

# Annual Report 2017





Image of Pteromalidae (*Eurydinomorpha* sp.) a genus previously known only from East and South. The pictured species (from Kakamega forest, Kenya) and a second species from Taita Hills, coastal Kenya, represent the first collections of this genus in the Afrotropical region.

# Annual Report 2017

April 2018



**International Centre of Insect Physiology and Ecology**  
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# Foreword



Dr Lukas Bertschinger  
Chair, *icipe* Governing  
Council

In recent years, there has been growing recognition of the importance of research for development (R4D) in attaining socio-economic transformation in Africa, with governments and development partners committing more support to the sector.

At the same time, there is rising regional and global determination towards sustainable and inclusive development. For example, it is evident that to achieve the intended outcomes of the United Nations Sustainable Development Goals (SDGs), launched in 2015, trade-offs must be avoided within the interlinked pillars of economic development, environmental sustainability and social inclusion.

These two scenarios present opportunities and challenges for institutions like *icipe*. For investments to translate into real impact, R4D institutions must be well organised and managed, and strategically linked to international, regional and national developmental research agendas

and priorities. They must also ensure coordination, interaction, partnerships and networks with other stakeholders, including research and higher education institutes, extension systems, community based organisations, civil society, and the private sector. They also have a duty to ensure that communities participate fully in development initiatives – from setting priorities, policy formulation and implementation of activities.

Many of the factors outlined above have always been central to *icipe*, and as clearly demonstrated in this report, the Centre continues to produce and translate world-class scientific knowledge into solutions that are environmentally friendly, accessible, affordable and easy-to-use by end-users.

However, *icipe* embraces the need for constant re-evaluation towards innovative planning, execution and overall operations. Therefore, in 2017, the Centre started several assessment processes. They include the establishment of a Sustainable Research

Evaluation System Framework by the *icipe* Governing Council in collaboration with the Management, to evaluate the Centre's scientific units. The appraisals commenced in 2017 with the review of the Animal Health Theme.

In addition, to secure its role as a global hub of bee health expertise in Africa, *icipe*, initiated a process towards developing a strategy to advance its bee research and development portfolio.

Looking forward, the *icipe* Institutional Periodic External Review for 2013 – 2017, to be undertaken in 2018, will also play a critical role in shaping the Centre's vision and strategy, in view of current and future developmental goals in Africa.

We believe these efforts, together with the partnership of our donors and collaborators, and the dedication of our various teams, will enable us to advance our mission of contributing to better food security and health, and overall, better livelihoods in Africa.

# Preface

In 2017, despite a fast changing environment for research and development (R&D), *icipe* achieved major outputs and outcomes across all its programmes. We have endeavoured to present key highlights in the 10 chapters of this report in a synthesised and easily readable format.

In addition, we have selected a number of outstanding accomplishments, which are presented in more detail as featured stories. These include the strengthening of *icipe*'s presence in Ethiopia, by boosting the capacity and operation systems of the country office, upscaling the geographical scope and focus of our R&D activities, and bolstering linkages with government, private sector and development agencies.

We also focus on our research to complete critical gaps on the knowledge on vector-plant interactions, specifically studies employing DNA barcoding to identify host plants of key mosquito vectors in East Africa. This information provides useful leads for the development of tools

and strategies to control mosquitoes, malaria and other mosquito-transmitted diseases.

In addition, this report draws attention to the review of the *icipe* Animal Health Theme, which revealed its international competitiveness and also proposed some improvements. We will use these recommendations to strengthen the Theme, and to advance the quality of R&D outputs across the Centre's Themes.

We present findings that the climate-adapted version of Push-Pull, an already widely used technology developed by *icipe* and partners, is effective in controlling the fall armyworm, providing a suitable, accessible, environmentally friendly and cost-effective strategy for management of this devastating pest.

Our progress towards developing a bee research strategy is also underscored in this document, specifically through a recent workshop which spelt out ways to build on the Centre's previous successes while addressing new challenges.

*icipe*'s research on the impact of the Push-Pull technology on women's empowerment as a stand alone factor, and in combination with nutritional status is spotlighted. This study is in line with the Centre's goal of ensuring women's empowerment by developing gender friendly technologies.

Also featured is *icipe*'s longstanding and impactful partnership with the German Academic Exchange Service (DAAD), a key and consistent supporter of the African Regional Postgraduate Programme in Insect Sciences (ARPPIS),.

We highlight our role in the development of a bioeconomy strategy for eastern Africa, led by Bioinnovate Africa Programme, Africa's largest regional innovation-driven science initiative, which is hosted and managed by *icipe*.

*icipe* gratefully appreciates the unstinting support and commitment of our donors, partners and staff, in effectively delivering on our mandate.



Dr Segenet Kelemu  
Director General, *icipe*

# Management and Leadership



**icipe core donors:**  
Swiss Agency for Development and Cooperation (SDC), Switzerland; Swedish International Development Cooperation Agency (Sida); UK Aid, Government of the United Kingdom; Ministry of Higher Education, Science and Technology, Kenya and Government of the Federal Democratic Republic of Ethiopia.

Members of the *icipe* Governing Council (GC) pictured during a visit to Real IPM Ltd, a Kenya based private sector partner in the commercialisation of the Centre's biopesticides (l-r): Dr Lukas Bertschinger, Chair, *icipe* GC; Prof. Bill Hansson, Vice Chair, *icipe* GC; Dr Segenet Kelemu, Director General, *icipe*; Andreas Schriber, CEO and co-founder of Biovision Foundation for Ecological Development, and Chair Sponsoring Group of *icipe*.

## Resource mobilisation



- Core donors**
- Swiss Agency for Development and Cooperation (SDC)
  - Swedish International Development Cooperation Agency (Sida)
  - UK Aid, from the Government of the United Kingdom
  - Ministry of Higher Education, Science and Technology, Kenya
  - Government of the Federal Democratic Republic of Ethiopia

### New donors

- JRS Biodiversity Foundation:** funding for the Pollinator Information Network for sub-Saharan two-winged insects (PIN-DIP) in which *icipe* is a partner.
- National Geographic Society:** for research on landscape setup and honey bee colony integrity.
- German Research Foundation:** as part of a consortium led by University of Bonn, Medical Centre, for the identification of virus transmission networks to control key arboviral diseases in Kenya.
- Scottish Funding Council/ University of Glasgow:** for research on microbe-based malaria transmission blocking in Anopheles mosquitoes.
- Global Challenges Research Fund:** through an agreement with University of Keele, UK, for a Global Agricultural and Food Systems Research project on developing a pheromone alternative to insecticides for control of thrips on legumes in Kenya (SAFARI).
- European Union Horizon 2020 programme:** *icipe* is among institutions involved in a project entitled the Microbial Uptakes for Sustainable management for major bananA pests and diseases (MUSA).
- Swiss family through Biovision Foundation for Ecological Development:** funding for 2nd year of the Push-Pull sub-Saharan Africa project to upscale the technology beyond eastern Africa.
- Newton Fund Institutional Links:** through a subcontract by the University of Liverpool, UK, for the development of microbe-based strategies for improved bee health.
- H3AbioNet pan-African bioinformatics network (phase two)** approved. *icipe* will be subcontracted by the lead partner, University of Cape town, South Africa.
- National Institute of Health (NIH, USA):** for a project titled East Africa Network for Bioinformatics Training (EANBIT). The project is led by *icipe* in partnership with Pwani University, Makerere University, Uganda Virus Research Institute, KEMRI Wellcome Trust Research Programme, University of Dar es Salaam and the BecA-ILRI Hub.
- Bayer AG, Germany:** funding for integrating stingless bees for crop pollination to sustain livelihoods of smallholder farmers in Africa.
- Bioinnovate Africa Programme grants for:**
  - Postharvest disinfestation of horticultural crops in Kenya and Uganda
  - Enhancing smallholder access to fungal biopesticides through public private partnerships in East Africa (ENSAFE)
  - Accelerating INSEct-based agriBIZness development for sustainable food and feed production in Kenya and Uganda (INSBIZ)
- Swedish International Development Cooperation Agency (Sida):** funding for Bioinnovate Africa Programme phase II, to support innovative advances in biosciences for inclusive growth and sustainable development.

## New partners

**Norwegian Institute of Bioeconomy Research (NIBIO)**, a leading public research institution in primary industries, agriculture, forestry, natural resources and rural development with cross cutting issues such as the environment and climate change.



**Institute of Research for Development (IRD)**, France: Renewal of scientific and technical cooperation in agriculture, food security and natural resources.



**Tel Aviv University, Israel**, for collaboration combining *icipe's* groundbreaking innovations, Israeli agricultural technology, and TAU's expertise in large scale policy formation, including joint research projects and students exchange programmes.



**Technical University of Vienna** in drought mapping in the ASAL region.



**Ohio State University, USA**, on behalf of its Global One Health initiative (GOHI): for research, capacity building and educational and cultural exchange.



**Agricultural Research for Development (CIRAD)**, France: Renewal of scientific and technical cooperation to foster bilateral cooperation in agriculture, food security and natural resources management.



**Ministry of Livestock and Fisheries, Ethiopia**, for collaborative development projects and capacity and institutional building in livestock and fisheries development and associated areas.



**International Center for Agricultural Research in the Dry Areas (ICARDA)** for collaboration on bee health and pollination services.



**Royal Museum for Central Africa in Tervuren, Belgium**, for collaboration on a project, titled: The Pollinator Information Network for sub-Saharan two-winged insects (PIN-DIP).



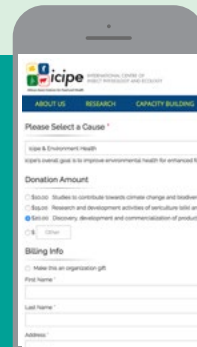
**Helmholtz-Zentrum für Umweltforschung, Germany**, for freshwater pollution and links to the distribution of Schistosoma host snails in western Kenya.



**World Health Organization Regional Office for Africa (WHO-AFRO)** for *icipe* to lead the evaluation of integrated vector management in six countries that are still using DDT in southern Africa.



**Kenya Agricultural and Livestock Research Organization**, for sericulture research and industry development in Kenya.



## Donation tool

Online donation tool to enable individuals and institutions to support *icipe*. Visit: <http://www.icipe.org/support-icipe>

## Communications

### Peer-reviewed journal articles

**137** peer-reviewed journal articles published in 2017

**25%** most cited in PLoS ONE

- Taxonomic identity of the invasive fruit fly pest, *Bactrocera invadens*: Concordance in morphometry and dna barcoding.
- Development and assessment of plant-based synthetic odor baits for surveillance and control of malaria vectors.

### Research recognition:

Article entitled: Identification of the ubiquitous antioxidant tripeptide glutathione as a fruit fly semiochemical, was selected for the *Journal of Agricultural and Food Chemistry* Research Article of the Year Award (AGRO Division).

### International Journal of Tropical Insect Science (IJT)

Manuscript management software instituted to streamline submission, review and publication.

### icipe website

**50,000** visitors and **225,000** page views

**Top 20 countries:** Kenya, United States, Nigeria, United Kingdom, Germany, Uganda, Tanzania, Ethiopia, Cameroon, South Africa, India, Ghana, Zimbabwe, Switzerland, Sudan, France, Benin, The Netherlands, Canada and Rwanda.

### Media coverage

**430** news items

**2150** media mentions

**281M** audience reach

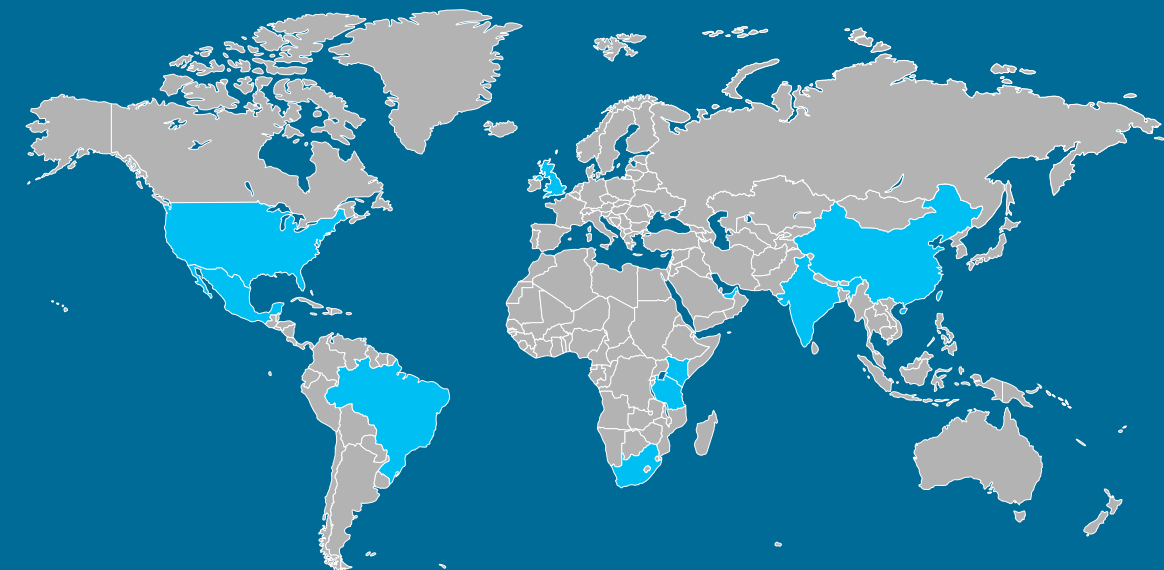
**US\$ 2.7M** advertising potential

### Top media that covered icipe activities (In addition to Kenyan and African media):

*National Geographic*, Reuters News Agency, Xinhua News Agency, ARD, Germany; TheConversation.com; Daily Mail, UK; Voice of America; Al Jazeera.

### Top 10 countries whose media covered icipe activities:

South Africa, Kenya, Brazil, Mexico, United States, China, India, United Kingdom, United Arab Emirates, Tanzania



## Featured story

### icipe in Ethiopia

Over the past four years *icipe* has significantly strengthened its activities in Ethiopia. These efforts include boosting the capacity and operation systems of the Centre's country office; upscaling the geographical scope and focus of R&D activities, and bolstering of linkages with government, private sector and development agencies.

Under the leadership of Dr Tadele Tefera and Dr Workneh Ayalew, the *icipe* Ethiopia Country Office has been outstanding in expanding programmatic activities, building capacity of the national systems, partnerships and strong financial management and accounting systems to the benefit of stakeholders in Ethiopia and beyond. Indeed, *icipe's* operations in Ethiopia have been recognised by the Government of Ethiopia as among the most efficient and impactful. The office won the "Outstanding Team of the Year (2017)", in the *icipe* internal awards.

*icipe's* ongoing initiatives in Ethiopia include: integrated vector management for malaria, commercial beekeeping and silk worm farming, and scaling up Push-Pull technology funded by Biovision Foundation for Ecological Development, Switzerland; Integrated Biological Control Applied Research Program (IBCARP), funded by the European Union to support the adoption of the Centre's technologies and strategies for improved cereal, horticulture and livestock productivity; the Mastercard Foundation-funded Young Entrepreneurs in Silk and Honey (YESH) project; and the maize, rice, chickpea

integrated pest management (IPM) project funded by USAID Feed the Future through Virginia Tech University, USA. Moreover, the *icipe* Ethiopia office has established itself as a leader in capacity building for farmers, mid and high level professionals, with more than 50 Ethiopians earning PhDs in different disciplines.

*icipe* has also been reinforcing the capacity of the Ethiopia Office, which now 37 staff members (19 of them in the field sites across the country) and 16 students (6 PhD and 10 MSc).

The *icipe* Ethiopia Country Office was awarded the Team of the Year (2017). Pictured after receiving the award from the Director General, Dr Segenet Kelemu (left) are Dr Workneh Ayalew (centre) and Dr Tadele Tefera (right).



## Human Health Theme

### Donors:

Biovision Foundation for Ecological Development, Switzerland; Bill & Melinda Gates Foundation; German Academic Exchange Service (DAAD); Federal Ministry for Economic Cooperation and Development (BMZ); Foundation for the National Institutes of Health, USA; German Doctors e.V., Germany; German Research Foundation (DFG), Germany; Global Environment Facility (GEF)/United Nations Environment Programme (UNEP); Government of Kenya; Innovative Vector Control Consortium, UK; Kenya National Research Fund; National Institutes of Health (NIH), USA; National Science Foundation (NSF), USA; R. Geigy Foundation, Switzerland; Swedish International Development Cooperation Agency (Sida); Swiss National Science Foundation; Swiss Agency for Development and Cooperation (SDC); The Swedish Research Council, Sweden; The World Academy of Sciences – Organization for Women in Science for the Developing World; UK Aid from the UK Government; Wellcome Trust, UK; World Health Organization-Regional Office for Africa (WHO-AFRO).

### Partners:

Addis Ababa University (Aklilu Lemma Institute of Pathobiology), Ethiopia; agricultural research institutes, non-governmental organisations, private sector partners, farmers and farmer groups; Canterbury Christ Church University, New Zealand; CEVA, France; Dabaso Tujengane Self Help Group – Watamu Marine Association, Kenya; Duke University, USA; Durham University, UK; Egerton University, Kenya; Elimination 8 programme; Free University of Berlin and Charité—Universitätsmedizin, Berlin, Germany; Helmholtz Centre for Environmental Research (UFZ), Leipzig, Germany; Ifakara Health Institute, Tanzania; International Livestock Research Institute (ILRI); Johns Hopkins University, USA; Kenya Medical Research Institute (KEMRI); Kenya Wildlife Service (KWS); KTH Royal Institute of Technology, Sweden; Liverpool School of Tropical Medicine, UK; London School of Hygiene and Tropical Medicine, UK; Millennium Institute, USA; Ministries of Health in Kenya and Ethiopia; Ministry of Agriculture, Livestock and Fisheries, Kenya; Ministry of Public Health and Sanitation (Division of Disease Surveillance and Response), Kenya; Mosquito Control in Nyabondo (MOCON) community group, Nyabondo, Kenya; national malaria control programmes of Botswana, Mozambique, Namibia, Swaziland, Zimbabwe and Zambia; National Museums of Kenya (Institute of Primate Research); Ohio State University, USA; Pennsylvania State University, USA; Punguza Mbu na Malaria Malindi (PUMMA) community group, Malindi; Radboud University, Netherlands; RWTH Aachen University, Germany; Sumitomo Chemical, Japan; Swedish University of Agricultural Sciences (SLU); Swiss Tropical and Public Health Institute, Switzerland; The KEMRI - Wellcome Trust Research Programme, Kenya; Ultimate Products (Aust) Pty Ltd, Australia; Umeå University, Sweden; University of Bonn, Germany; University of Glasgow, UK; University of Greenwich (Natural Resource Institute), UK; University of Nairobi, Kenya; University of Pretoria, South Africa; United States Department of Agriculture, USA; Wageningen University, The Netherlands; Wellcome Sanger Institute, UK; World Health Organization-Regional Office for Africa (WHO-AFRO).

## Malaria

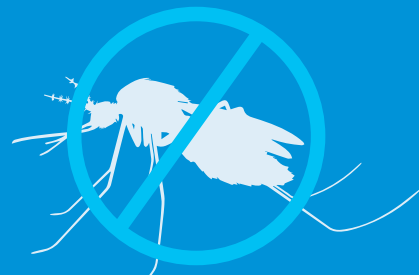


The Malaria Push-Pull Research team has demonstrated, for the first time, that the use of a strategy that combines repelling ('push') mosquitos from homesteads, while attracting them ('pull') to a trap reduced entry rates of the two major malaria vector species into houses. **Mosquito Push-Pull has the potential to become a complementary malaria vector control tool targeting mosquitoes outside the house.**

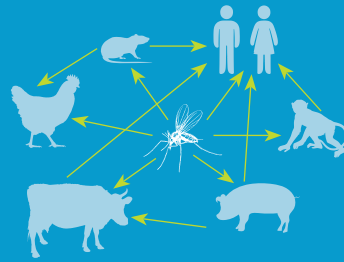
Applying microsatellite genetic markers, the number of female malaria vectors laying eggs in an aquatic habitat could be detected. These findings suggest that malaria vector mosquitoes distribute their eggs widely over several habitats. **This can inform the development of new tools such as auto-dissemination approaches, for larval control targeting outdoor malaria vector populations.**



The Spirovector project has found two novel symbiotic microbes associated with Malaria mosquitoes; *Spiroplasma* and *Microsporidia MB*. *Microsporidia MB* was found to confer Malaria mosquitoes with protection against the malaria parasite and therefore could be used to block the transmission of this disease.



## Arboviruses



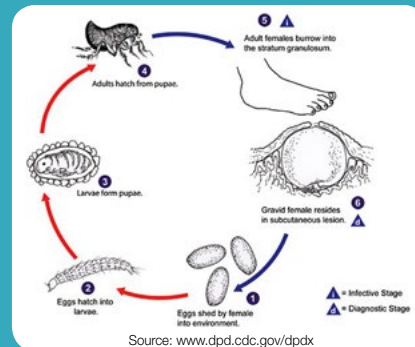
*icipe* has uncovered a previously unknown phlebovirus from sandflies in Kenya, which is broadly permissive in a wide range of mammals: **monkeys, rodents and bats; cattle, swine, goats and chicken, and people.** This data highlights zoonotic potential of the arbovirus.



**Risk for transmission of key mosquito-borne viral diseases including yellow fever and Dengue in selected parts of Kenya is ongoing.** These studies are critical to decision making for disease prevention/ control through targeted vaccination and vector control, thereby mitigating alarming re-emergence of such diseases in East and Central Africa.

## Neglected tropical diseases

Tungiasis (sand flea disease) is the most common parasitic infection in many resource-poor communities, causing severe morbidity and loss of quality of life yet has been neglected by policy makers and scientists alike. *icipe* has initiated pilot studies to enhance understanding of the disease ecology. A risk factor analysis revealed a strong association between the disease and poor housing conditions and suggests simple measures could prevent the disease.



## Featured story

# Mosquito-plant interactions

The spread of vector-borne diseases, globally and in Africa in particular, remains a significant public health threat. To develop novel control strategies, knowledge on vector ecology, including vector-plant interactions, is vital.

Survival and fitness are important attributes that make mosquito species effective in disease transmission. These traits can be enhanced when mosquitoes feed on plants. However, for mosquito disease vectors of African origin, precise knowledge on the identity of plant species they feed on in nature remains largely unknown.

Over the past several years, working specifically on mosquitoes, *icipe* has been conducting studies to understand critical gaps in such information. In accordance, in 2017, *icipe* employed DNA barcoding to identify host plants of key mosquito vectors in East Africa: *Aedes aegypti* (vector of dengue), *Aedes mcintoshi* and *Aedes ochraceus* (vectors of Rift Valley fever) and *Anopheles gambiae* (vector of malaria).

In addition, the researchers also sought to establish specific odour signatures that possibly mediate the ability of vectors to locate host plants. The results identified a variety of specific chemical cues that the mosquito species detect and use in their interactions with their respective host plants. While certain compounds were predominantly detected only by specific mosquito species, others were consistently detected by all the mosquito species and were present in all the identified host plants.

These findings indicate that the latter group of compounds could serve as signature cues for mosquitoes in locating plant hosts. The signature cues can be exploited to enhance the efficiency of existing vector control strategies, such as attractive toxic sugar baits or to develop new odour-bait technologies.

David Tchouassi, a disease vector ecologist at *icipe*, who was involved in the study on mosquito-plant interactions. David is experienced in researching, developing, testing and evaluating new surveillance and control tools for mosquitoes and sandflies, and in applied vector control and its impact on entomological and epidemiological outcomes. He applies a range of multidisciplinary approaches, ranging from chemical ecology, field ecology, molecular biology, genetics and bioinformatics, to identifying weak links in the vector-pathogen-host interactions.

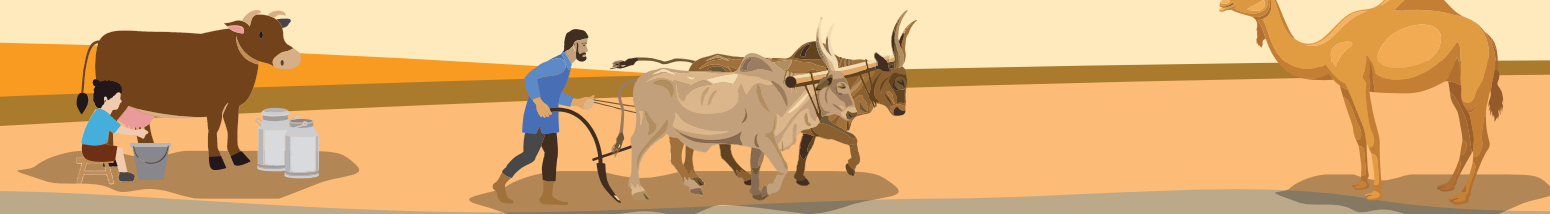




# Animal Health Theme

**Donors:** Biovision Foundation for Ecological Development, Switzerland; Consortium for National Health Research (CNHR), Kenya; European Union; Federal Ministry for Economic Cooperation and Development (BMZ); German Research Foundation (DFG); International Atomic Energy Agency (IAEA); Max Planck Institute, Germany; National Science Foundation (NSF), USA; Swedish International Development Cooperation Agency (Sida); The Wellcome Trust, UK; UK Aid from the UK Government; United States Agency for International Development's Partnerships for Enhanced Engagement in Research (USAID-PEER) grants program.

**Partners:** African Union Inter-African Bureau for Animal Resources (AU-IBAR); county governments of Marsabit and Isiolo, Kenya; Director of Veterinary Services, Kabete Veterinary Research Laboratories, Nairobi Kenya (DVS); Kenya Livestock Producers Association (KLPA); Kenya Tsetse and Trypanosomiasis Eradication Council (KENTTEC), Kenya; Kenya Wildlife Service (KWS); Marsabit county Livestock Office, Kenya; Max Planck Institute for Chemical Ecology, Jena Germany; Ministry of Agriculture, Livestock & Fisheries and Department of Veterinary Services in Kwale County; Mount Kenya University, Kenya; National Museums of Kenya; Smithsonian Institution, USA; Sokoine University of Agriculture, Tanzania; Tanzania National Parks; Tanzania Wildlife Research Institute (TAWIRI); University of Maryland, USA; University of Würzburg, Germany; Yale School of Public Health (USA).



## Animal and human trypanosomiasis



**Tsetse repellent collars**

- A recently published study summarised *icipe's* tsetse repellent collars research and development, culminating in field trials in Shimba Hills, coastal Kenya, which clearly demonstrated that the technology is effective in improving food security and general well-being of beneficiary households.
- A new and more cost effective collar has been developed and is currently undergoing field trials with positive results.
- The repellent blend used in the collars is currently being considered for registration and subsequent commercialisation.



**Integrated tsetse strategy**

*icipe* researchers showed that integrated use of the tsetse repellent collars and NGU traps, also developed by the Centre, could effectively prevent re-entry and reinvasion of tsetse flies into protected areas, thereby protecting livestock from these vectors of trypanosomiasis.

**Camel trypanosomiasis**

**Pioneer camel surra research**

*icipe* has identified, for the first time, the main vectors of camel trypanosomiasis (surra) includes *Hippobosca camelina*, *Stomoxys calcitrans*, *Pangonia ruppellii* and *Tabanus spp.*, filling in significant gaps and providing previously unknown vital information on the disease transmission, while presenting opportunities for control and management.



**Human African trypanosomiasis**

Found that a waterbuck repellent developed for *Glossina morsitans morsitans* is also effective against the vector of human African trypanosomiasis, *Glossina fuscipes fuscipes*.



## Featured story

# Animal Health Theme review

The *icipe* Governing Council in collaboration with the Management have established a Sustainable Research Evaluation System Framework to evaluate the Centre's scientific units to ensure adherence to international standards. The assessments commenced in 2017, with the review of the Centre's Animal Health Theme.

The review was conducted by: Prof. Diana Williams, Professor, Infection Biology, University of Liverpool, UK; Dr John Gilleard, Professor of Parasitology, University of Calgary, Canada; and Prof. Ulf Magnusson, Professor, Animal Reproduction, Swedish University of Agricultural Sciences, Sweden. The team was guided by Prof. Dr. Bill Hansson, *icipe* Governing Council Vice Chair and Vice President, Max Planck Society.

The report shows the *icipe* Animal Health Theme to be internationally competitive, with many components evaluated as excellent.

The team however suggested a number of areas of improvement, such as strengthening of the veterinary epidemiology component, and a more structured career progression for junior scientists. The Centre will use the review report to strengthen the Animal Health Theme, and to advance the quality of R&D outputs for other themes and the whole institute.

The *icipe* Animal Health Theme focuses on development of integrated strategies and tools for control of vectors of animal diseases and livestock pests, and to enhance livestock health and productivity, with the ultimate goal of improving the welfare of smallholder livestock keepers. The research activities are geared towards detailed understanding of vector behaviour, population ecology and vector-host and vector-parasite interactions.

More recently, *icipe* has commenced studies to develop strategies for the control of camel trypanosomiasis (also known as surra), which is spread mainly by biting flies. The disease

has devastating impact on camels: affected animals suffer reduced milk production, severe morbidity, reduced reproductive potential, including abortions. *icipe's* research aims to contribute novel knowledge on the interactions between camel and the biting flies that transmit trypanosomes, by studying odour emission changes caused by trypanosomiasis and how fly behaviour is affected by these alterations. Ultimately, this information will lead to the development of an attract and kill strategy for major vectors of camel surra.

*icipe's* strategies for managing ticks rely on biological control, use of botanicals and anti-tick pasture plants, repellents and behaviour modification of ticks using semiochemicals that they use to find hosts and mates. In addition, the Centre has also developed effective bioacaricides for control of ticks, and is working with the private sector to advance their application particularly with growing resistance of ticks to many acaricides in common use.

Diallo Souleymane (Burkina Faso), a PhD student within the *icipe* African Regional Postgraduate Programme in Insect Science (ARPPIS), registered at University of Western Cape, South Africa, is conducting research to identify the receptors of tsetse flies through which tsetse repellents are coded. The information is important to improve and develop novel repellents/attractants for tsetse control. His research is funded by the German Academic Exchange Service (DAAD) through ARPPIS, and the European Union through the Integrated Biological Control Applied Research Program (IBCARP).



# Plant Health Theme

## Donors:

Biotechnology and Biological Sciences Research Council (BBSRC), UK, through Rothamsted Research and Keele University (both in the UK); Biovision Foundation for Ecological Development, Switzerland; Canadian Government through International Development Research Centre (IDRC) and Grand Challenges Canada (GCC); European Union; Federal Ministry for Economic Cooperation and Development (BMZ), Germany; Food and Agriculture Organization of the United Nations (FAO); Government of Kenya; Humidtropics CGIAR Research Programme led by International Institute of Tropical Agriculture (IITA); International Atomic Energy Agency (IAEA), Austria; International Fund for Agricultural Development (IFAD), Italy; Liechtenstein Development Service (LED), Principality of Liechtenstein; McKnight Foundation, USA; National Commission for Science, Technology and Innovation, Kenya; Research Institute of Organic Agriculture (FiBL), Switzerland; Russell IPM Ltd, UK; Swedish International Development Cooperation Agency (Sida); Swiss Agency for Development and Cooperation (SDC); The Office of U.S. Foreign Disaster Assistance (OFDA); UK Aid from the UK Government; United States Agency for International Development (USAID), USA through the IPM innovation lab.

## Partners:

A to Z textiles Limited, Arusha; African Conservation Tillage Network, Malawi and Zambia; Agrarian Systems Ltd.; Agricultural Research Cooperation (ARC), Wad Medani, Sudan; Agroscope, Switzerland; Anglican Development Services, Kenya; Anglican Development Services Eastern (ADSE), Kenya; Austin Investment Ltd.; Avocado Growers Association, South Africa; Transformation Agency, Ethiopia; Biocontrol Research Laboratories, India; Bioversity International; CABI Africa; University of Bonn, Germany (Center for Development Research - ZEF); Citrus Research International, South Africa; Conservation Farming Unit (CFU), Zambia; Division of Plant Industry, Florida Department of Agriculture and Consumer Services, USA; Dudutech Ltd., Kenya; East African Seed Co. Ltd.; Elephant Vert; Embu University, Kenya; Ethiopian Institute of Agricultural Research (EIAR); Farmer groups and mango growers; Farmtrack consulting Ltd.; Forum for Agricultural Research in Africa (FARA); Hawassa University, Ethiopia; Heifer International - Kenya and Tanzania; Horticultural Research and Training Institute-Tengeru (HORTI Tengeru), Tanzania; HottiServe East Africa Limited; Humboldt-Universität zu Berlin, Germany; Institute for Sustainable Development (ISD), Ethiopia; Institute of Organic Chemistry and Biochemistry, Academy of Sciences of the Czech Republic; International Center for Tropical Agriculture (CIAT); International Crops Research Institute for the Semi-Arid Tropics (ICRISAT); International Institute of Tropical Agriculture (IITA); International Livestock Research Institute (ILRI); International Maize and Wheat Improvement Center (CIMMYT); International Potato Center (CIP); International Water Management Institute (IWMI); Jaramogi Oginga Odinga University of Science and Technology (JOUUST), Kenya; Jomo Kenyatta University of Agriculture and Technology (JKUAT); Julius Kühn-Institut (Institute for Biological Control), Germany; Kasisi Agricultural Training Centre, Zambia; Keele University, UK; Kenya Agricultural and Livestock Research Organisation (KALRO)- Horticulture Research Institute; Kenya Biologics Ltd.; Kenya Institute of Organic Farming (KIOF); Kenya Organic Agriculture Network (KOAN); Kenya Plant Health Inspectorate Service (KEPHIS); Kenyatta University, Kenya; Lake Zone Agricultural Research and Development Institute (LZARDI), Tanzania; Lasting Solutions; Leibniz Universität Hannover, Germany; Lilongwe University of Agriculture & Natural Resources (LUANAR), Malawi; Makerere University, Uganda; Maseno University, Kenya; Mikochei Agricultural Research Institute, Tanzania; Ministries of Agriculture in Botswana, Namibia, Zambia and Zimbabwe; Ministry of Agriculture and Natural Resources, Ethiopia; Ministry of Agriculture, Animal Industry and Fisheries, Uganda; Ministry of Agriculture, Food Security and Cooperatives, Tanzania; Ministry of Agriculture, Forestry, Cooperatives and Rural Development, South Sudan; Ministry of Agriculture, Livestock and Fisheries, Kenya, and County Departments of Agriculture; Agricultural Sector Development Support Programme, Kenya; Moi University, Kenya; National Agricultural Research Organisation (NARO), Uganda; Agricultural National Crops Resources Research Institute (NACRRI), Uganda; National Museums of Kenya; National Potato Council, Kenya; Norwegian Institute for Bioeconomy Research (NIBIO); Nutrel Ltd.; One Acre Fund, Kenya and Uganda; Royal Museum of Central Africa, Tervuren, Belgium; Sanergy Ltd.; Tanzanian Pesticide Research Institute, Tanzania; The New Zealand Institute for Plant & Food Research Ltd, Plant Research International, Wageningen University and Research Centre (WUR), The Netherlands; The Poverty Alleviation Department, Office of the President, Uganda; Real IPM Ltd, Kenya; Research Institute of Organic Agriculture (FiBL), Switzerland; Rothamsted Research, United Kingdom; Royal Museum for Central Africa, Tervuren, Belgium; The Seed Control and Certification Institute of Zambia; Seed Co. Zimbabwe Limited; Send a Cow; farmers' groups; Sokoine University of Agriculture, Tanzania; Texas A&M University, USA; Tigray Agricultural Research Institute (TARI), Ethiopia; Total LandCare, Malawi and Zambia; Treasure Industries Ltd.; Tropical Soil Biology and Fertility (TSBF) Institute of CIAT; Ugachik Ltd.; Unga Feed Ltd.; University of Hohenheim, Germany; University of Nairobi, Kenya; University of Pavia, Pavia, Italy; University of Sousse (Higher Agronomic Institute of Chott-Meriem), Tunisia; University of Tschang, Cameroon; University of Zambia; Wageningen University and Research Centre (WUR), The Netherlands; WeRATE; World Agroforestry Centre (ICRAF).

## Fruit fly IPM



*icipe*, Kenya Biologics Ltd, and public private sector partners launched a facility to commercially produce Fruitfly Mania™, a protein bait developed through the centre's research to control fruit flies. This facility is the first of its kind in the region.



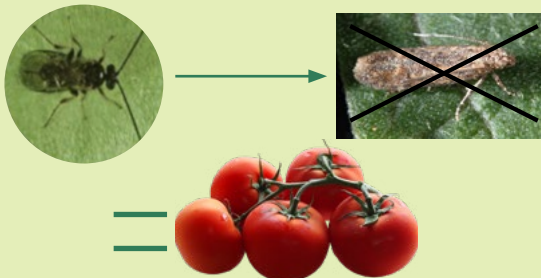
Following the detection in Africa of the citrus psyllid, *Diaphorina citri*, an invasive pest that causes Huanglongbing or Asian citrus psyllid greening disease, *icipe* documented the behavioural traits that attracts the pest to citrus, specifically to lemon. This knowledge could potentially lead to the development of management tools against the pest.



The first DNA barcode reference library of the African citrus triozid, *Trioza erytreae*, the principal vector of the African form of the devastating citrus greening disease has been constructed, presenting a basis for rapid and accurate identification of the pest to aid phytosanitary measures.

## Vegetable IPM

A natural enemy of the invasive tomato leafminer, *Tuta absoluta*, has been introduced from Peru (the native home of the pest) into Africa for field releases.



*icipe* has identified two indigenous parasitoids that can be considered for biological control of moths and butterflies that damage amaranth, an important African indigenous vegetable. Significantly, *Cotesia icipe* a new wasp species recently described by *icipe*, has been found effective against the leaf worms *Spodoptera littoralis* and *S. exigua*, and against the fall armyworm (*S. frugiperda*).

## Research on Nematodes

*icipe's* studies and capacity building activities are contributing to the tackling of the potato cyst nematode, first recorded in Kenya in 2014, and a major threat to potato production in the East African region. Activities include training of government technicians to detect PCN and determination of the pest's status in soil samples. In addition, research is ongoing on the potential use of African nightshade as a 'dead end trap crop' against the pest.



## Featured story

# *icipe* Push-Pull technology halts fall armyworm rampage

The fall armyworm is a destructive moth that causes devastating damage to almost 100 plant species, including sorghum, rice, wheat and sugarcane, as well as a variety of horticultural crops, thereby threatening food and nutritional security, trade, household incomes and overall economies.

Until 2016, the fall armyworm was constrained to its native region of origin, the Western Hemisphere (from the United States of America to Argentina). However, in January 2016, the pest was reported in Nigeria and it has since spread at an alarming rate across Africa; its presence has been confirmed in more than 28 African countries, while a further nine either strongly suspect, or are awaiting confirmation of invasion.

Already, in less than two years, the impact of the fall armyworm is being felt across Africa. Estimates from 12 African countries indicate that the pest is causing annual maize losses of between 8 – 21 million tonnes, leading to monetary losses of up to US\$ 6.1 billion, while affecting over 300 million people in Africa, who, directly or indirectly, depend on the crop for food and well-being. The pest's impact is likely to be even higher when its damage on other crops is quantified.

Efforts to control the fall armyworm through conventional methods, such as use of insecticides is complicated by the fact that the adult stage of the pest is most active at night, and the infestation is only detected after damage has been caused to the crop. The pest also has a diverse range of alternative host plants that enables its populations to persist and spread. Moreover,

fall armyworm has been shown to develop resistance to some insecticides, while the performance of such chemicals is also hindered by limited knowledge and purchasing power of farmers, resulting into use of low quality, and often harmful products.

In 2017, *icipe* studies established that a climate-adapted version of Push-Pull, an already widely used technology developed by *icipe* and partners is effective in controlling the fall armyworm, providing a suitable, accessible, environmentally friendly and cost-effective strategy for management of the pest. These findings represent the first documented report of a readily available technology that can be immediately deployed in different parts of Africa to efficiently manage the fall armyworm.

Push-Pull, an innovative companion cropping technology developed over the past 20 years by *icipe* in close collaboration with national partners in eastern Africa and Rothamsted Research, United Kingdom, is modelled along the African smallholder farming system of multiple cropping. Originally developed for the control of stemborers, the key pests of cereal crops across most of Africa, and the parasitic Striga weeds, Push-Pull involves intercropping cereal crops with insect repellent legumes in the *Desmodium* genus, and planting an attractive forage plant such as Napier grass as a border around this intercrop. The intercrop emits a blend of compounds that repel ('push') away stemborer moths, while the border plants emit semiochemicals that are attractive ('pull') to the pests. Push-Pull has recently been adapted to drier areas through the incorporation of drought tolerant companion plants: Greenleaf

*Desmodium* as an intercrop and *Brachiaria* cv Mulato as a border crop. In addition, Push-Pull also controls maize ear rots and mycotoxins, while improving soil health and providing high quality fodder, since the companion crops are superior forages. Therefore, the technology facilitates crop-livestock integration thus expanding farmers' income streams.

Over the past several months we received information from Push-Pull farmers that their fields were free of fall armyworm infestation while neighbouring monocrop plots were being ravaged by the pest. Therefore, we evaluated the climate-adapted version of the technology as a potential management tool for fall armyworm in Kenya, Uganda and Tanzania.

The study revealed fall armyworm infestation to be more than 80% lower in plots where the climate-adapted Push-Pull is being used, with associated increases in grain yields, in comparison to monocrop plots. The findings were supported by farmers' perceptions through their own observations regarding significantly reduced presence of fall armyworm in Push-Pull plots.

The ability to manage such a devastating pest clearly demonstrates Push-Pull's utility as a platform technology in addressing the multitude of challenges that affect cereal-livestock farming systems in Africa. *icipe* intends to continue disseminating the technology as widely as possible across Africa, while advancing studies to understand the scientific basis of its effectiveness against the fall armyworm.

# Environmental Health Theme



## Donors:

AIRD (French Inter-institution Agency for Research and Development); Bayer Bee Care, Germany; Biovision Foundation for Ecological Development, Switzerland; European Union (EU); Federal Ministry for Economic Cooperation and Development (BMZ), Germany; Fellowship from Swiss National Science Foundation (SNSF); International Fund for Agricultural Development (IFAD); JRS Biodiversity Foundation, USA; Ministry for Foreign Affairs of Finland; Ministry of Higher Education, Science and Technology, Kenya; National Geographic Society, USA; Newton Fund Institutional Links - 2016 call; Swedish International Development Cooperation Agency (Sida); SWITCH Africa Green; Swiss Agency for Development and Cooperation (SDC), Switzerland; The MasterCard Foundation; UK Aid from the UK Government; World Trade Organization (WTO) – Enhanced Integrated Framework(EIF).

## Partners:

Addis Ababa University; African Union Inter-African Bureau for Animal Resources (AU-IBAR); Agricultural Sector Development Programme, Zanzibar, Tanzania; Aklilu Lemma Institute of Pathobiology; Biovision Africa Trust; Centre de coopération internationale en recherche agronomique pour le développement (CIRAD), France; East Usambara Farmers Group; Faculty of Agriculture, University of Kinshasa (DR Congo); Federal Ministry of Health, Ethiopia; German Centre for Integrative Biodiversity Research (iDiv), Germany; Holeta Bee Research Centre, Ethiopia; Infonet-Biovision, icipe Duduville; Institut national de la recherche agronomique (INRA), France; Iziko South Africa Museum, South Africa; Jimma University, Ethiopia; KEMRI; Kenya Agricultural and Livestock Research Organization (KALRO) (National Sericulture Research Centre); Kenya Marine and Fisheries Research Institute (KEMFRI - Nyabondo), Ministry of Agriculture (MoA-Nyabondo), Ministry of Public Health and Sanitation (Nyabondo); Martin-Luther-Universität Halle-Wittenberg, Germany; Milba-brands Associates Limited; Millennium Institute; Ministry of Agriculture Botswana; Ministry of Agriculture, Livestock and Fisheries (Directorate of Livestock Production), Madagascar; Ministry of Agriculture, Ethiopia; Ministry of Agriculture, Fisheries, Environment and Urban Planning, Comoros; Ministry of Agriculture, Liberia; Ministry of Agriculture, Natural Resources, Livestock and Fisheries, Zanzibar; Ministry of Agro-industry and Food Security (Entomology Division), Mauritius; Ministry of Animal Resources and Fisheries, Burkina Faso; Ministry of Livestock, Fisheries and Animal Industries, Cameroon; Ministry of Health & Municipal Council of Malindi; Muliru Farmers Conservation Group (MFCG); Museum für Naturkunde, Berlin, Germany; National Agriculture and Food Research Organization, Japan; National Beekeeping Station, Kenya; National Museum, Bloemfontein, South Africa; National Museums of Kenya; Pangani Basin Water Board, Tanzania; Pennsylvania State University, USA; Royal Museum for Central Africa, Tervuren, Belgium; Ruhr-Universität Bochum, Germany; Schmalhausen Institute of Zoology, Ukraine; Seychelles Agricultural Agency; Smithsonian Institution, USA; Smithsonian National Museum of Natural History, USA; Sokoine University of Agriculture, Tanzania; Stellenbosch University, Department of Conservation Ecology and Entomology, South Africa; Strand Life Sciences, India; Taita Environmental Research and Resource Arc (TERRA), Kenya; Tanzania Farmers Conservation Group (TFCG); Tropical Entomology Research Center, Viterbo, Italy; Tuscia University, Viterbo, Italy; UN Food and Agricultural Organization; United States Department of Agriculture, USA; University of Bonn, Germany; University of California, Davis, USA; University of Dar es Salaam, Tanzania; University of Helsinki, Finland; University of Kansas, USA; University of Liverpool, UK; University of Umea, Sweden; University of Wuerzburg, Germany; University of York, UK; Wageningen University and Research Centre (Resource Ecology group), The Netherlands; Yeungnam University, South Korea.

## Bee research



### Comparisons of resistance and tolerance mechanisms of African and European honeybees, against Varroa destructor.

Lower infestations, as well as more damage to mites observed in African savannah honeybee colonies than in their European counterparts. Grooming behaviour was found to be a potential tolerance mechanism by the African savannah honeybee towards mite attack, although other resistance mechanisms might have an important role in the survival against the mite.



### Biopesticide for Varroa mite

Validation studies for Apicure®, a plant-based product in Kenya and other African countries have shown the product to be effective in killing varroa mites and repelling hive beetles in bee colonies. The invention is protected by a patent and a registration dossier has been compiled and discussions initiated towards its registration with Pest Control Products Board of Kenya, and subsequently to be modified for submission to other African countries.



### Research on the gut microbes of bees

Research on the gut microbial diversity and specific beneficial interactions between microbes and honeybees, for improved bee health management is ongoing, including analyses of bee gut samples from Kenya and the Indian Ocean nations to uncover novel gut microbiota members and their abundance, and isolation of bacteria strains to establish an African bee gut microbiota library for physiological studies.



### Stingless bee research

Survey and inventory of stingless bee species to assess diversity, nesting ecology and impact of landscape on species distribution have been accomplished in selected forest habitats and their surroundings in Kenya, Zanzibar and Madagascar.

## Beneficial and commercial insects



**Technology transfer** in beekeeping, including capacity building, development of honey market places and bee health research, to provide alternative livelihoods for food and income security concluded in September 2017 in four Indian Ocean Island Nations (Mauritius, Seychelles, Comoros and Madagascar) and in Zanzibar.



### YESH progress

**3,119** unemployed beneficiary youth (**26.5%** female) in apiculture and **553 (66%** female) in sericulture) in the six districts in Ethiopia trained through the Young Entrepreneurs in Silk and Honey (YESH) project had been recruited trained and engaged.



### New job opportunities

YESH is also expanding job opportunities along the value chain, including woodwork workshops to manufacture all the frame hives and sericulture starter kits; and tailoring enterprises for supply of protective clothing.



### Silkworm barcoding

icipe has succeeded in barcoding of seven silkworm stock to determine their genetic makeup and the results showed that the COI marker discriminated between *Eri* and *Bombyx mori* species.

## Biosystematics



150 previously unknown species have been described and published in collaboration with taxonomists worldwide.



Collaborative research between *icipe* and Institut de recherche pour le développement (IRD) have identified a new *Cotesia* species that could be used as a biological control agent towards *Sesamia nonagrioides* an important maize pest in France.

## AFERIA

**15,000** farmers benefitted from innovative strategies to cope with climate change, through the Adaptation for Food Security and Ecosystem Resilience in Africa (AFERIA), a project implemented in the highland ecosystems of Jimma, Ethiopia; Taita Hills and Murang'a in Kenya, and around Mount Kilimanjaro, Tanzania, which came to an end in December 2017. The project, which was coordinated by *icipe*, with the support of Ministry for Foreign Affairs of Finland, disseminated technologies developed through research conducted within the Climate Change Impacts on Ecosystem Services and Food Security in Eastern Africa (CHIESA), also implemented by the two partners, and various collaborators from 2011 – 2015.



Beekeeping as an alternative livelihood activity was introduced in Jimma area.



Farmers in Murang'a being trained on how to identify coffee pests.



Training of trainers on integrated pest management for horticultural crops.

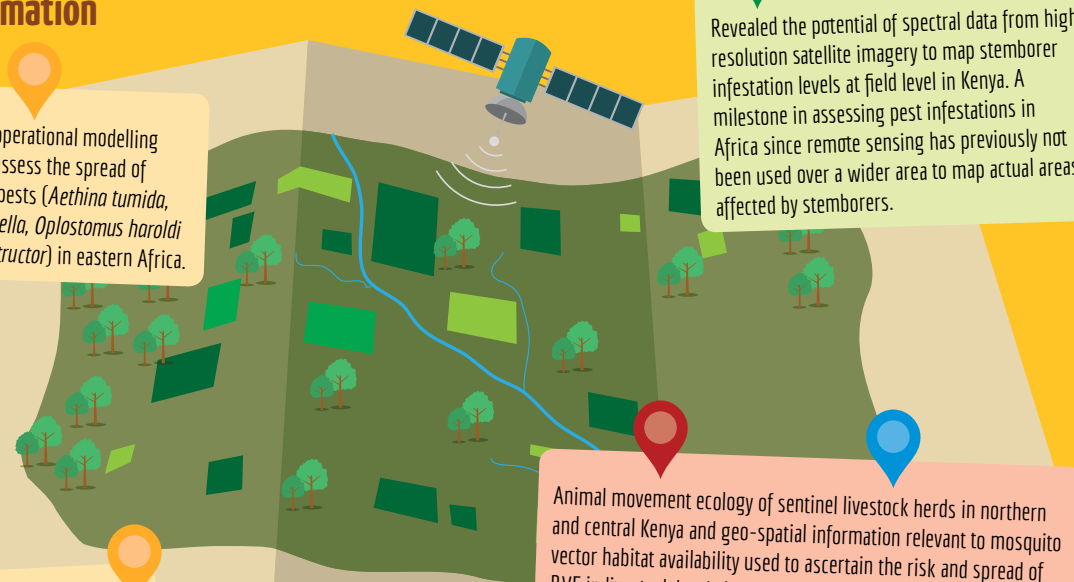


Women from Kilimanjaro area preparing tree seedlings to rejuvenate forests.

## Geo-Information

Developed an operational modelling framework to assess the spread of important bee pests (*Aethina tumida*, *Galleria mellonella*, *Oplostomus haroldi* and *Varroa destructor*) in eastern Africa.

Spatial distribution shifts of honeybees (*Apis mellifera*) abundances were assessed for Zanzibar Island (Tanzania).



Revealed the potential of spectral data from high resolution satellite imagery to map stemborer infestation levels at field level in Kenya. A milestone in assessing pest infestations in Africa since remote sensing has previously not been used over a wider area to map actual areas affected by stemborers.

Animal movement ecology of sentinel livestock herds in northern and central Kenya and geo-spatial information relevant to mosquito vector habitat availability used to ascertain the risk and spread of RVF in livestock herds in Kenya. This is the first comprehensive study that shows the potential of using several geo-spatial data feeds (Global Positioning System-collaring, remote sensing and climate variables) and sophisticated modelling (in this case logistic regression modelling) for health risk mapping at explicit landscape scales.

## Featured story

# Strengthening bee research

Over the past several decades, *icipe* has conducted extensive research on bees. These studies have been amplified since 2014, with the establishment of the African Reference Laboratory for Bee Health, headquartered in Nairobi, Kenya, with satellite stations in Burkina Faso, Cameroon, Ethiopia and Liberia, and a training site in Madagascar. This state-of-the-art facility, a partnership with the African Union Inter-African Bureau for Animal Resources (AU-IBAR), provides a platform for monitoring and preventing bee diseases and pests in Africa.

*icipe's* bee research activities revolve around three thrusts. First, *icipe* aims to complete gaps in knowledge and to rectify the absence of systematic procedures and capacity to monitor, analyse and safeguard bees.

Second, *icipe* aims to contribute knowledge on colony collapse disorder (CCD), and in collaboration with partners, the Centre is mapping bee health risk factors, while investigating mitigating strategies in Africa and globally. The third thrust is based on *icipe* research that has found that Africanised honeybees in the USA, many of which are hybridised crosses with European species, tolerate maladies associated with CCD better.

Towards this goal, *icipe* researchers are characterising the gut microbiota of African honeybees, the 'friendly bacteria' that aid insect defence against pathogens.

It is hoped that this increased understanding of how gut microbiota influences the health of bees will lay a foundation for microbe-based strategies for bee health management.

*icipe's* role as a global hub of bee health expertise in Africa was recognised in 2017, with the designation of the Centre as an OIE Collaborating Center for Bee Health in Africa.

This milestone elevate *icipe's* continent-wide basis and mandate, and provides further confidence for stakeholders in Africa to collaborate with advance its bee health research activities that currently revolve around three thrusts.

Further, in 2017, through a workshop attended by over 40 participants including researchers and policymakers and other key stakeholders from Africa, United Kingdom, France, Germany and the United States of America, *icipe* marked a major milestone towards developing a strategy to guide the advancement of its bee research and development portfolio.

The specific objectives of the forum were:

- Evaluate current *icipe* bee research against the Centre's strategy;
- Identify any aspects of *icipe's* bee activities areas that are not completely aligned to *icipe's* strategy and make recommendations.
- Review and evaluate past, ongoing, and future research domains of bee research on the basis of scientific excellence, operational effectiveness and impact;
- Assess accomplishments and impact of *icipe's* bee research and related activities;
- Identify and recommend a portfolio of bee R&D opportunities for partnerships and strategies for implementation;
- Outline procedures for developing a strategic document for *icipe* bee research and development.

Discussions focused on four sub categories: bee health; pollination; bee nutrition and endosymbionts. The workshop delivered a range of outputs, which will be helpful in creating a bee research environment that will build on previous successes while at the same time addressing new challenges.



# Insect for Food and Feed Programme

## Donors:

Australian Centre for International Agricultural Research (ACIAR) and International Development Research Centre (IDRC) through the Cultivate Africa's Future (CultiAF) programme; Bioinnovate Africa; BLE – German Federal Agency for Food and Agriculture; BMZ – German Federal Ministry for Economic Cooperation and Development through GIZ; DANIDA; Netherlands Organization for Scientific Research (NWO).

## Partners:


Agrarian Systems Ltd., Uganda; Egerton University, Kenya; Farm Radio International (FRI), Uganda and Kenya; Food Security Centre, University of Hohenheim, Germany; Jaramogi Oginga Odinga University of Science and Technology (JOOUST), Kenya; Jomo Kenyatta University of Agriculture & Technology (JKUAT), Kenya; Kenya Agricultural and Livestock Research Organization (KALRO), Kenya; Kenya Bureau of Standards (KEBS), Kenya; Kenya Marine and Fisheries Research Institute (KMFRRI); Kenyatta University (KU), Kenya; Lasting Solutions Ltd, Kenya & Uganda; Makerere University, Uganda; National Fisheries Resources Research Institute (NaFIRRI), Uganda; National Livestock Resources Research Institute (NaLIRRI), Uganda; Nutri Africa Ltd., Kenya; Nutreal Ltd., Uganda; Nyendo Grasshopper Association, Uganda; Old Masaka Basenene Association, Uganda; Sanergy Ltd., Kenya; Solidaridad Eastern & Central Africa Expertise Centre (SECAEC), Kenya; Technical University of Munich, Germany; TechnoServe, Kenya; Treasure Industries Ltd., Kenya; Uganda National Bureau of Standards (UNBS), Uganda; UGACHIK Ltd., Uganda; Unga Feed, Kenya; United States International University (USIU), Kenya; University of Bonn, Germany (Center for Development Research - ZEF); University of Copenhagen, Denmark; University of Hohenheim (UoH), (Food Security Center), Germany; University of Nairobi, Kenya; Wageningen University, The Netherlands.

## 2017 highlights




**28 insect species** have been profiled for the nutritional content including grasshoppers, cricket, black soldier fly (BSF) termites, mopane caterpillar, fruit flies, silkworm, blow flies, etc.

Diversity, host plants and abundance for over eight edible Saturniids moth (e.g. *G. zambezina*, *G. belina*, *Bunea alcinoe*, *Nudaurelia kruckii*, *Cirina forda*) are better known and their seasonality documented in East Africa.





Changes in nutritional profile of edible insects such as the grasshopper (*Ruspolia*) and the Saturniid caterpillars has been assessed.




No aflatoxin and pesticide residues were found in the **28 insect species analyzed**. Pathogens (*Escherichia coli*, *Salmonella typhi*, *Staphylococcus aureus* and faecal coliforms) in reared BSF and crickets, and harvested blue caliphora flies, were effectively inactivated by boiling or roasting for five minutes.

**92%** of the **28** profiled insect species have higher crude protein dry matter basis than fishmeal available in Kenya and Uganda.

**Rearing protocols for 16 insect species** were developed, the most productive colonies being BSF (*Hermetia illucens*), crickets (*Scapsipedus marginatus* and *Gryllus bimaculatus*), grasshoppers (*Schistocerca gregaria*, *Ruspolia differens*, *Acanthacris ruficornis*), silkworms (*Bombyx mori*) and American cockroaches (*Periplaneta americana*).





Over **80%** of interviewed fish and poultry farmers, **65%** of pig farmers and **75%** of feed traders and processors are willing to use insects as feed.



Production capacity for insect in colonies (cricket, grasshoppers, BSF, various saturniids) for smallholder producers varies from **100,000 – 300,000 adults/ week**.

**Natural regulatory factors of these insects** (parasitoids, predators and pathogens) that influence their abundance in nature documented and effort to mitigate them is under investigation.



Effective demand, at **5%** inclusion of insects in feed, translates into **27,000-32,000 tons** of dry insect material for Kenya.



Consumer perceptions, factors defining their consumption among communities in East Africa has been established. More than **58% (especially women)** are interested in rearing of saturniids for business.





**Institutional and scientific capacities** for insect use as feed and food built in Kenya and Uganda will ensure continued research and sustainability.

Further, at **5% inclusion**, the substitution of current protein with **BSF** in poultry feed alone in Kenya has a potential demand of **115,000 tons of dry insect** per year, translating into a market value of **US\$103.5-115 million per year**. This would potentially result in **14,328 jobs** if each person produced **2 tons** of fresh insects per month.

**US\$0.20/kg (DM)** to produce, and sold on the market for between **US\$0.90** and **US\$1/kg DM**.



**Insect use as a protein source** is estimated to reduce the protein cost of feed production by at least **25-37.5%**.

Nile tilapia fish fed with **BSF-based feed** were **23% heavier** than those fed with conventional feed.

Performance studies in catfish fingerlings revealed that a **37% higher growth rate** and **23% higher weight gain** was achieved from **BSF-based feed**, compared to conventional feed.



The production of **BSF** in a screen house of **5 m x 10 m** could yield **2 tons fresh BSF per month**, costing.

Replacement of **20% fishmeal** in conventional poultry feed with **BSF** resulted in higher (**53%**) **egg production** and improved quality compared to conventional feed.



**Insect rearing** is a sustainable practice that can be carried out **from home** with minimal required inputs and is therefore **ideal for women farmers** who are often constrained by limited access to agricultural resources.



A standard for **Dry Insect Product for Compounding Animal Feed** was approved and launched by the Standard Approval Committee in Kenya in March 2017, and in Uganda in June 2017. This will enable small, medium and large-scale feed producers to integrate insects into feed production and create a market for women and youth to mass rear insects as a business.



**506 (293 men and 213 women)** farmers, young entrepreneurs, policymakers and scientists were trained on insect rearing for integration into animal feed.

# Capacity Building and Institutional Development



**Donors:** Australian Centre for International Agricultural Research (ACIAR) & International Development Research Centre (IDRC) through the CultiAF programme; Biovision Foundation for Ecological Development, Switzerland; Boris Mints Institute for Strategic Policy Solutions to Global Challenges, Israel; European Union; German Federal Ministry of Economic Cooperation and Development (BMZ); German Research Foundation (DFG); Mastercard Foundation; Partnership for Economic Policy (PEP); Swedish International Development Cooperation Agency; Swiss Agency for Development and Cooperation; United State Agency for International Development (USAID); UK Aid from the UK Government; Wageningen University.

**Partners:** Biocontrol Research Laboratories (BCRL), Bangalore, India; CIRAD, France; Citrus Research International, South Africa; Egerton University, Kenya; ETH Zurich, Switzerland; Horticulture Research and Training Institute, Tanzania; International Food Policy Research Institutes (IFPRI); International Maize and Wheat Improvement Centre (CIMMYT); Kenya Agricultural and Livestock Research Organisation (KALRO); Kenya Bureau of Standards; Kenya Plant Health Inspectorate Service (KEPHIS); Kenyatta University, Kenya; Luleå University of Technology, Sweden; Mikocheni Agricultural Research Institute, Tanzania; Ministry of Agriculture, Food Security & Cooperative, Tanzania; Moi University, Kenya; Norwegian University of Life Sciences, Norway; Partnership for Economic Policy (PEP); Real IPM Ltd, Kenya; Sanergy Ltd., Kenya; Tel Aviv University; Texas A&M University, USA; University of Bonn (Center for Development Research (ZEF), and Medical Center), Germany; University of Geneva; University of Nairobi, Kenya; University of Zürich; Virginia Polytechnic Institute and State University, USA; Wageningen University; World Vegetable Center (AVRDC).

*icipe's* postgraduate training programmes bring together students from across Africa and the world. Pictured: ongoing students and their mentors pictured during the 2017 *icipe* Scholars Association cultural day.

## Postgraduate and postdoctoral training

African Regional Postgraduate Programme in Insect Science (ARPPIS)  
Dissertation Research Internship Programme (DRIP)  
Postdoctoral Fellowships Training Programmes

**84** PhD fellows (**43** ARPPIS and **41** DRIP PhD scholars), **74** DRIP MSc fellows, and **11** postdoctoral fellows were engaged in research at *icipe* in 2017.

**41%** of all fellows in the postgraduate and postdoctoral programmes are **women**.

**18 African nationalities** (Benin, Burkina Faso, Botswana, Cameroon, Cote D'Ivoire, DR Congo, Ethiopia, Ghana, Kenya, Nigeria, Rwanda, Sudan, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe) and **three non-African nationalities** (Germany, Mexico, Oman) were represented in the postgraduate and postdoctoral programmes in 2017.

**4 ARPPIS PhD** scholars, **11 DRIP PhD** scholars and **16 DRIP MSc** scholars, defended their thesis or graduated in 2017.

**Postgraduate** and **postdoctoral** fellows continue to make a significant contribution to the publication output of *icipe*. **50%** of peer-reviewed scientific articles by *icipe* were authored or co-authored by postgraduate or postdoctoral fellows.

## Alumni tracking

In 2017, a web-based tracer study of ARPPIS PhD alumni was conducted for all alumni since the inception of the ARPPIS programme in 1983.

Only **20%** were 'inactive', which included those who were deceased or could not be traced.

**74%** were categorised as 'active' in Africa, and **6%** 'active' outside of Africa - mostly in universities.

Of the 'active' category in Africa, almost all are working in research, development or higher education in universities, national and international research institutes, other national systems, government, and private sector organisations.

A number of alumni are in senior positions, such as vice chancellors, directors of institutes, principal and senior scientists, and departmental heads.

## Training and development



**54** training courses and workshops held for researchers, community workers and entrepreneurs

**2,955** participants (**42%** women) trained

Trainees from **17** African countries



Push-Pull programme trainings held in **6** countries

**52,410** farmers, pupils/students, extension workers and other stakeholders trained

**49%** of all trainees women

## Featured story



## DAAD-*icipe* partnership

Since its establishment in 1970, *icipe* has maintained a commitment of building the capacity of people and institutions, mainly through MSc, PhD and postdoctoral training programmes. The African Regional Postgraduate Programme in Insect Science (ARPPIS), is *icipe's* flagship PhD training programme. Established in 1983, ARPPIS, a partnership with African universities, aims to build a critical mass of qualified PhD professionals in arthropod-related sciences, with a focus on geographic and gender diversity and inclusion.

The German Academic Exchange Service (DAAD) has been a key and consistent supporter of ARPPIS, providing scholarships every year since 1983, benefitting 192 ARPPIS students, or 65% of all scholars in the programme. On average, DAAD has assisted about six new ARPPIS scholars each year, with the figure rising to 11 in 2017. In 2017, 42 DAAD-supported ARPPIS PhD scholars were in progress in the programme. To date the ARPPIS PhD programme has trained 239 PhD-level scientists.

Iman Brema Hassaballa (Sudan), one of the 2017 income DAAD sponsored ARPPIS PhD scholars. She is conducting research to assess sand fly plant feeding behaviour in Baringo Country, an endemic area of leishmaniasis and arboviruses in Kenya.

Various ARPPIS-DAAD graduates have held leadership positions in universities and national and international research institutes:

- Prof. John H. Pen-Mogi Nyeko (Uganda) (class of 1983): was until recently the Vice Chancellor of Gulu University, Uganda.
- Prof. Baldwyn Torto (Ghana) (class of 1985): Principal Scientist and Head of the Behavioural and Chemical Ecology Unit, *icipe*.
- Dr Hassane Mahamat (Chad) (class of 1987): Director General, Livestock Research Institute for Development (IRED), Farcha, N'Djamena, Chad.
- Prof. Eucharia Unoma Kenya (Nigeria) (class of 1990): Deputy Principal, Planning, Administration & Finance, and Professor of Biotechnology, Embu University College, Kenya.
- Dr Adèle Ngi-Song (Cameroon) (class of 1991) Program Officer with Canadian Institutes of Health Research (CIHR), Ottawa, Canada.
- Prof. Hellen Kutima (Kenya) (class of 1993): Associate Professor Dept. of Zoology and Director, Gender and Mentoring Centre, Jomo Kenyatta University of Agriculture and Technology, Kenya.
- Dr Sunday Ekesi (Nigeria) (class of 1995): Director of Research and Partnerships, *icipe*.
- Dr Samira Mohamed (Sudan) (class of 1997): Senior Scientist, Plant Health Theme, *icipe*.
- Dr Okwae Ken Fening (Ghana) (class of 2006): Senior Research Fellow, Soil and Irrigation Research Centre (SIREC), University of Ghana.



# Social Science and Impact Assessment Unit

## Donors:

Australian Centre for International Agricultural Research (ACIAR); International Development Research Centre (IDRC), Canada; Biovision Foundation for Ecological Development, Switzerland; UK Aid from the UK Government; European Union; German Federal Ministry of Economic Cooperation and Development (BMZ); German Research Foundation (DFG); Partnership for Economic Policy (PEP); Swedish International Development Cooperation Agency; Swiss Agency for Development and Cooperation; Mastercard Foundation, United State Agency for International Development (USAID); Boris Mints Institute for Strategic Policy Solutions to Global Challenges, Israel; and Wageningen University.

## Collaborators/Partners:

Tel Aviv University; Wageningen University, University of Zürich, ETH Zurich, Switzerland, International Food Policy Research Institutes (IFPRI), International Maize and Wheat Improvement Centre (CIMMYT); Partnership for Economic Policy (PEP); Virginia Polytechnic Institute and State University, USA; Norwegian University of Life Sciences, Norway, University of Geneva, Luleå University of Technology, Sweden; CIRAD, France; Egerton University, Kenya Agricultural and Livestock Research Organisation (KALRO); Plant Health Inspectorate Service (KEPHIS); Kenyatta University, Kenya; Ministry of Agriculture, Food Security & Cooperative, Tanzania; Moi University, Kenya; University of Bonn (Center for Development Research (ZEP), and Medical Center), Germany; University of Nairobi, Kenya; World Vegetable Center (AVRDC).



The *icipe* Social Science and Impact Assessment Unit is using digital technology to enhance data collection on the impact of the Centre's activities. Pictured: Dr Menale Kassie (extreme right), Head, SSIA Unit, pictured with *icipe* team members, enumerators, extension officers and farmers ready to conduct a randomized control trial on the Push-Pull technology in Hawassa, Ethiopia.

## Economic, human health and environmental impact of fruit fly IPM technologies in Kenya

• Fungi-derived biopesticides • Baiting and male annihilation techniques • Biological control with parasitoids • Cultural control through field sanitation • Minimal use of pesticide in localised bait stations of spot spray • Proper post-harvest treatment to provide and assure quarantine security

### Key findings

- Adoption of integrated pest management (IPM) contributes to economic benefits, and also improved health of producers, consumers and environment, due to reduced use of insecticides.
- Although individual components of IPM have an impact on human and environmental health, the greatest impact is achieved when the components are used in combination.

Use of one IPM technology



35%

Reduction in the negative health effects of insecticides use on producers.

0.7%

Reduction on the negative health effects of insecticides use on consumers.

38%

Reduction on the negative health effects of insecticides on the environment.

9%

(KSh/tree) net income increase for mango farmers.



Use of two or more IPM technologies

42%

21%

42%

140%

### The crucial factors that drive the use of IPM practices are:



Economic incentive (increased income from mango production)



Neighbourhood effects based by the number of adopters that farmers know in their vicinity



Social capital measured by membership of rural institutions



Participation in insect pest management training

## Economic potential of citrus IPM research

US\$ 52.3 million

return on investment (net present value) in citrus integrated pest management (IPM) research.

US\$ 16.9:1 benefit-cost ratio is

that is investing one US dollar can generate a benefit of US\$ 16.9. The internal rate of return (IRR) is 60.3%.

The performance indicators imply that investing in citrus IPM research is cost-effective as well as profitable.

## Role of *icipe* tsetse repellent collar in improving economic performance of livestock in Kenya

78% reduction in the proportion of animals falling ill with trypanosomiasis.

94% reduction in animal mortality rate according to farmers perception

98% reduction in abortion rate.

58% improvement in cow calving interval

97% increase in lactation period

200% increase in milk yield

55% & 150% increase price of oxen and cow

300% increase in draft power

## Enhancing *icipe* M&E capacity

Towards the goal of ensuring continuous tracking of all *icipe* research and development activities, in September 2017, the SSIA Unit organised a monitoring and evaluation (M&E) training workshop. The goal was to equip researchers with the necessary skills, increase understanding of the value of M&E and contribute towards the creation of a Centre-wide strategy.



## Impact of Push-Pull technology on women empowerment and nutrition security

*icipe's* mission is to conduct insect science and design strategies for its practical application, to contribute to better health and food and nutritional security and, ultimately, enhance the livelihoods of communities across Africa and beyond. The Centre firmly believes that true socioeconomic transformation can only be achieved through a holistic and inclusive approach to development. For this reason, one of *icipe's* key goals is to ensure empowerment of women in Africa through the development of gender neutral technologies.

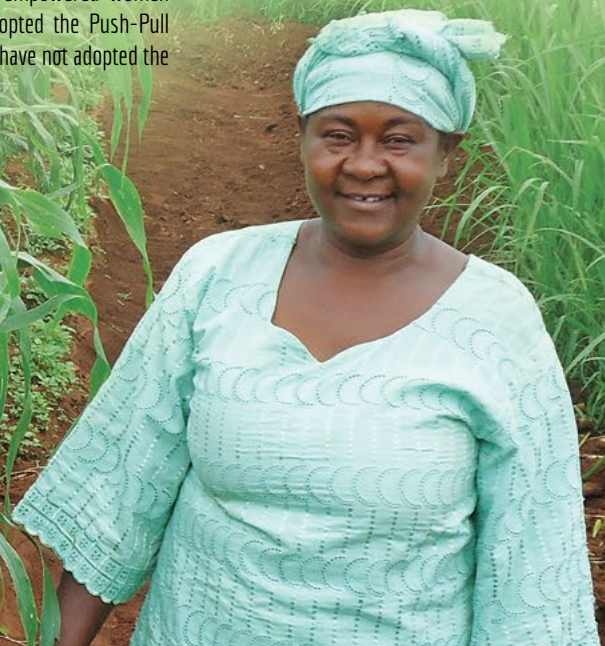
In accordance, in 2017, *icipe* conducted a study to examine the impact the Push-Pull technology on women's empowerment as a stand-alone component, and in combination with nutritional status. The researchers used the women's empowerment in

agricultural index (WEAI) and a proxy to dietary diversity score (DDS), to measure nutritional status.

### The study found that:

- Women's empowerment and adoption of Push-Pull technology have a positive and significant effect on women's dietary diversity scores (WDDS). Empowering women in agriculture, increases their number of food groups consumed by 5 percentage points.
- The impact is significantly higher for empowered women belonging to households that have adopted the Push-Pull technology than their counterparts who have not adopted the technology.

- For instance, the average DDS for empowered women belonging to households that have adopted the Push-Pull technology is 1.01, compared with empowered women belonging to non-adopting households (0.584); the difference between the empowered women in the two types of household represents a 73% increase in WDDS.
- These results highlight the role of empowering women and technology adoption to enhance nutrition security in Africa.



Mrs Agnes Maureen Ambubi, a former housewife, started practising Push-Pull at the lowest point of her life, after becoming suddenly widowed. She says the technology empowered her and has enabled her to support her family.

## Technology Transfer Unit



**Donors:**  
Australian Centre for International Agricultural Research (ACIAR) & International Development Research Centre (IDRC) through the CultiAF programme; Biovision Foundation for Ecological Development, Switzerland; Boris Mints Institute for Strategic Policy Solutions to Global Challenges, Israel; European Union; German Federal Ministry of Economic Cooperation and Development (BMZ); German Research Foundation (DFG); Mastercard Foundation; Partnership for Economic Policy (PEP); Swedish International Development Cooperation Agency; Swiss Agency for Development and Cooperation; United States Agency for International Development (USAID); UK Aid from the UK Government; Wageningen University.

**Partners:**  
Biocontrol Research Laboratories (BCRL), Bangalore, India; CIRAD, France; Citrus Research International, South Africa; Egerton University, Kenya; ETH Zurich, Switzerland; Horticulture Research and Training Institute, Tanzania; International Food Policy Research Institutes (IFPRI); International Maize and Wheat Improvement Centre (CIMMYT); Kenya Agricultural and Livestock Research Organisation (KALRO); Kenya Bureau of Standards; Kenya Plant Health Inspectorate Service (KEPHIS); Kenyatta University, Kenya; Luleå University of Technology, Sweden; Mikochei Agricultural Research Institute, Tanzania; Ministry of Agriculture, Food Security & Cooperative, Tanzania; Moi University, Kenya; Norwegian University of Life Sciences, Norway; Partnership for Economic Policy (PEP); Real IPM Ltd, Kenya; Sanergy Ltd., Kenya; Tel Aviv University; Texas A&M University, USA; University of Bonn (Center for Development Research (ZEF), and Medical Center), Germany; University of Geneva; University of Nairobi, Kenya; University of Zürich; Virginia Polytechnic Institute and State University, USA; Wageningen University; World Vegetable Center (AVRDC).

## Overview

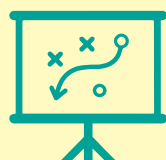
Since its founding, *icipe* has maintained a clear mission of producing world-class knowledge, backed by the determination of developing solutions that are environmentally friendly, accessible, affordable and easy-to-use by end-users. Therefore, the Centre places great emphasis on ensuring effective transfer of technologies, by instituting strategies to translate research into tangible products, building indigenous capacity to use and adapt them to local conditions, and working with public and private partners to create relevant and effective value chains. In accordance, and building on previous

experience, in 2017, *icipe* re-launched its Technology Transfer Unit (TTU), which is aligned to the Centre's Vision and Strategy 2013 – 2020.

TTU will enable the assignment of the dissemination of strategies and solutions developed by the Centre to a dedicated, appropriately skilled team. The Unit presents a platform for synchronised, sustainable and visible technology dissemination. It will build on pilot technology dissemination projects by *icipe* and partners, to scale them out for

enhanced impact. TTU will also strengthen cross-linkages between *icipe*, farmers, researchers, donors, enterprises and policymakers, facilitating better processes for providing information and advice, testing and improving technologies, capacity building, innovative project development and business incubation. TTU is being incubated within the Push-Pull sub-Saharan Africa project, funded by funded by a Swiss family through Biovision a Swiss family through Biovision Foundation for Ecological Development, Switzerland.

## 2017 highlights



Five-year **strategic plan** developed.



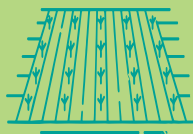
**Inventory of *icipe* technologies** established, to facilitate packaging, and coordinated and effective dissemination.



**Technology profiling** and packaging, and mapping of dissemination constraints ongoing.



**Stakeholder mapping** in in southern and western Africa ongoing.



**114 demonstration sites** established for Push-Pull training.



**7 staff members** recruited.



**3,074 farmers (1,296 males and 1,778 females)** trained on Push-Pull technology.



**115 extension officers** and farmer facilitators (**71 males** and **44 females**) trained on Push-Pull technology.



**Countries where Push-Pull was already being practised by beginning of 2017**

**Countries into which TTU had expanded Push-Pull by end of 2017**

# BiInnovate Africa Programme

## Donors:

Swedish International Development Cooperation Agency (Sida), Sweden.

## Collaborators/Partners:

Addis Ababa University (AAU), Ethiopia; Agri Seed Company Limited, Kenya; Busitema University, Uganda; East Africa Nutraceuticals Ltd (EAN), Kenya; Food and Nutrition Solutions Ltd (FONUS), Uganda; GLOBAL AGRO CONCEPT Limited, Rwanda; Green Enzyme Technologies Ltd (GETL), Kenya; Guavay Company Limited, Tanzania; Hawassa University, Ethiopia; Hottiserve East Africa Limited, Kenya; International Centre of Insect Physiology and Ecology (icipe), Kenya; ITEC, Tanzania; Jomo Kenyatta University of Agriculture and Technology (JKUAT), Kenya; Kenya Biologics Limited, Kenya; Kenya Industrial Research and Development Institute (KIRDI), Kenya; Kibwezi Agro Limited, Kenya; Lasting Solutions Limited, Uganda; Makerere University (MAK), Uganda; Maseno University, Kenya; Mikochoeni Agricultural Research Institute (MARI), Tanzania; MIMEA International Kenya Limited, Kenya; Ministry of Trade, Industry and Cooperatives, Uganda; National Agricultural Research Organization (NARO), Uganda; National Semi Arid Resources Research Institute (NASARRI), Uganda; Nelson Mandela African Institution of Science and Technology (NM-AIST), Tanzania; OKOA Society, NGO, Tanzania; Pwani University (PU), Kenya; Rwanda Agricultural Board (RAB), Rwanda; SENAI Farm Supplies Limited, Uganda; Sokoine University of Agriculture (SUA), Tanzania; Sulma Foods Limited, Uganda; Tanzania Commission for Science and Technology (COSTECH), Tanzania; Tanzania Industrial Research and Development Organization (TIRDO), Tanzania; The Real IPM Company Limited, Kenya; TONNET Agro-engineering company Limited (TONNET), Uganda; Treasure Industries Limited (TIL), Kenya; Tursam Investment Limited (TIL), Uganda; University of Dar es Salaam (UDSM), Tanzania; University of Nairobi (UoN), Kenya; W.E Tilley Fish Processors, Kenya.

Among the 11 winners of BiInnovate Africa's first call in 2017, is a project led by the University of Nairobi, Kenya, to develop an innovative and efficient process for dehairing leather and descaling fish. Pictured, Ms Eva Dama Mwakazi, a postgraduate student at the University, conducting research that will lead to laboratory scale production of industrial enzymes that are central to the technology.

## BiInnovate Africa Programme finds true home

In 2016, the Swedish International Development Cooperation Agency (Sida) and *icipe* reached an agreement for the Centre to host and manage the Bioresources Innovations Network for Eastern Africa Development (BiInnovate) programme, Phase II (2016 – 2021).

One of Africa's largest regional innovation-driven science initiative, BiInnovate Africa was established in 2010 with support from Sida, its first phase running up to 2015. The programme provides grants to enable scientists, researchers,

innovators and entrepreneurs in eastern Africa (Burundi, Ethiopia, Kenya, Rwanda, Tanzania and Uganda), work together to turn innovative ideas and technologies based on biological sciences into viable businesses.

*icipe* has become a true home for Bioinnovate Africa, based on synergies between the Centre and the Programme in the vision of working with researchers, policymakers and private sector actors towards inclusive growth and sustainable development in Africa.

## 2017 highlights

**Increased funding:** Sida increased funding for BiInnovate Africa to 120.7 Million SEK (approximately USD 15 million), up from SEK 100.7 (around USD 11.8).

**Bioeconomy strategy:** Bioinnovate Africa contributed towards the development of a bioeconomy strategy for eastern Africa, through a high-level forum convened in partnership with *icipe* and the National Council for Science and Technology (NCST), Rwanda, held in Kigali, on 2 and 3 November 2017.

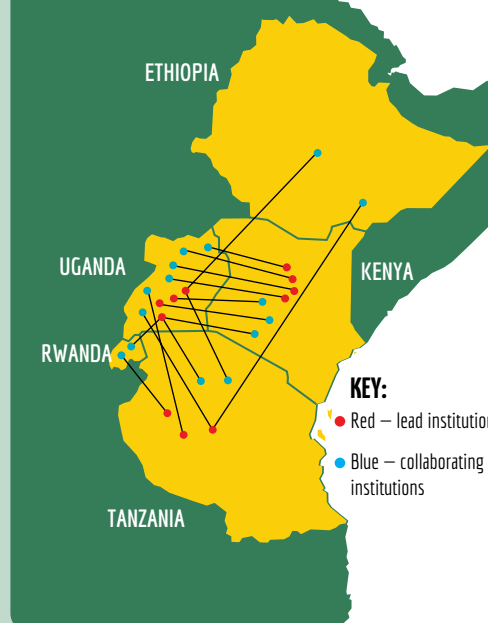
**First grants call:** In April 2017, BiInnovate Africa announced its first call for concept notes for sustainable bioinnovations towards value addition and agro/bioprocessing for smallholder farmers and communities in eastern Africa.

**443**  
applications received

**11**  
research teams selected

**US\$6M**  
worth of grants awarded

## First call winners networks



## 11 innovation grant winners



Technology that will use mechanisms to dry and package fruits and vegetables in a manner that preserves natural quality;

Development of agribusinesses by ensuring all-year-round production and processing of insects that are traditionally consumed in Africa, for instance grasshoppers (*nsebene*) and crickets;

Initiative to produce new, conveniently and attractively packaged sorghum and millet products, that can be consumed instantly in various solid forms, or as malted drinks

Strategies to integrate information communication technologies (ICT) in the production and marketing of tissue culture sweetpotato vines to increase yields.

Support to scale-up production and commercialisation of a renewable fertilizer that is fortified with nitrogen from biodegradable waste obtained in urban centres.

Project to avail across Africa a more efficient material (known technically as a substrate), that will significantly enhance smallholder mushroom cultivation.

Industrial processing technology, which greatly improves, through time efficiency, reduction of wastage, and reduced environmental pollution, the dehairing of leather and descaling fish, among other procedures.

Maize and finger millet varieties, that are resistant to the obnoxious Striga weed, a major challenge in Kenya and Uganda, developed by Maseno University, will also benefit from the funding.

Commercialisation of biopesticides developed from fungi

Promotion of strategies and technologies to enable disinfection of pests from fruits and vegetables from Africa, thereby

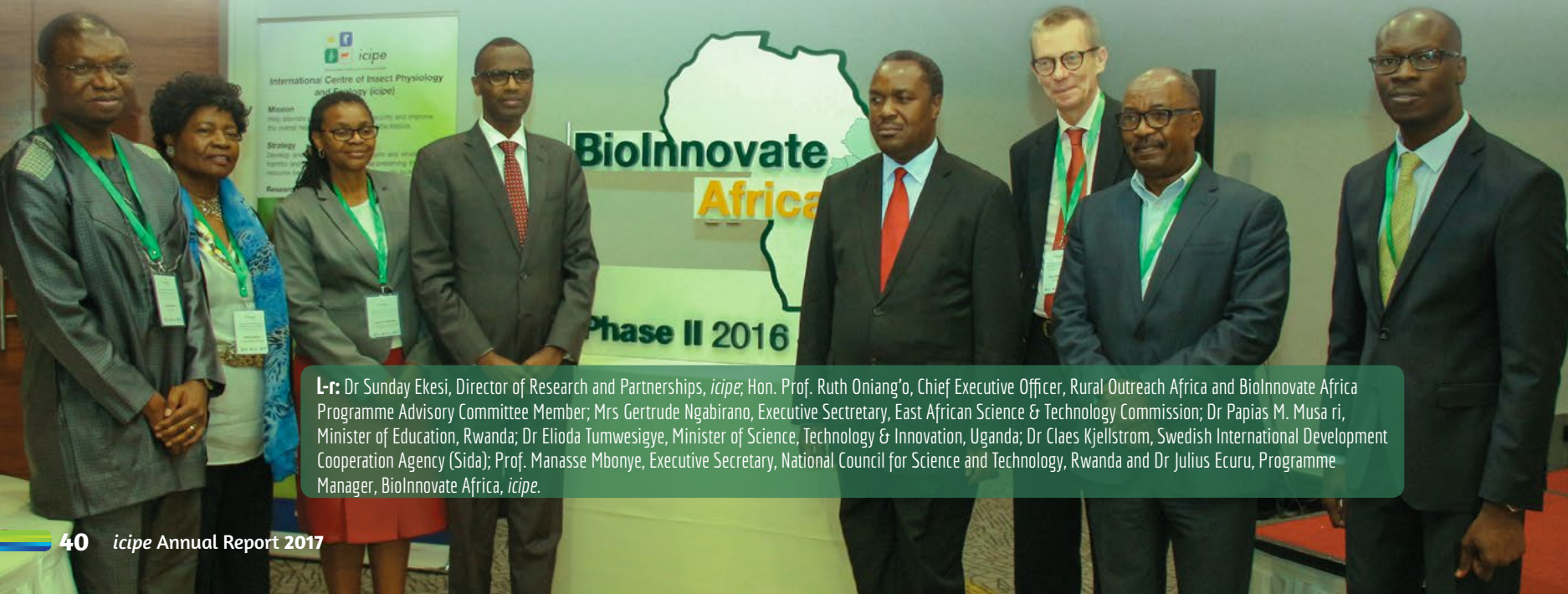
## Promoting bioeconomy in eastern Africa

On 3 and 4 November 2017, BioInnovate Africa programme, *icipe* and the National Commission of Science and Technology (NCST) of Rwanda, held a high-level forum on developing a bioeconomy in eastern Africa will be held in Kigali, Rwanda.

A bioeconomy brings together the commercial activity surrounding the use of renewable biological resources – such as crops, forests, animals and micro-organisms (like bacteria) – to solve challenges related to food, health, environmental protection, energy and industrial processes.

The main advantage of a bioeconomy for eastern Africa is its high innovation potential; the fact scientists and entrepreneurs use scientific knowledge and technologies on living organisms or biological systems to create new economic enterprises. This knowledge-based approach on harnessing biological resources results in business partnerships between scientists, inventors, small and medium-sized enterprises, farmers, and eco and social entrepreneurs, which are more efficient and less damaging to the environment.

A bioeconomy can, therefore, bring about economic growth and the international competitiveness of a country or region, while creating new employment opportunities. The forum explored opportunities and ways to address challenges for bioeconomy development in eastern Africa. Specifically, the forum considered strategies to create stronger links between scientific institutions, policy and private sector actors. The deliberations also proposed a roadmap towards developing a regional bioeconomy strategy.



**L-r:** Dr Sunday Ekesi, Director of Research and Partnerships, *icipe*; Hon. Prof. Ruth Oniang'o, Chief Executive Officer, Rural Outreach Africa and BioInnovate Africa Programme Advisory Committee Member; Mrs Gertrude Ngabirano, Executive Secretary, East African Science & Technology Commission; Dr Papias M. Musiri, Minister of Education, Rwanda; Dr Elioda Tumwesigye, Minister of Science, Technology & Innovation, Uganda; Dr Claes Kjellstrom, Swedish International Development Cooperation Agency (Sida); Prof. Manasse Mbonye, Executive Secretary, National Council for Science and Technology, Rwanda and Dr Julius Ecuru, Programme Manager, BioInnovate Africa, *icipe*.

# Annex I

## 2017 Awards, Recognition, and Nominations

### Centre-wide recognitions

***icipe* designated OIE Collaborating Centre for Bee Health in Africa:** In May 2017, *icipe* was officially designated as an OIE Collaborating Centre for Bee Health in Africa by OIE – World Organisation for Animal Health (the intergovernmental organisation responsible for improving animal health worldwide).

**Recognition by National Commission for Science, Technology and Innovation (NACOSTI):** *icipe* was granted a Certificate of Registration, jointly endorsed by the Cabinet Secretary, Ministry of Education, Science and Technology, and the Director General, NACOSTI, Kenya in March 2017.

### Staff recognitions

***icipe* Director General, Dr Segenet Kelemu:**

- Appointed member of the international evaluation panel of the Boris Mints Institute (BMI) prize, awarded to an exceptional individual who has devoted their research and academic life to solving a strategic global challenge. Also appointed member of the BMI International Academic Committee.
- Appointed member, National Science and Technology Council of Rwanda, the governing body of the country's National Commission of Science and Technology (NCST).
- Featured in the Mind of the Universe ([http://www.themindoftheuniverse.org/scientist?id=Segenet\\_Kelemu](http://www.themindoftheuniverse.org/scientist?id=Segenet_Kelemu))
- Named one of five 'heroes in the field', by leading philanthropist, Bill Gates, for using their talents to fight

poverty, hunger and disease, while providing opportunities for the next generation.

**Dr Sunday Ekesi, Director Research and Partnerships:**

- Appointed to the African Academy of Science Membership Advisory Committee (MAC) in the field of Agricultural and Nutritional Sciences.
- Appointed member of the Scientific Committee for the International Congress of Entomology (ICE2020), Helsinki, Finland.

**Dr Baldwyn Torto, Head Behavioural and Chemical Ecology unit:**

- Recognized as one of the top 50 scientists in Africa in the African Researchers Booklet, Science in Africa, published by the Department of Science and Technology, South Africa to celebrate Africa Science Day.
- Appointed Extraordinary Professor, University of Pretoria, South Africa (<http://www.universityofpretoria.co.za/en/sirg/article/59870/staff>)
- Appointed Member, Board of Trustees, JRS Biodiversity Foundation (<http://jrsbiodiversity.org/jrsboard-cockman-torto/>).
- Appointed Member, Editorial Advisory Board of the Journal of Agricultural and Food Chemistry of the American Chemical Society (<http://pubs.acs.org/pb-assets/documents/eab/jafcau-eab.pdf>)
- Appointed Reviewer and Panel Chair, Research Councils of the

United Kingdom, Global Challenges Research Fund, United Kingdom.

- Named Team Leader, African Academy of Sciences Assessment Team to review African Union Commission Call proposals on "Food, Nutrition Security and Sustainable Agriculture (FNSSA) with a focus on Sustainable Intensification".

**Dr Clifford Mutero, Leader integrated vector management for Malaria:** Recognized one of the top 50 scientists in Africa in the African Researchers Booklet, Science in Africa, published by the Department of Science and Technology, South Africa to celebrate Africa Science Day.

**Menale Kassie, Head, Social Sciences and Impact Assessment Unit (SSIAU):** Elected Member of the Research Committee for the Environment for Development (EfD) initiative (<http://www.efdinitiative.org/>), University of Gothenburg, Sweden.

**Beatrice Muriithi, Postdoctoral Fellow, SSIAU:** awarded Fellowship on: Science by Women: Programme For Women, Science, Technology and Innovation in Africa.

**Merid Getahun, Scientist, Animal Health Theme:** appointed as Head of the Partner Group of the Max Planck Institute for Chemical Ecology in December 2017.

**Juan Parades, Scientist, Bee Health Research:** awarded the Newton-Utafiti Fund for research and innovation, by the UK and Kenya governments, and the Advanced Postdoctoral Mobility grant, Swiss National Science Foundation.

## 2017 Awards, Recognition, and Nominations

### **icipe Governing Council 2017 students awards**

**Annette O. Busula (DRIP PhD):** Best science paper awards: won the first prize for paper titled: Gametocytemia and attractiveness of *Plasmodium falciparum*-infected Kenyan children to *Anopheles gambiae* mosquitoes, published in *Journal of Infectious Diseases*.

**Ruth Muthoni Kihika (DRIP MSc):** Second prize, for paper titled: Parasitic nematode *Meloidogyne incognita* interactions with different *Capsicum annum* cultivars reveal the chemical constituents modulating root herbivory published in *Nature Scientific Reports*.

**David K. Mfuti (ARPPIS PhD):** Third prize for his paper on Lure and infect strategy for application of entomopathogenic fungus for the control of bean flower thrips in cowpea published in *Biological Control* journal.

**Nancy Karimi Njeru (ARPPIS PhD):** First prize for poster on: Effect of stemborer management under Push-Pull cropping system on ear rots of maize in western Kenya.

**Faith Akinyi Obange (DRIP MSc):** Second prize for poster entitled: On the Trail of a Killer: A multi-locus sequence typing approach to characterizing deformed wing virus strains.

**Seydou Diabaté (ARPPIS PhD):** Third prize for poster on: Effect of host and non-host volatiles on the behaviour of *Megalurathrips sjostedti*.

### **External scholars award**

**Sheila Agha (ARPPIS, PhD)** received best oral presentation at the 5th Medical and Veterinary Virus Research conference (MVVR), Nairobi, 7-8 Dec 2017.

**Nelly Ndungu (ARPPIS, PhD),** received the Genome Award: Best Presentation and the Pensoft Award for Best Presentation for *Resolving taxonomic ambiguity and cryptic speciation of *Hypatrigona* species through morphometrics and DNA barcoding* at the International Barcode of Life Conference, Kruger National Park, South Africa, 20-24 Nov 2017.

**Akbar Ganatra (DRIP, PhD),** received the best poster award for his poster on “*The effect of pollutants on the distribution and infectivity of schistosomiasis intermediate host snails in western Kenya*” at the 11th Annual Neglected Tropical Disease Conference hosted by Ministry of Health and KEMRI, Nairobi, Kenya, 6-7 Dec 2017.

**Tatenda Chiuya (ARPPIS PhD),** Awarded a place on the new Molecular Data for Infectious Disease course run by the Institute of Tropical Medicine (ITM), Antwerp.

**Faith Obange** awarded a National Research Fund (NRF) grant in 2017 to undertake her MSc studies.

### **icipe internal awards**

**Robert Skilton, Head of the Capacity Building and Institutional Building Unit:** Outstanding employee of the year 2017 for transforming the *icipe* capacity development efforts by ensuring progressive interactions among students, staff and supervisors, and maintaining a supportive academic environment across the Centre.

**Subramanian Sevgan, Scientist and Head of Arthropod Pathology Unit:** Outstanding professional staff of the year 2017, for his contributions to *icipe* in the development and dissemination of IPM strategies for thrips, insects for food, plant

virus-vector interactions, fall armyworm and capacity building.

**Dolorosa Osogo, Science Editor, Communications Unit:** Outstanding support staff of the year 2017 for her contribution to ensuring high quality scientific communication at *icipe*.

**Xavier Cheseto, Donald L. Kachigamba, Sunday Ekesi, Mary Ndung'u, Peter E. A. Teal, John J. Beck, and Baldwyn Torto:** Outstanding Publication of the Year 2017: Identification of the Ubiquitous Antioxidant Tripeptide Glutathione as a Fruit Fly Semiochemical. *Journal of Agricultural and Food Chemistry*. DOI: 10.1021/acs.jafc.7b03164.

**Outstanding Team of the Year 2017:** *icipe* Ethiopia Country Office for outstanding efforts at expanding programmatic activities, building capacity of the national systems, partnerships and strong financial management and accounting systems to the benefit of stakeholders in Ethiopia and beyond.

**Outstanding partner of the year 2017:** The Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ), which mainly implements technical cooperation projects of the German Federal Ministry for Economic Cooperation and Development (GIZ/BMZ) recognised for being an outstanding donor and partner of *icipe* since 2000.

**For more details about *icipe* and its activities, contact:**

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

# Annual Report 2017

*icipe* was established in 1970 in direct response to the need for alternative and environmentally friendly pest and vector management strategies. Headquartered in Nairobi, Kenya, *icipe* is mandated to conduct research and develop methods for pest control that are effective, selective, non-polluting, non-resistance inducing, and affordable to resource-limited rural and urban communities. *icipe*'s mandate further extends to the conservation and utilisation of Africa's rich insect biodiversity.

*icipe* focuses on sustainable development, including human health, as the basis for development, and the environment, as the foundation for sustainability. Working through a holistic and integrated approach through the 4H paradigm – Human, Animal, Plant and Environmental Health – *icipe* aims at improving the overall well-being of communities in tropical Africa by addressing the interlinked problems of poverty, poor health, low agricultural productivity, and degradation of the environment.

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An FAO Reference Centre



OIE Collaborating Centre for Bee Health in Africa



A Stockholm Convention Regional Centre