois, T. (2024). Co-occurrence and abundance of pollinators and pests in horticultural systems in Africa using an

integrated Earth observation-based approach. GIScience & Remote Sensing, 61(1), 2347068. 4) Impact of integrating pest and pollinator management training on knowledge, perceptions, and livelihoods of avocado farmers in Kenya. In this study, we investigated the impact of IPPM training on farmers' knowledge, attitude, and management of avocado pests, changes in the size of avocado orchards, avocado losses due to insect pests, expenditure on pesticides, and income. We compared farmers using IPPM against those using each component in isolation (integrated pest management (IPM) or pollination services (PS) through beehive supplementation (PS)) and a control group that used conventional practices without PS. We utilized 2 rounds of panel data obtained from avocado growers from Murang'a County, Kenya, and employed difference-in-difference (DiD) and multinomial logistic regression models. The results indicate that individuals utilizing IPM demonstrated notable enhancements in their perceptions of avocado pests, pollinators, and IPPM packages in comparison to the control group. Conversely, those utilizing IPPM employed more effective pest management strategies than users of IPM only. In contrast to using IPM and PS in isolation, farmers who utilized IPPM registered a significantly higher (9.6%) increase in the proportion of household annual income from avocado farming compared to the control group. Our findings further show that farmers who received training were more likely to adopt IPM, PS, and IPPM practices. We recommend wide promotion of IPPM to enhance avocado production and livelihoods of smallholders in sub-Saharan Africa. Muriithi, B. W., Dubois, T., Kirui, L., Lattorff, H. M. G., Mohamed, S., Abdel-Rahman, E. M., ... & Kassie, M. (2024). Impact of integrating pest and pollinator management training on knowledge, perceptions, and livelihoods of avocado farmers in Kenya. Journal of Integrated Pest Management, 15(1), 35. 5) 5) Compositional Profile of Honeys from Stingless Bees and Honeybee Honey from a West African Country

		Using 1H NMR Spectroscopy We collected 21 samples of A. mellifera honey and 21 samples of stingless bee honey from eight localities in Burkina Faso. The chemical composition of the samples was characterized using 1H NMR spectroscopy. Our results showed that stingless bee honey composition differed from that of A. mellifera honeys with a lower sugar content and a higher acid content due to different fermentation processes, producing a honey with a higher functional chemodiversity. The greater functional diversity in stingless bee honey may influence synergistic interactions between its compounds, thereby amplifying the beneficial properties of the honey. Our results provide a chemical characterization of Afrotropical stingless bee honey, highlighting the complexity of this natural medicine whose properties remain under investigated. Kanazoe, I. W., Noiset, P., Nombré, I., Héger, M., Salmon, C., Nkoba, K., & Vereecken, N. J. (2024). Compositional Profile of Honeys from Stingless Bees and Honeybee Honey from a West African Country Using 1H NMR Spectroscopy. ACS Food Science & Technology.
Impact assessment and policies	Assessing impacts of bee keeping	1) Ethiopia Beekeeping's pollination services impact: Managed bees increase gross crop income by about $1,800 per household per year (25% of the average gross income of the farm households). A back-of-the-envelope calculation reveals that the ecosystem contribution of managed bees to Ethiopia's economy is about $606 million annually, about 5% of the agriculture GDP. The findings suggest that policymakers and development partners will need to pay attention to the role of pollination services of the sector in increasing crop productivity and income. A draft paper developed and it is internal review. 2) Socioeconomic impact of stingless bees research (Draft paper) This study establishes a baseline on the status of stingless bees in Ethiopia and Kenya using data collected from 822 and 629 respondents. Respondents reported earning an average of USD 151 per year in Ethiopia and USD 144 per year in Kenya. 3) Randomized control trial (RCT) to

(true)	and pollination services for livelihoods and Income.	estimate the livelihood and ecosystem services of managed bees (Work in progress) Using RCT, the study evaluates the incremental pollination and livelihood benefits of beehives provided by the More Young Entrepreneurs in Silk and Honey (MOYESH) programme. The key primary outcomes are income of youths (from 600 youth enterprises) and the yields of pollinator-dependent crops (tonne/ha). 4) An RCT to address free riding problems of members of youth beekeeping enterprises in Ethiopia (Work in progress) By reducing equal contribution among members of group enterprises, free-riding reduce enterprise income and overall performance. This RCT aims addressing free-riding behavior of youth groups and their enterprises (1,900) and find alternative cost-effective mechanisms for improving youth group effort and enterprise-level outcomes, income and productivity.

TOR 3: HARMONISATION OF STANDARDS

2. Proposal or development of any procedure that will facilitate harmonisation of international regulations applicable to the main fucus area for which you were designated

Proposal title	Scope/Content	Applicable Area
	Stingless bee honey and other bee product standards Background: Traditionally communities know the medicinal value of stingless bee honey and it is highly sought after. In fact, the value of stingless bee honey can be more than 3 folds costlier than Apis honey. However, the value chain associated with stingless bee honey is still marginal and not mainstreamed. Adoption of hiving practices for stingless bee is still marginal, but there is good opportunity to scale this and the associated value chain. We are currently doing this in stingless bee hotspots of Kakamega forest, Taita Taveta in Kenya; Zanzibar in Tanzania; locations in Ethiopia and some island nations of Africa. The markets of honey of stingless bees are largely restricted on the individual locations and often traded directly between the farmers and the consumers. The honey is not widely traded in the	

Establishment of unique standards for stingless bee honey and their products.	national/International level. There are some key constraints that need to be addressed to broaden the markets for stingless bee honey at national level/international level, which also answers your next query. Unlike the Apis honey, standards for Stingless bee honey and other associated products have not been widely established and approved. One of our key focus is to address this gap. In this regard, we recently had a dialogue with the regulatory authorities in Kenya to understand their challenges in establishing standards. Some key facts emerged in this discussion 1) The Kenya Bureau of Standards along with its Tanzanian counterparts have tried to develop standards for stingless bee honey and a draft has been developed, 2) However, they have considered stingless bee honey as one entity, rather than categorising them according to the various species. This has resulted in enormous variability among stingless bee honey samples making establishment of standard parameters a challenge, 3) The attempts to establish standards for stingless bee honey has often been related to Apis honey, which are widely different products altogether. For instance, the water content in stingless bee honey is by nature high and cannot be compared with Apis honey 4) the processing techniques for stingless bee honey is different, needs maturation after harvest to reduce the moisture content and stabilization, while with Apis honey, brief warming of the extracted honey stabilizes the product. The quality of the stingless bee honey especially percentage of fermentation products varies with the processing techniques. Hence, there is need for establishing standards, which encompasses prescribed processing techniques 5) the shelf life of stingless bee honey is much shorter than Apis honey. An appropriately processed honey, within the effective shelf-life period is safe for human consumption. We are also characterising pest and diseases association with stingless bees and understanding their impacts on the safety of the product can be critical. The area of establishing standards for stingless bee honey needs some critical intervention globally and if standards are established successfully and localized to the diversity of species in the different regions, this can be a game-changer for the stingless bee honey value-chain. We are happy to discuss this further	Animal Production Veterinary Products Wildlife Health and Biodiversity

	with you at any opportune moment. Proposed interventions include 1) Assess the market and consumer preference for various stingless bee honey in Kenya 2) Characterisation the property of the most preferred stingless bee honey and other hive products, along with standardization of appropriate processing methods 3) Optimize stingless beehive designs and develop their quality standards 4) In partnership with standards organization at the national and continental level, draft quality standards, discuss them widely with stakeholders and gazette the same. 5) Create awareness on the new standards developed among stakeholders, especially youth and women entrepreneurs, industry partners and policy makers.	
Harmonization of policies and standards related to geographically indicated honey and other hive products from Africa.	Africa has a wide diversity of honeybee honey types and many of them unique characteristics. However, the value of these unique honey types has not been realized as they are not geographically indicated and branded. Policies around geographic indication and more so for honey products are poorly developed in the continent. There is need to strengthen, harmonize and implement standards.	Animal Production Veterinary Products Wildlife Health and Biodiversity

3. In exercising your activities, have you identified any regulatory research needs* relevant for WOAH?

Yes

Research need 1

Please type the Research need: 1) Characterization of unique types in Africa with a long-term focus on quality control and geographic indication. 2) Characterization of Stingless honey types in Africa in relation to species types and geographies for development of standards.

Relevance for WOAH Capacity Building, Standard Setting, Facilitation of international collaboration,

Relevance for the Code or Manual Code, Manual,

Field

Animal Category Terrestrial,

Disease:

Kind of disease (Zoonosis, Transboundary diseases)

If any, please specify relevance for Codes or Manual, chapter and title

(e.g. Terrestrial Manual Chapter 2.3.5 - Minimum requirements for aseptic production in vaccine manufacture)

Answer:

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Notes:

Answer:

4. Did your Collaborating Centre maintain a network with other WOAH Collaborating Centres (CC), Reference Laboratories (RL), or organisations designated for the same specialty, to coordinate scientific and technical studies?

Yes

Name of WOAH CC/RL/other organisation(s)	Location	Region of networking Centre	Purpose
WOAH headquarters, Paris	Paris, France	Europa	Development of a joint publication on "Bee diversity, Health and Sustainable agriculture in Africa" in article titled "Bee diversity, health, and sustainable agriculture in Africa featured in the latest issue of the WOAH Bulletin - Panorama.
WOAH Sub-Regional Representation for Southern Africa	ESwatini Kingdom	África	Facilitation of Report for Workshop on Antimicrobial Resistance (AMR) in Apiculture Mbabane, eSwatini, 13-15th August 2024 By Dr Nganso and Dr Ndungu.
Animal and Plant Health Agency	Ghana	África	Participation in participate in a bee health meeting - Ghana
WOAH Collaborating Centre on Good Beekeeping Management and Biosecurity in Apiculture	Online	África Europa	Participation and presentation of a talk in the 3rd International Event on Bee health towards sustainable Apiculture - 17th May 2024.

TOR 4 AND 5: NETWORKING AND COLLABORATION

5. Did your Collaborating Centre maintain a network with other WOAH Collaborating Centres, Reference laboratories, or organisations in other disciplines, to coordinate scientific and technical studies?

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Yes

Name of WOAH CC/RL/other organisation(s)	Location	Region of networking Centre	Purpose
WOAH Headquarters	Paris	Africa Europe	Joint publication
WOAH subregional office for South Africa	Eswatini	Africa	Joint organisation of a training on Antimicrobial Resistance management in Beekeeping.
WOAH Collaborating Centre on Good Beekeeping Management and Biosecurity in Apiculture	Online	Africa Europe	Participation in the "3rd International Event Organized of the International Technical Working Group on bee health towards sustainable apiculture"

TOR 6: EXPERT CONSULTANTS

6. Did your Collaborating Centre place expert consultants at the disposal of WOAH?

Yes

Name of expert	Kind of consultancy	Subject
Dr Beatrice Nganso Dr Nelly Ndungu	Offer training program on Antimicrobial Resistance (AMR) in Apiculture Mbabane, eSwatini, 13-15th August 2024	Apiculture and Antimicrobial Resistance (AMR)
Dr Kiatoko Nkoba	Offer training on improved beekeeping and management in Ghana.	Improved beekeeping training

TOR 7: SCIENTIFIC AND TECHNICAL TRAINING

7. Did your Collaborating Centre provide advice/services to requests from Members in your main focus area?

No

8. Did your Collaborating Centre provide scientific and technical training, within the remit of the mandate given by WOAH, to personnel from WOAH Members?

Yes

a) Technical visit : 60

b) Seminars : 730

c) Hands-on training courses: 254

d) Internships (>1 month) : 10

Type of technical training provided (a, b, c or d)	Content	Country of origin of the expert(s) provided with training	No. participants from the corresponding country
A	The France Embassy	France, Kenya, Brazil, India, DR Congo	35
A	The Mastercard Foundation Finance Leadership team consisting of seven executives, To gain insights and experiences related to the MOYESH programme implementation and learn from the programme setup to enhance the Foundation's effectiveness and impact, seven members of the Foundation's Finance Leadership team, visited us on 13 June 2024.	Ethiopia and many other Countries	7
A	The Gender Director of the Mastercard Foundation (Ms. Marieme Esther Dassanou)	Senegal	1
A	Visit by Mastercard Foundation Partner African Higher Education Institutions	University professors from Various African Countries	15
A	Dr. Danny Nef, the programme manager at the Biovision Foundation	Switzerland	1
A	Dr. Peter Donelan, Coordinator of the Enhanced Implementation Framework (EIF) of the WTO	Ireland	1

B	World bee day celebrations, 19th – 20th May 2024.Kajiado, Kenya	Kenya, DR Congo, Cameroon	500
B	Association of Kenyan Entomologist at the NMK 5th June 2024	Kenya	100
B	Building Equitable Climate-Resilient African Bean & Insect Sectors (BRAINS). Project Implementation Agenda Workshop. icipe – Technical Team. DATE: 12-13 September 2024.VENUE: Serena Hotel, Mombasa, KENYA	Kenya	60
B	Symposium on Harnessing Insect Pollination to Enhance Nutrition and Economic Benefits in Global South Organized in the International Congress of Entomology, Kyoto, Japan, August 30th 2024	Various countries	70
C	Sericultural and Apicultural training workshop for Wachna Green World CBO members, Rongo University and Migori county beekeeper Association. Dates: 22nd -28th Sep 2024. Venue: Uriri Migori County	Kenya	150
C	Three-Day Workshop on Antimicrobial Resistance (AMR) in Apiculture Mbabane, eSwatini, 13-15th August 2024 Organized by WOAH And facilitated by ICIPE and FAO	Angola, Botswana, Comoros, DRC, eSwatini Kenya, Lesotho, Madagascar, Malawi, Mozambique, Namibia, Seychelles, Tanzania, Zambia, and Zimbabwe	25
C	First national level training on sustainable stingless bee farming and product development in Kakamega county, Kenya, 26th – 27th July 2024	Kenya, Belgium, Ethiopia, DRCongo	70
C	Stingless bee farming for livelihood, Kakamega county, Kenya, 18th – 31st March 2024.	Burkina Faso	2

C	Sustainable stingless bee farming for livelihood and biodiversity conservation. Kakamega & Nairobi county, Kenya, 29th November– 8th December 2024	DRCongo, Burundi, Uganda	7
D	PhD study on Ecology and Evolution of Afrotropical stingless bees	Belgium	1
D	PhD Assessing the effects of integrated pest and pollinator management on Welfare and Environmental Health in the Horticultural Value Chain	Ethiopia	1
D	MSc. Assessing bee forage plant diversity and pesticide residues in bee products in Cameroon	Cameroon	1
D	MSc Assembling and digitizing existing plant-insect pollinator biodiversity data in Cameroon	Cameroon	1
D	Intern - To learn and assist in carrying out laboratory collection and analysis from plants and data recording of laboratory and field experiments	Kenya	1
D	Internship on build knowledge in literature review collecting data cleaning and storage, Learning on conducting socio-economic assessment in beekeeping	Kenya	1
D	o conduct a study on Optimization of the formulation and application of Ocimum tenuiflorum extracts to contol the fruit fly Bactrocera dorsalis in Kenya	Switzerland	1
D	To build knowledge in quality assessement, data collection, cleaning and storage	Kenya	1

D	To build knowledge in analyszing silkworm frass biopesticide activity	Kenya	1
D	Learning on in vitro production of stingless bee queen	Kenya	1

TOR 8: SCIENTIFIC MEETINGS

9. Did your Collaborating Centre organise or participate in the organisation of scientific meetings related to your main focus area on behalf of WOAH?

Yes

National/International	Title of event	Co-organiser	Date	Location	No. Participants
Internationally	Harnessing Insect Pollination to Enhance Nutrition and Economic Benefits in Global South Symposium in International Congress of Entomology	Menale Kassie	2024-08-29	Kyoto, Japan	70
Internationally	Global Bioeconomy Summit	Global Bioeconomy council	2024-10-22	Nairobi	3000
Nationally	Invitation to the National Validation Meeting of the Draft Training Curriculum for Certificate in Apiculture, 2024	National Bee Keeping Institute, Ministry of Livestock, Kenya	2024-06-23	Nairobi	25
Nationally	Gender integration in Bio-innovations	Bioinnovate	2024-10-06	Nairobi	25
Internationally	Earth observation and environmental sensing for climate-smart sustainable agropastoral ecosystem transformation in East Africa – ESSA	University of Helsinki	2024-10-23	Nairobi	25

TOR 9: DATA AND INFORMATION DISSEMINATION

10. Publication and dissemination of any information within the remit of the mandate given by WOAH that may be useful to Members of WOAH

a) Articles published in peer-reviewed journals:

14

1) Kanyora, M. G., Kegode, T. M., Kurgat, J., Kibogo, H., Asudi, G., Tanga, C. M., ... & Ndungu, N. (2024). Evaluating antibacterial and antioxidant properties of sericin recovered from cocoons of Bombyx mori, Gonometa postica and Samia ricini in Kenya. PloS one, 19(12), e0316259.

2) Aduvukha, G. R., Abdel-Rahman, E. M., Mudereri, B. T., Sichangi, A. W., Makokha, G. O., Lattorff, H. M. G., ... & Dubois, T. (2024). Co-occurrence and abundance of pollinators and pests in horticultural systems in Africa using an integrated Earth observation-based approach. GIScience & Remote Sensing, 61(1), 2347068.

3) Sangha, M. N., Barwani, D. K., Xavier, C., Muhonja, L., Moseti, K., Karanja, P. N., ... & Tanga, C. M. (2024). We are what we eat: Implications of host plant suitability on sustainable production of silkworm pupae as novel ingredient with dietary and health benefits. PloS one, 19(12), e0316290.

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14) Nganso, B. T., Ayalew, W., Wubie, A. J., Assefa, F., Belayhun, L., Ndungu, N. N., ... & Subramanian, S. (2024). Managed honey bee colony losses and causes during the active beekeeping season 2022/2023 in nine Sub-Saharan African countries. bioRxiv, 2024-04.

b) International conferences:

6

1) Symposium in International Congress of Entomology, Kyoto, Japan, August 30th, 2024

2) Earth observation and environmental sensing for climate-smart sustainable agropastoral ecosystem transformation in East Africa – 24-25 October 2024

3) African Association of Insect Scientists (AAIS) - 18th - 22nd November 2024

4) ESSA workshop Targeted communication of research, development and engagement findings. - 25th to 27th March 2024

5) Earth observation and environmental sensing for climate-smart sustainable agropastoral ecosystem transformation in East Africa – ESSA - 25th October 2024
6) Attended the 20th Conference of the International Honey bee Research Association (COLOSS remotely), Wageningen, Netherlands - 12-13 November 2024

c) National conferences:
2
1) The National Validation Meeting of the Draft Training Curriculum for Certificate in Apiculture, 2024 - 24th June, 2024
2) Gender integration in Bio-innovations- Oct 7 & 8 2024

d) Other (Provide website address or link to appropriate information):
1) Workshop in Eswatini - For the eSwatini training on the AMRs enetitled, Three-Day Workshop on Antimicrobial Resistance (AMR) in Apiculture Mbabane, eSwatini, 13-15th August 2024, we listed some recommendations for action by WOAH as below;
1. Capacity Building and Technical Support:
- *Recommendation: That WOAH should provide continuous support to Southern Africa countries in building capacity for disease surveillance, regulation development, biosecurity and regulation implementation on the proper use of antimicrobials to mitigate resistance development. Additionally, foster collaboration between member states to share experiences, challenges, and successful interventions regarding bee health and AMR management.*
- *Support Needed: Mobilize international funding and technical resources to assist member states, focusing on long-term sustainability and self-sufficiency.*

2. Standards and Guidelines Development:
- *Recommendation: WOAH to Assist in developing standardized guidelines for the responsible use of antimicrobials in beekeeping, ensuring they are adapted to the local context of southern Africa. This may involve the provision of update and disseminate comprehensive guidelines on bee health management, including specific sections on AMR, to assist member states in developing their own regulations.*
- *Support Needed: Provide technical expertise and resources to member states for the adoption and enforcement of these standards in partnership with FAO and/or icipe.*
- *Since beekeeping policies of Ethiopia and Kenya do not have clear provisions on stingless bees research & development, and conservation, it might be important to support policy makers to revise their policies.*

2) Publications:

- *Ndungu, Nelly, et al. "Taxonomic patterns of host plants and its impact on honey properties by two sympatric Afrotropical stingless bee species in Zanzibar (Tanzania)." African Journal of Ecology 62.2 (2024): e13257.*
- *Nkoba, K., Nelly, N. U., Pozo, M. I., Lattorff, H. M. G., Jaramillo, J., & Hundt, B. (2024). Black queen cell virus detected in endemic African stingless bees (Apidae: Meliponinae). International Journal of Tropical Insect Science, 1-7.*
- *Nelly N. Ndungu,Timothy M. Kegode, Justus K. Kurgat, .,.., Sevgan Subramanian, Beatrice T. Nganso (2024). Bio-functional properties and phytochemical composition of selected Apis mellifera honey from Africa. Heliyon. https://doi.org/10.1016/j.heliyon.2024.e30839*
- *Beatrice T. Nganso*, Victoria Soroker, Angelina F. Osabutey, Christian W. W. Pirk, Tino Johansson, Ntirenganya Elie, Z. Ngalo Otieno-Ayayo, Mohammed M. Ibrahim 7, Nelly N. Ndungu 1, ..Sevgan Subramania (2024). Managed honey bee colony losses and causes during the active beekeeping season 2022/2023 in nine Sub-Saharan African countries. JAR. doi: https://doi.org/10.1101/2024.04.30.591982*
- *Nelly Ndungu, Pierre Noiset, Mary Chege, Jacqueline Wahura Waweru, Nassor Sharifu,Nicolas J. Vereecken,Nkoba Kiatoko.(2024) Taxonomic patterns of host plants and its impact on honey properties by two sympatric Afrotropical stingless bee species in Zanzibar (Tanzania). African Journal of Ecology. https://doi.org/10.1111/aje.13257*
- *Nganso BT, ..., Ndungu NN, Ayalew W, Wubie AJ. (2024). Best practices for colony management: a neglected aspect for improving*

honey bee colony health and productivity in Africa. Journal of Apicultural Research. https://doi.org/10.1080/00218839.2024.2308418 .

- *Abro, Z., Muriithi, B., Kiatoko, N., Tefera, T., Belayhun, L., and Subramanian, S. (2024). Harnessing the potential of stingless beekeeping (meliponiculture): Insights from Ethiopia and Kenya. Draft manuscript. Integrated Data and Analytical Platform, icipe, Nairobi, Kenya.*
- *Ochola J.B.; Nganso B. T.; Sevgan S., Kiatoko N. (2024). Evaluation of volatiles from ethnobotanical plants as attractants for the honey bee swarms in Kenya. Journal of Applied Entomology, 148, 938–947. https://doi.org/10.1111/jen.13312.*
- *Malena S. L., Lattorff M.H.G., Nkoba N., Require F. (2025) Climate effects on honey bees can be mitigated by beekeeping management in Kenya. Journal of Environmental Management, volume 374, 123879 . https://doi.org/10.1016/j.jenvman.2024.123879.*
- *S. Subramanian, B. Nganso, N. N. Ndungu & K. Nkoba (2024). Bee diversity and health for sustainable agriculture and livelihood improvement in Africa. WOAH Bullettin. https://doi.org/10.20506/bull.2024.1.3497*
- *Kegode, T. M., Mokaya, H. O., & Kiatoko, N. (2024). Total phenolic and flavonoid content of P. armata honey and propolis produced in Bomet, Kisii and Maralal, Kenya. JSFA Reports, 4(4), 191–196. https://doi.org/10.1002/jsf2.190.*
- *Kasiera, W., Pozo, M. I., Toroitich, K., Karanja, R., Odhiambo, M., Jaramillo, J., Hundt, B., van Langevelde, F., & Nkoba, K. (2024). When size matters: Effectiveness of three endemic African stingless bees as watermelon pollinators. Apidologie, 55(4), 1–16. https://doi.org/10.1007/s13592-024-01092-6 .*
- *Noiset, P., Ndunda, R. M., Mokaya, H. O., Chege, M., Ndungu, N. N., Sharifu, N., Vereecken, N. J., & Nkoba, K. (2024). Insularity and its impact on stingless bee honey properties: A case study in the Zanzibar Archipelago (Tanzania). JSFA Reports, 4, 64-71. https://doi.org/10.1002/jsf2.170*
- *Bridget Bobadoye, Beatrice T. Nganso, Charles Stuhl, Baldwyn Torto and Ayuka T. Fombong. Chemical ecology of the small hive beetle, Aethina tumida (Coleoptera: Nitidulidae). Accepted for publication in the Journal of Chemical Ecology.*

11. What have you done in the past year to advance your area of focus, e.g. updated technology?

1) Bee attractants identified
2) Socioeconomic assessment of stingless beekeeping (meliponiculture) undertaken in Ethiopia and Kenya.
3) Artificial production of queen's optimized
4) Establishment of Bee Research Satellite Laboratory
5) Enhanced beekeeping in Zanzibar
6) Organic certification and geographic indication of honey and other products in Ethiopia.
7) Independent Strategic Review for MOYESH completed

12. Additional comments regarding your report:

None