2012 icipe CORE ANNUAL REPORT BASED ON RESULTS BASED MANAGEMENT REPORTING

May 2013

icipe

African Insect Science for Food and Health

International Centre of Insect Physiology and Ecology

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2012 BRIEF OF *icipe* KEY ACHIEVEMENTS

icipe Brief Background

The primary mandate of *icipe* is research in integrated control methodologies for crop and livestock insect pests and other related arthropods, and insect vectors of tropical diseases and the strengthening of scientific and technological capacities of developing African countries in insect science and its application through training and collaborative work. *icipe*'s work is organized through its *4-H* paradigm (H for health), where targeting the improvements in Human, Animal, Plant and Environment Health have been identified as the most holistic, and cost effective ways to meaningfully engage with the complex development requirements of African communities and to provide the much needed poverty-alleviating solutions. Cutting across the *4-Hs* are *icipe's Capacity Building and Institutional Development* activities that work to develop well-trained and highly motivated human resource capacity.

icipe Centre-wide programmes

Overall objective for Human Health: Contribute to the reduction of malaria and other vector borne-diseases by developing tools and strategies that control the vectors and break the cycle of transmission, and which can be integrated with other disease management efforts.

Overall objective for Animal Health: Contribute to the improvement of livestock health and productivity through the development of integrated strategies and tools for livestock disease vectors' control and adoption by development partners, thus leading to greater availability of meat and milk, hides and draught power and thereby assisting livestock owners to get out of the poverty trap.

Overall objective for Plant Health: Contribute to stabilizing horticultural and staple food production by reducing quantitative and qualitative pre- and post-harvest yield losses due to insect pests, mites, weeds and mycotoxin-producing fungi by developing economically viable and ecologically sound production systems with low pesticide input.

Overall objective for Environmental Health: Conservation and sustainable utilization of the agricultural production base and important natural ecosystems, by encouraging and utilizing arthropod diversity, cataloguing and sharing biodiversity data, and discovering endemic wealth by bio-prospecting for useful natural products.

Overall objective for Capacity building: To develop well-trained and highly motivated human capacity, and strengthen institutional and policy making capacity and capability required to respond to the arthropod-related development challenges in Africa.

Brief on *icipe*'s Results Based Management Framework

In early 2010, *icipe*'s Governing Council (GC) and Management in consultation with its **core donors** agreed to develop a Results Based Management (RBM) framework to support the Centre's Strategic Priorities, Policies and Guidelines of insect science research and development. Initially, *icipe* used the Medium Term Plan Framework but like many other international organisations, *icipe* introduced RBM in early 2011 as its new strategic planning and management tool. Many development co-operation agencies including UN and CGIAR organisations are now in the process of introducing or reforming their performance management systems and measurement approaches and *icipe* is no exception.

The operational guidelines specifically state that the RBM framework will take into consideration existing good practice and lay out an approach that:

(i) incorporates measuring results with widely recognized tools;
(ii) assesses risk on an ongoing basis; and
(iii) incorporates learning into strategies, projects and programmes.

icipe RBM was instituted in 2012 and is an operational framework that explicitly links the strategic objectives and priorities of the Centre to the various programmes and projects that it finances so that collectively they help achieve the goals and objectives of *icipe*.

The RBM helps *icipe* to promote efficient management techniques. The systematic approach of gathering and assessing data and results on progress towards objectives is a cost-effective way to diagnose early weakness in implementation plans. Periodic and targeted information will help the GC and *icipe* Management recognize those activities that generate the highest pay-offs in terms of results, or those, which appear to need more support to deliver results aligned with strategic priorities. The Centre is then able to track and measure progress towards objectives, and make targeted decisions to improve performance on an ongoing basis. Process monitoring takes place on an ongoing basis to track whether portfolios are being implemented as intended, standards are being met, and resources are being used efficiently.

Each of *icipe's* core activity areas has developed their RBM Framework. All projects entail knowledge management and learning, which are the main components for any organization dealing with research and development (R&D) like *icipe*. The R&D *icipe* Thematic Clusters (*i.e. 4-H paradigm*) and Capacity Building frameworks encompass a cycle of planning, periodic performance assessment and organizational learning – all of which are supportive of knowledge creation and sharing. Learning from the R&D activities influences strategy development and programme/project design, and the lessons are fed back into programme/project implementation. The learning component is also critical for identifying and managing risks while bearing in mind the expected results and resource levels. This involves increasing knowledge by learning, knowledge dissemination and feedback into decision making, project design and strategy development.

Applying RBM is the beginning of an on-going process to better define the specific goals of *icipe* and to design mechanisms to ensure the measurement of progress towards those goals. At this stage, *icipe* tracks specific performance measures at an institutional level on an annual basis. Projects implemented by *icipe* are the basis of its RBM framework. As such, tracking results begin from a project vantage point. At a project level, results are tracked during implementation and evaluated upon project completion. While the tracking tools are utilised during implementation it is important that the three major phases in a project's evolution are linked: (a) project design; (b) implementation; and (c) evaluation. Breaking down the project cycle into these three phases, highlights the learning and management aspect of *icipe*'s RBM framework and facilitates in attributing outcomes and impacts to a specific project or programme.

RBM is indeed a strategic management approach that ensures *icipe*'s R&D activities are implemented in collaboration with our partners in order to contribute to a logical chain of results that are millennium development goals related priorities and provide knowledge-based solutions aimed at equipping the communities in Africa to survive and live within a rapidly changing global environment.

icipe Corporate Events Undertaken in 2012

1. *icipe* Launches an Honorary Prize in Recognition of Prof. Thomas Odhiambo's Outstanding Research Work

In honour of the late Prof. Thomas Odhiambo, founder of *icipe* and the Centre's 1st Director, *icipe* launched in January 2012, the ***Thomas Odhiambo Distinguished Research Fellowship,*** an international award recognizing the achievements of individuals who have made advancement in the field of entomology that improve the quality of the livelihoods of the beneficiaries by enhancing food security, health and environmental sustainability. The Prize recognizes scientific contributions in any field principally involving entomology. The Prize emphasizes the importance of improving the overall health status of peoples of the tropics by developing and extending management tools and strategies for harmful and useful arthropods, while preserving the natural resource base through research and capacity building.

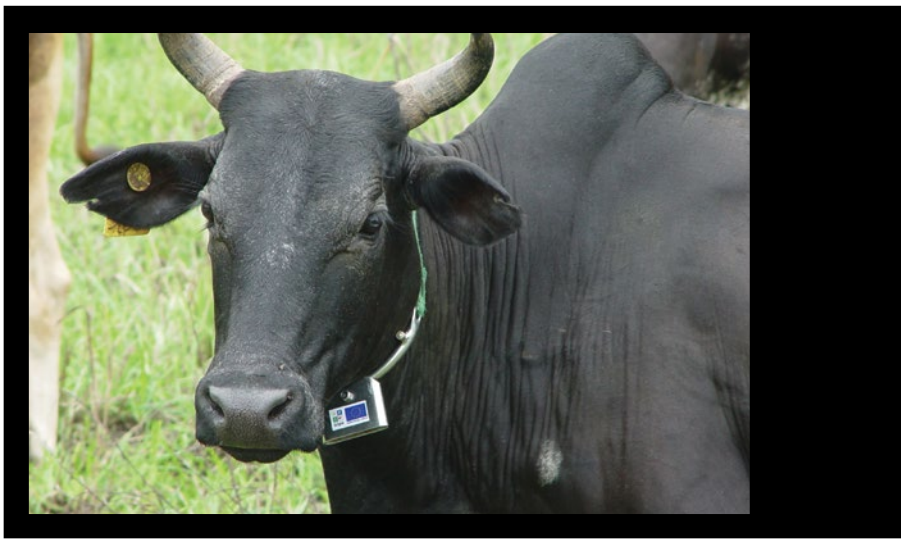
2. The Association of Independent Research and Development Centres for Agriculture

In March 2012, the *icipe* Director General participated in the 1st meeting of AIRCA - the Association of Independent Research and Development Centres for Agriculture (www.airca.org). AIRCA is a new loose association of nine non-CGIAR Centres, including CABI, CATIE, AVRDC, ICBA, ICIMOD, *icipe*, IFDC, INBAR and CFF. The aim of the association is to give these Centres higher visibility, especially within the international donor community, and to facilitate and strengthen outside participation in the new CGIAR Research Programs (CRPs). The meeting was hosted by GFAR in Rome. Additionally, *icipe* actively participated in the development of a white paper for AIRCA as well as in the AIRCA side event during the 2nd GCARD (Global Conference on Agricultural Research for Development) Meeting held in Uruguay from 29 October to 4 November 2012.

3. *icipe* designated as FAO Reference Centre

Effective 1st August 2012, *icipe* was designated as a Food and Agricultural Organisation of the United Nations (FAO) Reference Centre for vectors and vector-borne animal diseases, which include tsetse flies and animal trypanosomosis as well as arthropod-transmitted viral animal pathogens. FAO Reference Centres are selected by the Director-General of the organisation on the basis of their high level scientific expertise as well as their commitment to capacity building and provision of services.

The designation of *icipe* as a Reference Centre follows a thorough evaluation of its mandate, main activities and competencies. It is also based on *icipe's* extensive experience and prior collaboration with FAO. Read an Article featured in our current "*icipe* Biennual Highlights" 2011 – 2012: Collaborations and Partnerships (*Published December 2012*) that informs on *icipe Designated as an FAO Reference Centre*. Access the Full Report on: http://www.icipe.org/images/stories/pdf/about_us/icipe-biennial-highlights-2011-2012_digitalversion.pdf



As a Reference Centre, *icipe* will contribute in four key areas that are vital to the control of vectors and vector borne animal diseases. First, *icipe* will provide FAO and its members with specific, independent technical and scientific advice, as well as recommendations on interventions against these factors. Second, the Centre will facilitate the identification of African trypanosomes and arthropod transmitted viral diseases, and provide advice on their ecology. *icipe's* third contribution will be in the building of the capacity of researchers in FAO member countries and/or in the African region, for instance through training courses, workshops and the development of technology innovation and

transfer programmes. Fourth, *icipe* will help to improve the performance and harmonisation of vector and disease diagnostic services, by sharing biological materials and its relevant with FAO and other Reference Centres. More information can be found at http://www.icipe.org/index.php/news/622-icipe-designated-fao-reference-centre.html

4. Review of *icipe*'s R&D, capacity building and management programmes

Starting November 2012 *icipe* embarked on a periodic 5-year external review commissioned by its Governing Council. *icipe* considers the regular external and internal monitoring and evaluation of its performance an important activity to regulate both quality and relevance as well as ensure compliance to its mandate and mission. As a result, the Centre undergoes numerous reviews to assess its institutional performance and output. This includes research projects, which have their own mechanisms of review and planning, based on agreements with funding partners, and with close participation of the stakeholders. It is through these periodic monitoring and evaluation exercises, that *icipe*'s activities and operations are prioritised, and refocused to meet the needs of the beneficiary communities as well as the larger constituency.

The last external review was conducted during the 1st half of 2007 covering the period 2002–2007. The final report of this review can be found at http://www.icipe.org/index.php/external-review.html. The 2007 review focused exclusively on the programmatic and strategic issues, in particular the research and capacity building agenda of the Centre. The 2012 review was much broader and covers the entire operations of *icipe*, including management, internal organisation, administration, policies and partnerships of the Centre. The review involved a study of relevant documentation summarising the main R&D findings and institutional developments 2007-12 as well as the envisaged programs and institutional forecasts 2013-2020, visits and review of on-going work of *icipe*'s programmes, field sites and stations. The three external reviewers also consulted with a broad range of partners and collaborators. The review will result in a detailed report providing key recommendations for the Centre, and is expected to be publically available in June 2013.

5. icipe Case Studies published by EU, UNDP and EIARD in 2012

EU: Science-led innovation protects livestock from the Tsetse fly in Kenya case study was published by The EU and is available on: http://ec.europa.eu/europeaid/documents/case-studies/kenya_agriculture_tsetse_en.pdf

UNDP: The Muliru Farmers Conservation Group, supported by *icipe's* applied bio-prospecting program, which contributes to the conservation of the Kakamega Forest through the domestication of indigenous medicinal and insecticidal plants, case study was published by UNDP. http://www.equatorinitiative.org/images/stories/winners/110/casestudy/case_1348163412.pdf

EIARD: Another case study for the Mwingi Honey Marketplace: *icipe* - Linking insects to forest conservation through honey and silk was published by EIARD. Access the website for more information - http://www.eiard.org/key-documents/impact-case-studies/2013/

icipe 2012 Selected Programme Key Achievements

Thematic Highlights:

1. Human Health:

Development and Evaluation of an Effective Non-toxic Method for Controlling Malaria (SolarMal)

In collaboration with Wageningen University, in The Netherlands, *icipe* in 2012 initiated a project "**Solar power for malaria eradication**" now known as SolarMal that targets all residents of Rusinga Island, an island in Lake Victoria, Western Kenya, principally comprising a rural community located on a 44 square km island which depend economically on fishing and agriculture. Rusinga has a diverse topography, ranging from flat areas near the shoreline to a central hill and from low to medium density vegetation cover. Although malaria is transmitted throughout the year, intensity varies greatly according to seasons. The project aims to demonstrate proof of principle for the elimination of malaria from Rusinga Island using the nation-wide adopted strategy of Long Lasting Insecticide Treated Nets (LLINs) and case management augmented with mass trapping of mosquito vectors. Each house on Rusinga Island will be provided with a solar panel that will be used to power a trap to catch malaria-transmitting mosquitoes before they enter houses.

This project is developed against a backdrop that recent reductions in malaria morbidity and mortality are largely attributed to indoor application of insecticides through insecticide treated bed nets (ITNs) and indoor residual spraying (IRS) as well as the use of potent anti-malarial therapies. However, the long term effectiveness of current vector control strategies are undermined by resistance to insecticides and changes in feeding behaviour and outdoor transmission capacity of malaria vectors. Odour baits that are capable of attracting as many malaria vectors as human subjects do, can be exploited to capture and kill mosquitoes without the use of insecticides against which physiological and behavioural resistance can develop.

External Evaluation of icipe's Integrated Vector Management Malaria Programme

icipe's IVM malaria program, supported by the Swiss Biovision (BV) Foundation, was externally evaluated in May 2012. In addition *icipe* scientists, together with partners from national programs in Kenya and Ethiopia, developed a strategic 3-year plan, which was subsequently submitted to and approved by BV. The new program will allow *icipe* and its partners to substantially broaden and upscale IVM activities in the 2 countries. The report is available for download at: http://www.icipe.org/index.php/component/content/article/25-about-us/654-external-evaluation-of-the-biovision-icipe-malaria-ivm-projects-in-kenya-and-ethiopia.html

2. Animal Health:

Livestock bacteria origin correlates with livestock domestication

Members of the '**Mycoplasma mycoides** cluster' affect livestock in Africa and impact the agricultural sector. They also represent a threat to developed countries. A team of researchers from *icipe* and ILRI, together with other international partners, has elucidated the origin of the 'Mycoplasma mycoides cluster'. The study, published in May 2012 in the Public Library of Science [Fischer et al. 2012 **PLoS One 7(4): e36150** http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0036150], suggests that domestication was likely the event triggering the spread of the bacteria in livestock. The bacteria of the genus **Mycoplasma** are directly transmitted; therefore, increase in density of animals increases the chances of transmission and maintenance of the pathogens in the herd.

icipe's eco-friendly Tsetse Repellent Collar showcased to Stakeholders

icipe showcased its tsetse repellent technology to over 50 different national and International stakeholders at Shimba Hills Game Reserve (Kenyan Coast). Participants, among them the Kenyan Minister of Environment and Mineral Resources Hon Chirau Ali Mwakwere, were taken to the outskirts of Shimba Hills where over 1500 animals are protected with repellent collars to see for themselves how the technology was improving livestock health and productivity and positively affecting the livelihoods of the livestock keepers. All the stakeholders present were impressed by the repellent technology and noted that the project had met its objectives and the technology was now beyond proof of concept stage. They agreed to sensitize their respective institutions for dissemination and adoption of the technology. It was recommended that development of cheap, affordable dispensers with Public Private Partnerships should be a priority so that the technology can be rolled out to all tsetse affected countries in Africa. In this connection it was recommended that a new regional/continental project be developed. After the event a joint EU-*icipe* press release was released resulting in press articles in several local and international newspapers (Frankfurter Allgemeine Sonntagszeitung, Global Times, Standard, The Star, and Coast Week etc.). A case study was also put on the EU website - Science-led innovation protects livestock from the Tsetse fly in Kenya http://ec.europa.eu/europeaid/documents/case-studies/kenya_agriculture_tsetse_en.pdf

3. Plant Health:

icipe publishes cutting edge research on tritrophic interactions in Journal of Chemical Ecology (JCE)

A recent study published in the *Journal of Chemical Ecology* (JCE) by scientists from *icipe* and Rothamsted International showed that maize varieties popular with smallholder farmers in East Africa, when attacked by stemborers, produce volatiles that attract the pests' natural enemies. Moreover, the cover of the March 2012 issue of JCE shows a farmer's push-pull field from Kisumu district in western Kenya. More information at http://www.springerlink.com/content/776505p2840862w2/

icipe scientists make first reports of two plants diseases in Kenya

icipe reported for the first time the Tomato yellow ring virus (TYRV) (Tospovirus, Bunyaviridae) infecting tomatoes in Kenya. Tospoviruses are the only plant pathogens of the Bunyaviridae exclusively transmitted by thrips causing important yield losses worldwide. Thrips and Tospoviruses threaten sustainable and profitable production of tomatoes in Kenya. For years, symptoms of tospoviruses were often confused with those caused by other fungal and bacterial pathogens resulting in farmers' application of fungicides with no tangible results. Previously, TYRV has only been reported in various host crops in Iran, and *icipe's* study is the first confirmation of the presence of the disease in Africa. The scientists intend to continue their

research on vector competence of thrips species infesting tomato, risk assessment in neighbouring countries where it is found infesting tomatoes, the bio-ecology and epidemiology of the disease in order to come up with ecologically management strategies of the virus and the vector. The full report can be found at http://apsjournals.apsnet.org/doi/abs/10.1094/PDIS-05-12-0462-PDN

icipe has also newly reported Hyparhennia grass white leaf disease (HGWL), caused by 16SrXI phytoplasma in Kenya. *Hyparhennia rufa* is a thatching grass commonly found throughout the tropics where it also serves as valuable fodder and border grass to prevent soil erosion. To our best knowledge this is the first record of the group 16SrXI, 'Ca. Phytoplasma oryzae' associated with the white leaf disease of *H. rufa*, and the first record of the thatching grass as a host for a phytoplasma. This report also shows that *H. rufa* may be an alternative host plant for the dreaded Napier grass stunt phytoplasma and might play a role in the epidemiology of Napier grass stunt disease in East Africa. As the disease spreads, it will affect the continued use of *H. rufa* as cattle fodder and thatching grass. Moreover, the disease might impact on soil conservation efforts in parts of East Africa where *H. rufa* is the main border grass. The full report can be found at http://www.ndrs.org.uk/article.php?id=024017

icipe launches a regional programme for biological control of the Diamondback moth pest on crucifers

In August 2012, *icipe* launched its technology transfer and dissemination activities in scaling-up the biological control of the Diamondback moth (DBM) pest on crucifers in East and southern Africa. Previously, in order to reduce insecticide misuse and its associated problems of public and environmental health, *icipe* embarked on a project to improve natural control of DBM through importation and release of natural enemies. Two parasitoid species, *Diadegma semiclausum* and *Cotesia plutellae* were introduced from Taiwan and South Africa, respectively, to Kenya in 2001 and tested for their adaptation to different growing conditions. *Diadegma semiclausum* is suitable to cooler climatic conditions and has been released in all highland cabbage and kale growing areas of Kenya, Tanzania and in Uganda with outstanding results, and the technology is currently being promoted in Ethiopia and Cameroon. *Cotesia plutellae,* on the other hand, is adapted to warmer and dryer conditions and was released in the Lake Victoria Region of Uganda in 2003 from where it has since spread to Western Kenya, also providing good control of the pest. Both natural enemies have great potential for similar growing conditions across Africa and the unveiling is instrumental for *icipe*'s R&D activities aimed at scaling-up this approach across other African crucifer production areas. The lessons learned in the DBM biocontrol–based integrated pest management (IPM) in parts of eastern Africa will be used as the entry points and also springboard for the introduction and promotion of this approach in the new target countries of Mozambique, Malawi, Zambia and Rwanda.

4. Environmental Health:

icipe's partner, Muliro Farmers Conservation Group announced among the 2012 ONE Africa Award Finalists: Saving a Forest While developing a Community

Founded in 1997 and formally registered as a Community Based Organization in 1999, a group of small-scale farmers in rural Western Kenya established the *Muliro Farmers Conservation Group* (MFCG) (http://www.mulirufcg.org/) with the mission to protect and conserve Kakamega Forest. Kakamega Forest, covering an area of 240 km^2 and containing >1,000 unique species of flora and fauna, is Kenya's last remaining rainforest, which was once part of the vast equatorial Congo-Guinean forest that stretched from the continent's Atlantic coast to the Indian Ocean. The farmers that founded MFCG saw an acute, urgent need to raise awareness

in the local communities of the dire state of the forest and to support the local and national governments' efforts to conserve the forest.

In 2000, MFCG partnered with *icipe* with the strategic objective of using science to discover natural resources that could be developed and commercialized to promote the conservation of the endangered forest. MFCG and *icipe*'s efforts focused on traditional plants that the communities around Kakamega used, in particular wild *Ocimum kilimandscharicum*, which had been traditionally used to treat insect bites, muscle aches, colds and nasal congestion. *icipe* scientists soon determined the active compound in the plant and began testing different products for potential commercialisation. MFCG managed to domesticate the plant and encouraged farmers around Kakamega forest to grow the plant in order to provide enough material for extraction of its essential oils. Fast forward a few years and MFCG now has 460 farmers growing *O. kilimandscharicum*, which is turned into a whole range of products like under the Naturub brand (http://www.icipe.org/index.php/naturubr.html) that are sold in supermarkets across Kenya, providing an additional income to the farmer and creating employment at the local processing and collection centres.

icipe is proud to be in partnership with MFCG, a finalist for the 2012 ONE Africa Award! The **ONE Africa Award** celebrates these innovations and progress towards achievement of the Millennium Development Goals (MDGs), the world's blueprint to a better future, ranging from halving extreme poverty to halting the spread of HIV/AIDS and providing universal primary education.More info: http://www.one.org/africa/blog/announcing-the-2012-one-africa-award-finalists and http://www.one.org/international/blog/2012-one-africa-award-saving-a-forest-while-developing-a-community/

icipe participates in '2012 Save the Earth Expo'

The 2012 Save the Earth Expo, held from 13th – 14th November 2012 with the main theme being *Building Resilience against Climate Risks*, involved both local and international participants whose work, career, business or undertaking makes them stakeholders in the environmental discourse. The Expo was hosted by the Kenya Meteorological Society and convened at Kenyatta International Conference Center in Nairobi and *icipe* was part of it.

icipe participated in the Expo and showcased its R&D accomplishments, key among them its flagship programme activities on Climate Change Impacts on Ecosystem Services and Food Security or CHIESA Project (http://chiesa.icipe.org). *icipe* benefitted from strategic partnership discussions and highlighted its contributions towards the course of climate and environmental conservation as the Expo was attended by over 30,000 persons.

5. Capacity Building:

icipe ARPPIS tracer study conducted

In 2012, *icipe* conducted a tracer study on its ARPPIS programme, which over the last 40 years plus has trained over 242 PhD and 120 MSc-level scientists from 29 African countries. The tracer study targeted scientists trained since 1983, when ARPPIS was started. The report confirmed the programme's profound impact in scientific capacity building in Africa. According to the study, the majority of the ARPPIS trained scientists consider the programme to be one of the most important experiences in their lives and careers. They said that they found the mentorship and networking with scientists from *icipe* and partnering universities, as well as the exposure to quality research methodologies and equipment an invaluable source of knowledge and skills. The scientists also commended the opportunity to engage in real-life research projects.

Most of the scientists trained through ARPPIS have gone on to become successful professionals in a variety of institutions, primarily in Africa. Indeed, the tracer report strongly indicated that ARPPIS has contributed to food and health security, and overall sustainable development in Africa.

However, the study revealed several challenges for the programme. First, is the need to expand the programme's reach to include scientists from countries that are currently under-represented, including from Franco- and Lusophone region countries. Second, is the need to put in place institutional and financial measures to secure ARPPIS sustainable future. Such strategies should include stronger and wider linkages with regional and national research and training institutions. The ultimate aim should be the incorporation of a more integrated research-for-development framework within ARPPIS, aligned to the long-term, regional-continental vision. Third, is the need to assess possibilities of post-study support, for instance through follow-up programmes, that would enable ARPPIS alumni to establish their own research projects to replicate and transfer their training.

icipe will endeavour to address these challenges. We are encouraged by one of the key findings of the report and the pledge by the ARPPIS alumni – which congregates an unrivalled platform of scientific leadership and expertise – of their support to collaborate with icipe towards these goals……..The network of ARPPIS scholars. The full report is accessible on: http://www.icipe.org/images/stories/icipe/publications/publications/icipe-arppis-tracer-study-conducted.pdf

Capacity Building and Institutional Development (CB&ID) Programme Evaluation

icipe's Project on Developing an institutional programme for collaborative organisational capacity development (OCD) in Africa which is part of *icipe's* CB&ID programme was evaluated in the last quarter of 2012. This evaluation also included *icipe's* postgraduate training activities that are also part of the CB&ID programme, and are carried out under the auspices of the OCD project. In this regard, both the OCD project and *icipe's* postgraduate training activities are interrelated and interdependent, with the latter being coordinated and managed under the OCD, within the comprehensive framework provided by CB&ID. As further elaboration:

- *icipe's* CB&ID framework provides the overall development framework for building human resource and institutional capacity in insect science and related areas of the biosciences in Africa;
- The OCD project is strengthening the institutional and organisational capacity of *icipe's* key collaborators as well as enhancing the implementation capability of the implementing programme units to enable them function optimally to achieve their long-term objectives; and
- *icipe's* postgraduate's training activities are building a "critical mass" of scientists in insect science at MSc, PhD and postdoctoral levels in Africa through: i) the African Regional Postgraduate Programme in Insect Science (ARPPIS); ii) the Dissertation Research Internship Programme (DRIP); iii) postdoctoral fellowships in-built within the various research projects; and iv) short-term internships (3 to 6 months) carried out within *icipe*.

A consortium of donors currently funds the three activities, namely CB&ID, OCD and *icipe's* postgraduate training activities. The External Evaluation Report of CBID's OCD Project is available on our website http://www.icipe.org/images/stories/pdf/arppis_external_evaluation.pdf

Centre-Wide Highlights

As an international, pan-African research centre, *icipe* plays a crucial role in building expertise across the continent. The Centre's R&D activities focus on research, strategy, policy and programme design, as well as the evaluation and implementation of projects in the thematic areas of arthropod pests and diseases, health, environment, capacity building, social policy and technology transfer. Against this backdrop, policy research and development offers a good approach for the systemic, integrated development of farming communities in Africa. *icipe* recognises that arable and grazing land and water resources are on the decline. Therefore, the Centre aims to develop scientific strategies that could circumvent the changing cropping conditions to increase food production and secure the prospects of future generations without harming the environment or compromising biodiversity. The support from the core donors and strategic collaborations with our partners is significant to *icipe's* important role of promoting agriculture while also protecting natural resources for poverty reduction and Africa's development.

Further elaboration is featured in:

1. icipe Stockholm Convention Regional Centre on Persistent Organic Pollutants

As the Regional Centre for Africa for the Stockholm Convention on Persistent Organic Pollutants (which is hosted by UNEP), *icipe* hosted a major training workshop in August 2012 on DDT organized by the Secretariat of the Stockholm Convention in collaboration with WHO. The training workshop was on data collection, information exchange and informed decision-making within IVM approach for disease vector control to reduce reliance on DDT. The audience included national coordinators of the vector control programme and Stockholm Convention Focal Points and delegates from Ethiopia, Gambia, Madagascar, Mauritius, Mozambique, Namibia, Senegal South Africa, Swaziland, Uganda, and Zambia.

Additional information is on the Article featured in our current "*icipe* Biennual Highlights" 2011 – 2012: Collaborations and Partnerships (*Published December 2012*) that discusses *icipe*'s role as a Stockholm Convention Regional Centre. Access the Full Report on: http://www.icipe.org/images/stories/pdf/about_us/icipe-biennial-highlights-2011-2012_digitalversion.pdf

2. icipe CERNVec, a CNHR Community of Research Excellence (CoRe) Centre

In its endeavour to expand its Community of Excellence for Research in Neglected Vector Borne and Zoonotic Diseases (*CERNVec*) Consortium activities, *icipe* CERNVec essence is captured on: "*icipe* Biennual Highlights" 2011 – 2012: Collaborations and Partnerships (*Published December 2012*) that discusses *CERNVec: Contributing towards the Eradication of Neglected Diseases*. The Full Report is available on: http://www.icipe.org/images/stories/pdf/about_us/icipe-biennial-highlights-2011-2012_digitalversion.pdf .

Further *icipe* has received additional support from the Kenyan Consortium for National Health Research (CNHR - http://cnhrkenya.org), to undertake research focussing on "***Surveillance of enzootic yellow fever virus, dengue virus and malaria parasites circulating in non-human primates habituating within urban centres***". This research aims to investigate emerging infectious diseases in urban areas and will be undertaken in the *icipe's* Martin Lüscher Emerging Infectious Diseases Laboratory, BSL 3 facility.

3. Training Health Researchers into Vocational Excellence in East Africa (THRiVE)

icipe Hosts Major Meeting on Health Research Leadership

On 18th to 20th June 2012, *icipe* hosted a major meeting bringing together over 80 health researchers and administrators from Kenya, Uganda, Tanzania, Rwanda and the United Kingdom; under the auspices of a consortium known as Training of Health Researchers into Vocational Excellence in East Africa (THRiVE). The THRiVE consortium is led by Makerere University, Uganda, and in addition to *icipe*, partners with eight other institutions (http://www.thrive.or.ug). THRiVE is one of seven partnerships initiated in 2009 through a grant from the Wellcome Trust under the African Institutions Initiative, which aims at developing leadership and excellence amongst African professionals and institutions while reversing the trend of North-driven health research agendas in the South.

icipe is a key beneficiary of the excellent scientific R&D opportunities that exist within THRiVE to develop and empower academic institutions for full participation in the march of science. Notably, *icipe* participates in THRiVE's research and training, networking, institutional development, support systems and research resources. More information at: http://www.icipe.org/thrive/

The meeting provided an outstanding forum for networking with scientific and administrative staff who included MSc students, PhD and post-doctoral fellows supported by the consortium, their supervisors, partners in research and institutional research leaders as well as consortium members, the consortium coordinator, administrator, IT and financial officers. The attendees shared experiences, discussed challenges, solutions and evaluated the consortium's progress.

Read more information on THRiVE in our current "*icipe* Biennual Highlights" 2011 – 2012: Collaborations and Partnerships (*Published December 2012*) that informs on *THRiVE: Enhancing Africa's Health Research Capacity.* Access the Full Report on: http://www.icipe.org/images/stories/pdf/about_us/icipe-biennial-highlights-2011-2012_digitalversion.pdf.

4. Research activities operationalized in icipe's Biosafety level 2, 2+ and 3 EID Laboratory

icipe's Martin Lüscher Laboratory for Emerging Infectious Diseases is operational and in 2012 the first *icipe* publications on EIDs started to appear. Moreover, in early October a dedicated website for the EID lab went live (http://www.icipe.org/eidlab/). A case-specific example of this exciting research is herein captured:

Common Host-Derived Chemicals Increase Catches of Disease-Transmitting Mosquitoes and Can Improve Early Warning Systems for Rift Valley Fever Virus

In an article published in 2012 in *PLoS Neglected Tropical Diseases*, *icipe* scientists and collaborators from South Africa and the US demonstrate that enzootic transmission of arboviral diseases such as Rift Valley Fever (RVF) continues to occur at a low intensity among mosquito vectors in Kenya, which may remain undetected by most monitoring programs unless very sensitive tools are employed to detect virus activity before an outbreak occurs. In the article, the scientists present a more sensitive and mosquito-specific surveillance trapping system for RVF mosquito vectors based on mammalian-skin derived semiochemicals. They show that these vectors detect similar components (heptanal, octanal, nonanal, decanal) in the skin of RVF mammalian hosts. In field trials, each of these compounds when combined with CO_2 increased captures of the mosquito vectors in a dose-dependent manner. Additionally, a blend formulated from optimal attractive dose of each of these compounds combined with CO_2 significantly increased trap captures compared to control traps baited with CO_2 alone. The four-component blend attracted multiple RVF mosquito vectors under field conditions suggesting that a trapping system based on this formulation offers opportunity for its

use as a tool for RVF vector surveillance. For these findings lead author David Tchouassi, and ARPPIS fellow currently enrolled in a PhD program at the University of Pretoria, received the **Young Investigator Award** during the 2012 annual meeting of the American Society of Tropical Medicine and Hygiene Conference held on 11-15th November in Atlanta, USA.

More info: http://www.plosntds.org/article/info%3Adoi%2F10.1371%2Fjournal.pntd.0002007

5. Post Harvest Losses Focused Research

Beginning February 2012, *icipe* initiated a programme to investigate pertinent issues in Post harvest Losses at Different Levels of the Supply. The investigation aims at evaluating and presenting evidence on current post harvest losses in sub-Saharan Africa (SSA) to help decision-makers in governments to optimize their post-production policies and strategies in order to prevent post harvest food losses at different levels of the supply chain.

Current estimates of post harvest losses in SSA are often highly inaccurate. Without systematic empirical evidence on the real losses, the arguments over the potential for reducing global food losses as a contribution to feeding nine billion people by 2050 will remain largely rhetorical in the context of developing countries, and measuring progress against any global reduction target will be impossible. Hence the need for true quantitative evidence of post harvest losses in SSA and beyond. The findings of this programme will be published in 2013.

6. Private Sector-icipe Involvement

Mediae Company and icipe sign a Production Agreement to feature icipe technologies on 'Shamba Shape Up', a television production.

Mediae Company and *icipe* signed a Production Agreement in July 2012 at *icipe*'s Duduville Campus in Nairobi.

Mediae a media production company for education and development has created a television production known as "Shamba Shape Up". This is a practical makeover style television series aimed at the farmers and designed to deliver effective agricultural and livelihoods research-into-use to the widest possible audience in practical and accessible forms that are relevant, appropriate and up to date so as to raise living standards and incomes for an estimated 7 to 11 million smallholder farming families in East Africa and to benefit research organisations.

"Shamba Shape Up" will feature shot in 2012 and air in 2013 seven lead episodes derived from three of *icipe*'s flagship programmes namely: Push-Pull IPM technology, Fruit Fly control and management technologies and Commercial Insects Farming practices. *icipe* scientists will provide proven technical information to the Production Company for promotional purposes; as well as raise awareness, create demand and increase adoption of Push-Pull IPM technologies; Fruit Fly control and management technologies; and, Commercial Insects Farming practices for improved production of main staple and horticultural crops.

Private Sector Commercialisation of icipe's Biopesticide

On 13 February 2012, *icipe* signed a **second** Commercialisation Agreement with Real IPM (www.realipm.com), a Kenya-based producer of bio-pesticides, for the *Metarhizium anisopliae* ICIPE 78 isolate. This isolate has been intensively studied by *icipe* scientists who found it, among others, effective against spider mites like *Tetranychus evansi* and *Tetranychus urticae*. Real IPM has taken it up for commercialisation against these and other key pests of vegetables and fruits. In early 2011 *icipe* already signed a similar agreement for

the *M. anisopliae* ICIPE 69 isolate, which has in the meantime been registered for control of mealybugs in papaya in Ghana, and which is additionally in the registration process for microbiological control of other pests in Ethiopia, Kenya, Mozambique and the Republic of South Africa. More information on the status of *icipe*'s fungal isolates developed as biopesticides: http://www.icipe.org/index.php/news/700-status-of-icipes-fungal-isolates-developed-as-biopesticides.html

7. Scientific infrastructure

icipe TRO Campus at Mbita Point laboratory and screen houses overhaul completed

The major infrastructural laboratory and screen house renovation program at *icipe*'s second campus in Kenya, the Thomas Risley Odhiambo (TRO) campus at Mbita Point, was completed in 2012. At the same time a dedicated section of the TRO campus on the main icipe web domain was launched. More information can be found at:

http://www.icipe.org/mbita/

8. icipe hosts Europe Day 2012

On 9th May 2012, *icipe* was the host of Europe Day 2012, organized by the European Union (EU) Delegation to the Republic of Kenya. The 2012 event was designed to celebrate "Research for Development" and create a better understanding of the EU and featured a science fair at *icipe*'s Duduville Campus in Nairobi in which several International Centers of Excellence, Research Institutes, Think Tanks, Non-Governmental Organizations and the Embassies and Consulates of EU Member States in Kenya took part to showcase some of their work.

icipe was honoured to welcome the EU delegates to *icipe* on the propitious event of the Europe Day. The delegates were led by Mr. Lodewijk Briët, The Head of the EU Delegation in Kenya, Mr. Georges-Marc André, the EU Representative to Somalia and The Head of the European Investment Bank Regional Representation, Mr. Kurt Simonsen.

Europe Day events included Research and Development (R&D) exhibitions, speeches, and ceremonial events related to the European Union or to EU Member States. This was culminated with *"The toast to the EU's commitment to research for development in Kenya"*!.

During the occasion, a total of 12 research institutes including *icipe* proudly showcased their R&D activities to an estimate audience of over 500 visitors. *icipe* was truly delighted to be the partner hosting the memorable EU Day occasion. More information at http://www.icipe.org/index.php/news/597-europe-day-held-at-icipe-at-a-reception-celebrating-research-for-development.html

9. *PRIZES: - icipe Staff and Projects*

icipe Director General, Christian Borgemeister, elected Fellow of the Entomological Society of America and African Academy of Sciences

ESA fellow: On 1st August 2012, the Governing Board of the Entomological Society of America (ESA) – the largest entomological society in the world – elected 10 new Fellows of the Society for the year 2012. Among them was Christian Borgemeister, the Director General of *icipe*, who was honoured for his contribution to biological control and integrated pest management (IPM) in the tropics. Borgemeister follows in the footsteps of *icipe* scientist Zeyaur Khan,

who was elected a Fellow of ESA in 2010. More information at http://www.entsoc.org/press-releases/2012-fellows

AAS fellow: In addition, in 2012 Christian Borgemeister was also elected Fellow of African Academy of Sciences (AAS) for his contribution to science in Africa

Prof. Zeyaur R. Khan receives icipe's first TRO Distinguished Research Fellow award and 2011 TWAS Price for Agriculture

TRO fellow: *icipe* designated Prof. Zeyaur R. Khan, leader of the widely reputed *icipe* Push–Pull Programme (www.puh-pull.net), the first recipient of its highest honour, the Thomas Risley Odhiambo Distinguished Research Fellow (TRO DRF), in recognition of his outstanding achievements in the advancement of agricultural sciences. The award giving ceremony was carried out on 7th November 2012 during the Centre's 2012 Annual Governing Council Meeting held at *icipe*'s Thomas Risley Odhiambo Campus (TOC), Mbita Point, on the shores of Lake Victoria. In attendance were 11 *icipe* Governing Council members, two members of the Sponsoring Group of *icipe* (SGI), *icipe* Management and staff.

Prof. Khan has dedicated his 30-year career as an entomologist and agricultural scientist to advancing the science and practice of entomology by studying and applying chemical ecology, behaviour, plant–plant and insect–plant interactions to improve agricultural production to combat poverty and food insecurity in Africa. Following the original dream of *icipe*'s founding father Prof. Thomas R. Odhiambo, the work of Prof. Khan is a wonderful combination of scientific creativity and agricultural innovation that provides practical solutions for real problems of thousands of small-holder poor farmers which in turn promotes their food security and sustainable livelihoods.

Prof. Zeyaur Khan, was awarded the inaugural prize for his leadership in development and wide-scale implementation of the push-pull technology (www.push-pull.net), a pro-poor scientific innovation, for enhancing food security, incomes and environmental sustainability among smallholder farming communities in Africa, and for building human capacity in Africa and beyond.

More: http://www.icipe.org/index.php/news/645-prof-zeyaur-r-khan-receives-icipes-first-tro-distinguished-research-fellow-award.html

TWAS Prize: In September 2012, Prof. Khan, together with Segenet Kelemu of ILRI, received the 2011 *TWAS Prize for Agriculture* for his work on push-pull (http://www.icipe.org/index.php/news/503-prof-zeyaur-khan-icipe-scientist-and-leader-of-the-push-pull-programme-wins-twas-prize.html). The TWAS award ceremony was held in Tianjin, China hosted by Chinese Academy of Sciences. The TWAS Prizes, that include a medal and prize money, are awarded by TWAS, The Academy of Sciences for the Developing World, to honour individual scientists in developing countries in recognition of an outstanding contribution to knowledge. Based in Trieste, Italy, TWAS promotes scientific excellence and capacity in the South for science-based sustainable development, through a range of programmes that includes research grants; awards and prizes; fellowships and associate fellowships. *Prof. Khan received his TWAS Prize during the award giving ceremony from HE Hu Jintao, The President of the People's Republic of China held in Trieste, Italy.*

***icipe's* Beekeeping Project scoops the 3rd Prize in ApiExpo Africa 2012 Awards in Addis Ababa, Ethiopia.**

It was a memorable occasion during the ApiExpo Africa 2012 event held in Addis Ababa, Ethiopia between 26-30, September 2012, when *icipe*'s programme on beekeeping technology and eco-honey production for the improvement of the livelihoods of the Tolay Community, Ethiopia was assessed very positively and emerged as the 3rd overall winner. More than a thousand participants attended the event.

icipe's Tolay beekeeping demonstration and presentation by the farmers was identified as very successful in its mission and rated highly amidst international participants from Africa, Europe and Canada. Project staff received a Certificate from The Ethiopian Minister of Trade and Industry for their good performance.

10. NEW Strategic Alliances and External Relations

Officials from German Federal Ministry of Economic Cooperation and Development and Journalists visit icipe

On 18th January 2012, seventeen guests from the German Federal Ministry of Economic Cooperation and Development visited *icipe*. The group consisted of eleven German Journalists accompanied by:

- The spokesman of the Federal Ministry of Economic Cooperation and Development,
- Members of the German Development Bank KfW; and
- Members of the German Embassy

The aim of the visit was to discuss and document how the research done at *icipe* has a direct impact on the development of agriculture. The team was received by Roger Finan, Director of Finance and Administration (DFA) and briefed on *icipe* R&D activities as well as a brief individual introduction from the present *icipe* scientists. The program included viewing of mini-exhibits during which time most of our scientists who had exhibits were interviewed. There was a brief wrap-up after the various R&D tours where the DFA gave closing remarks and Dr. Natascha Beinker, Counsellor, Head of German Development Cooperation, also gave a brief speech and expressed the teams gratitude and satisfaction with the reception and interaction with the scientists.

AATF and icipe sign a partnership Agreement on Integrated Striga Management in Africa (ISMA)

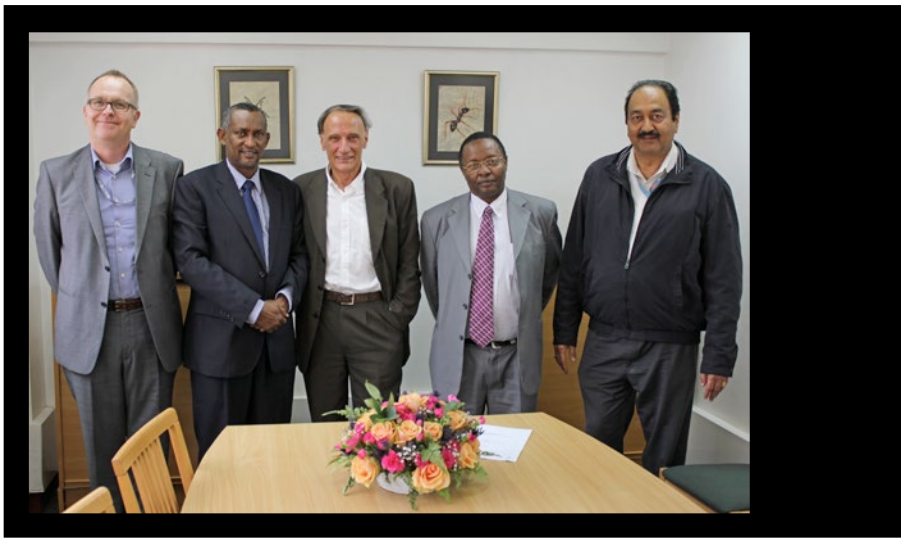
The Executive Director of African Agricultural Technology Foundation (AATF) Dr Denis T. Kyetere and *icipe* Director General, Prof. Christian Borgemeister signed a Partnership Agreement on Monday, 5th March 2012 at *icipe*'s Duduville Campus in Nairobi.

This partnership has been developed under the Gates Foundation-supported 'Integrated Striga Management in Africa (ISMA)' project and aims to undertake a survey on integrated striga management. Striga is a highly destructive parasitic weed that attacks cereal crops and poses a serious challenge to food security in many affected regions of Africa.

Dr Kyetere was very impressed by *icipe*'s achievements in the development of sustainable and environmentally-friendly crop management techniques for smallholder farmers in Africa, and expressed interest in closer collaboration between AATF and *icipe*. http://www.icipe.org/index.php/news/573-important-new-partnership-with-aatf.html

icipe signs MoU with IGAD

On 2nd August 2012, *icipe* and the Intergovernmental Authority on Development (IGAD) signed a Memorandum of Understanding (MoU) to facilitate cooperation in promoting food security and environmental protection through scientific research and capacity and institutional building.



The MoU was signed by Director General of *icipe* and Eng. Mahboub Maalim, the Executive Secretary of IGAD, with Prof. Suresh Raina, *icipe's* Head of the Centre's Adaptation to Climate Change and Ecosystem Services and Mario Margiotta, *icipe's* Head of the Capacity Building and Institutional Development Programme and

Dr Solomon Munyua, IGAD Coordinator, as observers.

The MoU will enable IGAD and *icipe* to implement a range of initiatives in several areas of mutual interest, including integrated vector management (IVM) in animal and human diseases as well as in enhancing animal production, health and marketing. The two institutions also intend to cooperate in apiculture, for instance in promoting good sericulture practices; in addressing bee health and in quality assurance and value addition of bee products. Collaborations in IPM of key crops of the region, and in overall capacity building activities are additionally envisaged.

Tanzanian High Commissioner to Kenya visits icipe

On 27th September 2012, the Tanzanian High Commissioner to Kenya, Her Excellency Ms Batilda Salha Burian visited *icipe*. Ms Burian, who was accompanied by Ms Kemilembe Salome Mutasa, the Environment Attaché at the Tanzanian High Commission in Kenya, obtained an overview of *icipe's* activities from the Centre's Director General, Christian Borgemeister; Onesmo ole-MoiYoi, an *icipe* Emeritus Scientist and former Director of Research and Roger Finan, Director of Finance and Administration. The two diplomats then toured *icipe's* Fruit Fly and Commercial Insects Programmes and the Centre's recently inaugurated Martin Lüscher Emerging Infectious Diseases Laboratory (http://icipe.org/eidlab/).

Ms. Burian was extremely impressed by the variety and high quality of *icipe's* R&D activities, as well as effective contribution towards food security, human and plant health and their contribution towards meeting the Millennium Development Goals (MDGs). Further, she was most gratified by the wide range of partnerships and research activities between icipe and Tanzanian institutions and communities. Indeed, Ms Burian expressed great interest, on behalf of the Tanzanian Government, towards enhancing such linkages. More information: http://www.icipe.org/index.php/news/625-the-high-commissioner-of-the-united-republic-of-tanzania-and-icipe-hold-strategic-discussions.html

CIRAD and IRD MoUs with icipe

On 15th October 2012, *icipe* signed collaborative MoUs with International Cooperation Center For Agronomic Research Applied To Development (CIRAD – Agronomic Research For Development) and Research Institute For Development (IRD – Institute Of Research For Development) - *Under The Umbrella Of Her Excellency The Ambassador Of The French Republic In Kenya*. This will strengthen the parties collaboration in Scientific Research, Knowledge Exchange, Capacity and Institutional Development

icipe Director General Visits University of South Florida's College of Public Health and Signs Agreement

In November 2012, *icipe* Director General Prof. Christian Borgemeister visited the College of Public Health (COPH) at the University of South Florida for collaborative discussions that culminated in the signing of a Memorandum of Understanding (MOU). The MOU lays the groundwork for future collaborations between the COPH and *icipe*. The main areas of cooperation will be in public health and capacity building, initially through joint supervision of COP MSc that will conduct their thesis research affiliated to *icipe* projects.

More info: http://www.icipe.org/index.php/news/652-icipe-director-general-visits-coph-to-sign-agreement.html

11. XXIV International Congress of Entomology - icipe Exhibition & Plenary Speaker

icipe participates in the XXIV International Congress of Entomology, Daegu, Republic of South Korea

The 24th International Congress of Entomology (XXIV ICE 2012) was held in Daegu, South Korea from 19th to 25th August 2012, attracting 2,500 delegates from across the globe. The deliberations at ICE ranged from issues regarding genetically modified organisms (GMOs), biological control and IPM for improving food security and sustainable development to developments in commercial insects and climate change.

icipe was represented by a 17-strong delegation drawn from the centres research clusters: Integrated Pest Management (IPM); Integrated Vector and Disease Management (IVDM); Adaptation to Climate Change & Ecosystem Services (ACCES) and Capacity Building.

The *icipe* delegation participated actively in the symposium, through oral and poster presentations. Significantly, of the six plenary speakers, two were associated with *icipe* - the Director General of *icipe*, Christian Borgemeister and *icipe* Governing Council Member, Prof. Kongming Wu. Certificate of Distinction were awarded to Prof. J.C. van Lenteren, Prof. H.M. Robertson and the *icipe* Governing Council Chair, Prof. J.A. Pickett.

Throughout the Congress, *icipe's* exhibition booth attracted a great number of visitors, who were thoroughly impressed by the Centre's publications; commercial products generated through its research and African-inspired promotional material, which included the 2013 Calendar and other artifacts embossed with beaded insects. The general consensus seemed to be that: "icipe truly and totally represented Africa at the ICE 2012 symposium". Photos from ICE2012 Symposium are available here...

12. SGI Newsletter renamed icipe quarterly E-bulletin

SGI Newsletter renamed:

What originally started as a quarterly information pack for the *icipe* donor community (represented by the Sponsoring Group of *icipe* or SGI) in 2011, has now become a Centre-wide newsletter that is much more widely read — from alumni of *icipe's* capacity building programmes to scientific and development partners of the Centre in Africa and beyond. Consequently we decided to rename the SGI newsletter to *icipe* quarterly E-bulletin in 2012. With the new name comes a broader thematic perspective, including more stories on scientific and developmental achievements of the Centre, coupled with a broader circulation.

New icipe SGI Chairperson:

In November 2012, *icipe* got a new SGI Chair Dr. David Lymer - Sida. During the transition, the outgoing Chair, Dr. Wolfgang Kasten – GIZ, noted that he had thoroughly enjoyed the three (3) years he was the Chairperson of the SGI informal group, among others because of all the positive developments at *icipe* during his period. He did wish his successor good luck and pledged to remain committed to *icipe* and its important mandate in and for Africa.

The E-bulletin is routinely issued on a calendar quarterly basis.

RESULTS BASED MANAGEMENT REPORTING

icipe's Results Based Management Framework Thematic Clusters

As earlier mentioned, each of *icipe's* core activity areas developed their RBM Framework and the reporting that follows is specific to the R&D Thematic Clusters (i.e. 4-H paradigm) and Capacity Building frameworks. We are pleased to inform that, in line with *icipe's* Vision and Strategy focus, *icipe's* operative 4-H paradigm - addressing Human, Animal, Plant and Environmental Health - and the many integrated pest and vector management (IPVM) and insect-based income generating technologies developed by the Centre over the years, including the Capacity Building and Institutional Development Programme are of immediate relevance to future strategies for contributing to solutions for food insecurity and malnutrition, disease, poverty and environmental degradation. *icipe* is about much more than insects. To strategically address the problems associated with arthropod pests and disease vectors on one hand, and the opportunities for their conservation and utilisation on the other, we have now thematically aligned the 4-H as follows:

1. Integrated Pest Management (IPM) – with a focus on plant health
2. Integrated Vector and Disease Management (IVDM) – with a joint focus on animal and human health; and
3. Adaptation to Climate Change & Ecosystem Services (ACCESS) – with a focus on environmental health.

A. Integrated Pest Management Outcomes

Plant Health Results Based Management Framework

Overall objective for Plant Health: Contribute to stabilizing horticultural and staple food production by reducing quantitative and qualitative pre- and post-harvest yield losses due to insect pests, mites, weeds and mycotoxin-producing fungi by developing economically viable and ecologically sound production systems with low pesticide input.

Specific 2012 RBM Framework Outcomes:

Objective 1: **Increase horticultural and staple food production by at least 30% by 2020 by reducing pre- and post-harvest quantitative and qualitative losses due to pests in *icipe*'s target areas**				
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
Specific Objective 1.1: Develop and create awareness on integrated pest management approaches for *Maruca* infesting cowpea and other legume crops in East Africa in collaboration with international and national partners by 2014				
1. Baseline information on pests' status, farmer practices and their impacts on ecosystem and livelihoods assessed	At least five *ex ante* study outcomes utilised by scientists, policy makers and other stakeholders by 2013	• Pest status of at least five key pests determined by 2013	2012 Achievements summarized below	
1. Biocontrol agents identified 2. *Maruca* IPM strategies based on semiochemicals, biopesticides and biorationals developed	*Maruca* IPM strategy that encompasses at least two IPM components formulated by 2014	• At least one pheromone compound identified by 2014 • At least 1 biopesticide and 1 botanical evaluated by 2014 • No. of peer reviewed publications	• Two *icipe* isolates of *Metarhizium anisopliae* have been proven to be efficacious against *Maruca vitrata* both under lab and field condition. One of these isolates has recently been commercialized. • The commercial available neem product (Nimbecidine) has also been proven to be moderately effective for *M. vitrata* control under field conditions. • Two manuscripts are in preparation and will be published by end of 2013	

Objective 1:	**Increase horticultural and staple food production by at least 30% by 2020 by reducing pre- and post-harvest quantitative and qualitative losses due to pests in *icipe*'s target areas**			
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
1. Training of trainer's programme organised for cowpea farmers 2. Training materials and curricula developed 3. IPM technology adapted and validated with cowpea farmers.	Awareness on *Maruca* IPM strategy created among at least 500 cowpea farmers by 2014	No. of cowpea farmers aware of new IPM technology		
Specific Objective 1.2: Develop and implement integrated pre- and post-harvest pest management approaches for thrips and tospoviruses infesting vegetables and grain legume crops in East Africa in collaboration with international and national partners by 2015.				
1. Biopesticide for thrips IPM developed and commercialised 2. Thrips IPM strategies based on intercropping, use of biopesticides, semiochemicals and botanical pesticides developed	Thrips and tospovirus management strategies for French bean, onions, tomato and grain legumes encompassing at least two IPM components formulated by 2014	At least one microbial bio-pesticide commercialised for thrips control by 2013	One isolate of *M. anisopliae* ICIPE 69 commercialized in partnership with private biopesticide producer Real IPM Kenya under the trade name Campaign ™	
		At least 1 intercropping strategy for thrips control in French beans, grain legumes and onion evaluated by 2013	In French bean intercropping with baby corn/Irish potato/sunflower found to reduce thrips incidence and enhance marketable yields by over 50% (Nyasani et al., 2012) Intercropping onions with spider plants for thrips and tospovirus control evaluated in two season trials (Birithia, 2013). There was significant reduction in thrips densities, however smothering effect of spider influenced onion yields	
		At least one tospovirus resistant cultivar of onion and tomato identified by 2014	Screening of commercial onion cultivars in East Africa for resistance to thrips and tospoviruses over two seasons in 2011 – 2012. Texas Grano and Bombay red were found to have some resistance to thrips and tospovirus (Birithia et al. 2013, Manuscript in draft). Over 60 lines and cultivars in AVRDC's germplasm is under screening for resistance to thrips and tospovirus	

Objective 1:	**Increase horticultural and staple food production by at least 30% by 2020 by reducing pre- and post-harvest quantitative and qualitative losses due to pests in *icipe*'s target areas**			
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
		Large scale implementation of IPM strategies for thrips and tospoviruses encompassing at least two IPM components undertaken in at least two key production areas by 2014	Activities are planned in 2013 – 2014 in this regard.	
		Reduction in use of synthetic pesticides by at least 20% by 2014	Three PhD studies underway in *icipe;* and In order to enhance the prospects for adoption of biopesticide based thrips management through reduction of cost of control and enhance efficacy, studies are underway to develop novel application strategies for entomopathogens.	
		No. of peer reviewed publications	1) Niassy et al. (2012) Entomologia Experimentalis et Applicata 142: 97 – 103 2) Nyasani et al. (2012) Entomologia Experimentalis et Applicata 142: 236 – 246. 3) Niassy et al. (2012) Letters in Applied Microbiology 54: 487–493. 4) Niassy et al. (2012) International Journal of Pest Management 58, 131-137. 5) Birithia et al. (2012) Plant Disease http://dx.doi.org/10.1094/PDIS-05-12-0462-PDN	
		Number of theses	Two PhD students graduated in 2012	

Objective 1:	**Increase horticultural and staple food production by at least 30% by 2020 by reducing pre- and post-harvest quantitative and qualitative losses due to pests in *icipe*'s target areas**			
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
3. Training of trainer's programme organised for agricultural extension officers/ plant quarantine inspectors in East Africa 4. Training materials and curricula developed 5. Field demonstration of thrips IPM strategies based on intercropping, use of biopesticides, semiochemicals and botanical pesticides undertaken 6. IPM technology adapted and validated with French bean, tomato, onion, and grain legume farmers 7. *Ex-ante* and *ex-post* assessment of the introduced thrips and tospovirus management strategies	Awareness on thrips, tospovirus monitoring and management strategies created among agricultural extension officers/plant quarantine inspectors and French bean, tomato, onion and grain legume farmers enhanced by 2015	Awareness among at least 150 agricultural extension officers/ plant quarantine inspectors enhanced on thrips and tospovirus monitoring and management by 2013	3 Plant quarantine officers in Kenya trained on thrips identification and monitoring Further a group of 10 students and stakeholders in Jimma University, Ethiopia were trained on thrips identification and monitoring in 2013 LuCID key for pest thrips of East Africa published in 2013 The Thrips IPM strategies were exhibited in the Europe day and Science day celebrations in *icipe*	
		Awareness among at least 1000 French bean, tomato, onion and grain legume farmers enhanced for adoption of the thrips and tospovirus management strategies by 2014	Posters presenting thrips IPM strategies in English and Swahili were prepared distributed to participants in ToT courses LuCID key for pest thrips of East Africa published in 2013	
		No. of training reports	One report on the joint inception of the Thrips IPM Phase II and the AU – grain legume thrips projects	
		French bean, onions, tomatoes and grain legume yields increased by at least 15%		
		Rejection of French beans reduced by at least 10% in local, urban and export markets by 2013 Popular articles, mass media reports No. of publications, theses		

Objective 1:	**Increase horticultural and staple food production by at least 30% by 2020 by reducing pre- and post-harvest quantitative and qualitative losses due to pests in *icipe*'s target areas**			
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
Specific Objective 1.3: Develop and implement integrated pest management approaches for invasive agromizid leafminer flies infesting vegetables and flower crops in East Africa in collaboration with international and national partners by 2014.				
1. Leafminer flies' (LMF) Biopesticides identified	Agromizid leafminer IPM strategies that encompasses at least three IPM components formulated by 2014	The role of at least 1 indigenous parasitoid species in Kenya, Uganda and Tanzania characterized by 2013	Field surveys undertaken in Uganda and Tanzania and field Parasitism rates by indigenous parasitoids (*Opius dissitus* and *Diglyphus isaea*) were higher in both countries than in Kenya. An augmentative biological control is envisaged in Uganda and Tanzania.	
2. LMF natural enemies introduced and released 3. LMF IPM strategies based on use of intercropping, botanicals, biopesticides, trapping and biorationals developed.		At least 2 exotic leafminer parasitoid species released by 2013	*Phaedrotoma scabriventris* release and recovery activities accomplished in Kenya with consistent recovery and successful establishment of the parasitoids. Parasitism rates increased significantly compared to previous year Performance studies of *Halticoptera arduine* against *Liriomyza huidobrensis, L. sativae* and *L. trifolii* finalized and release permit obtained from KEPHIS *H. arduine* released in pilot sites in high, mid and low altitudes and recovery activities ongoing. *Diglyphus websteri* and *D. begini* are very efficient against LMF in Peru, causing a high feeding-stinging mortality in addition to the parasitism. KEPHIS granted import permit renewal for *Chrysocaris flacilla* and new import was done with some delays due to change in government policy in Peru Performance of *C. flacilla* against *L. huidobrensis, L. sativae* and *L. trifolii* ongoing in order to obtain release permit from KEPHIS	
		At least 1 microbial biopesticide identified against LMF by 2013	Pathogenicity and virulence of 8 endophytic fungi isolates studied Four endodophytic fungi (F3ST1 (*Hypocrea lixii*), G1LU3, ICIPE279 and SASU1 (*Beauveria bassiana*)) were found very efficient against LMF with no or limited effect on parasitoids. Compatibility of the entomopatho-genic nematode (EPN) *Heterorhabditis indica* and two selected parasitoids *C. flacilla* (endoparasitoid) and *D. websteri* (ectoparasitoid) is ongoing. The EPN *H. indica* is found compatible with *C. flacilla* and *D. websteri* Effect of different concentrations and frequencies of EPN on LMF ongoing under field condition in the Cañete valley of Peru	
		At least one botanical evaluated by 2013	Pyrethrum and 2 neem products (Achok and Neemroc) were found efficient against LMF with limited effect on parasitoids.	
		At least 1 intercropping strategy evaluated by 2013	Faba bean as trap crop against *L. huidobrensis* in association with pesticide use in potato crop was evaluated but were not effective whether considering adult flies activities, adult feeding or larval infestation.	

Objective 1:	**Increase horticultural and staple food production by at least 30% by 2020 by reducing pre- and post-harvest quantitative and qualitative losses due to pests in *icipe*'s target areas**			
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
1. Training of trainers conducted 2. Training of French bean, faba bean, rose coco bean, cowpea, tomato, snow peas, sugar snaps and Chrysanthemum farmer's conducted 3. Training materials and curricula developed 4. Field demonstration of leafminer management strategies conducted 5. IPM technology adapted and validated with farmers 6. *Ex-ante* and *ex-post* impact assessment of the introduced technologies undertaken	Awareness on Agromizid leafminers IPM strategies created among agricultural extension officers, plant quarantine inspectors and French bean, faba bean, rose coco bean, snow peas, sugar snaps, tomato and Chrysanthemum farmers by 2014	Awareness created among at least 100 agricultural extension officers and plant quarantine inspectors by 2013	A total of 196 farmers were trained in Narumoru, Sagana, Kabaru, Kibwezi and Oloitokitoki between September and November 2012	
		Awareness created among at least 500 French bean, faba bean, rose coco bean, snow peas, sugar snaps, tomato and Chrysanthemum farmers by 2014		
		No of training reports	Training reports were produced for activities carried out between September and November 2012	
		Popular articles, mass media reports	Posters in Kiswahili and English distributed to farmers and agricultural officers	
		No of publications and theses	A total of 3 Ph.D, 4 M.Sc and 10 undergraduate students were involved in the project activities in 2012	
		At least 15% yield increase in French bean, faba bean, rose coco bean, peas, sugar snaps and tomato by 2014	Ex-ante studies conducted in Uganda revealed that farmers' knowledge on leafminer is very limited in Kabale, Kabarole and Kasese districts. Most famers especially in Kasese and Kabarole confuse the effects of leaf miner infestation with effects of drought. Major control approach is by use of pesticides.	
		At least 10% reduction in rejection of French bean, faba bean, snow peas, sugar snaps and Chrysanthemum by 2014	Ex-ante studies carried out in mid altitude of Kenya revealed that LMF is a great concern for farmers in this area and that existing pesticides are inefficient against the pest leading them to mixing of types and increased dosage in pesticide use	
Specific Objective 1.4:	**Implement, in collaboration with international and national partners in sub-Saharan Africa, effective approaches to reduce pre- and post-harvest mango losses due to insect infestations leading to improved quality and quantity of production to meet the demands of local, urban and export markets by 2015**			
		The role of landscape complexity on LMF incidence and control evaluated in at least 1 country by 2013	Survey activities carried out in high, mid and low altitudes revealed that in Kenya and Tanzania, *Liriomyza huidobrensis* was dominant in all 3 altitude levels, while in Uganda it was abundant only at high altitude and *L. sativae* was the most abundant at low and mid altitudes. Parasitism rates were not different across altitudes in Uganda, However in Kenya, it was higher in low and mid altitudes while in Tanzania it was highest at high altitude.	

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Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
		Reduction of pesticide use against LMF reduced by at least 20% by 2014	Study of effect of various pesticides used in horticulture production systems in Kenya revealed that none of them could control effectively the larval stage. The pesticide use was assessed in the different agroecological zones and its implication on parasitism rates of indigenous and exotic parasitoids is ongoing.	
		No. Peer reviewed publication	*Chabi-Olaye et al., 2013, Biological Control 65: 1 – 5.* *Akutse et al, (in press) Fungal Ecology*	
Community-based participatory dissemination of fruit fly and mango seed weevil (MSW) IPM technologies based on baiting and male annihilation technique, application of entomopathogens, *soft* pesticides and orchard sanitation implemented	At least 50% of the mango growers in the benchmark sites get acquainted with the fruit fly and MSW IPM technologies by 2013	• At least 20% of growers in project localities adopt at least 2 components of IPM package for fruit flies and MSW by 2013 • Fruit fly and MSW infestation reduced by at least 70% • Mango yield increased by at least 20% by 2013 • Use of synthetic pesticides for fruit flies management in the benchmark sites reduced by at least 40% by 2013 • Rejection of mango reduced by at least 10% in local, urban and export markets by 2013	• Over 70% of growers have adopted 2 to 3 components (namely baiting technique, male annihilation and orchard sanitation) of the fruit flies IPM package. So far only 20% of the growers adopted measures related to management of MSW. • Fruit flies infestation in the mango orchards at the benchmark sites reduced by between 70-80% compared to the orchard of non-participating farmers. • Mango yield has increased in the bench mark sites by an average of 20% during 2012/2013 mango fruiting season. • The insecticide application targeting mango fruit flies dropped by 55% during the 2012/2013 mango fruiting season in the bench mark sites. • Mango rejection from the bench mark sites reduced by 54.3%. New markets in Uganda, South Sudan, and Rwanda have opened up for mango imports from the bench mark sites.	Grower and community sensitization is crucial for technological uptake and adoption.
Field releases, post release evaluation and impact of *Fopius arisanus* and *Diachasmimorpha longicaudata* for the suppression of *Bactrocera invadens* and native *Ceratitis* species conducted	Establishment of the two parasitoid species in at least two of the target countries leading to at least 30% reduction of fruit flies populations by 2013	• *F. arisanus* and *D. longicaudata* released in at least 15 major mango production localities by 2013 • Impact of released parasitoids and their establishment quantified by 2013 • At least 50% of growers are aware of parasitoid releases and impact, and reduce cover spray of pesticides by 20% by 2013 • Parasitoid species recovery	• Two parasitoid species were released in 60% of the target sites and more released are planned to cover the remaining major mango production localities by the coming mango fruit season (start in November, 2013) • The two parasitoid species are well established in and recovered from the released sites and the surrounding localities • 80% of growers in Eastern and 40% in Coast provinces are aware of parasitoid releases, their potential impact and how to conserve them • The insecticide application targeting mango fruit flies dropped by 55% during the 2012/2013 mango fruiting season in the bench mark sites	• As above. • The initial sensitization is very important to minimize indiscriminate pesticides application and conservation of the parasitoids.

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Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
The role of the weaver ant (*Oecophylla longinoda*) in the management of fruit flies and MSW adapted, validated and disseminated and their conservation promoted	The weaver ant technology adopted as a component of fruit flies and MSW management by mango growers by 2013	• At least 30% of growers become aware of ant importance in fruit flies and MSW management by 2013 • At least 10% of growers become knowledgeable on weaver ant conservation practices • Weaver ants reduce fruit fly and MSW infestation by at least 30% and increase mango yields by at least 30% by 2013	• 40% of growers are now aware of the importance of ant technology for fruit flies and MSW control. More awareness campaigns on the importance of the weaver ants in the suppression of fruit flies are planned for 2013 • The set target has been exceeded • In the orchards of the growers that adopted the weaver ant technology, fruit flies and MSW infestations was reduced by 25% during the 2012/2013 mango fruiting season	• A sound knowledge of existence of the type of the plantation predominant in an area can be a determinant factor for the weaver ant establishment as the ants thrive better on some crops and not others • Like the case of parasitoid, sensitization on the importance and role of the weaver ants in the suppression of the fruit flies is crucial for the ant conservation
Parameters for post-harvest treatment based on hot water treatment of mango against *B. invadens* developed and disseminated	Heat treatment parameters required to achieving Probit of 99.9968% for *B. invadens* on at least one mango cultivar developed by 2013	• Parameters established • Opportunity for access to export markets by the mango growers	• The most heat tolerant stage of *B. invadens* has been identified in three export mango cultivars. The parameters are expected to be established by the end of 2013	• Multidisciplinary approach to accomplish this activity is essential
Socio-economic impact of introduced control technologies determined	Number of adopters of the disseminated fruit flies and MSW IPM technologies established by 2013	• At least 2 *ex-ante* studies completed by 2012 • At least 1 *ex post* impact assessment of the management package on mango production and livelihood completed by 2013	• One *ex ant* study completed for one bench mark site	• Gaining trust of the local communities is a pre-requisite for genuine responses from the growers • Income/monetary gain resulting from adoption of the IPM package require a panel approach over several years to get a realistic outcome

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Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
Capacity of NARS and other partners in the transfer of IPM technologies strengthened	Knowledge on fruit flies and MSW IPM technologies enhanced at all levels	• At least 50 NARS personnel trained on fruit fly and MSW management by 2013 • At least 6 IPM technology learning sites/FFS established for grower training by 2012 • At least 1000 leaflets, manuals and posters on management printed and distributed by 2013 • At least 3 PhD and 5 MSc students trained on fruit fly and MSW management and post-harvest treatments by 2013	• 64 NARS personnel from East Africa have been trained on fruit fly and MSW management • 8 learning sites have been established (3 in Kenya, 3 in Tanzania and 1 each in Benin and Cameroun) • The set target was achieved and exceeded as three folds of the projected figures was printed and distributed • Three PhD students are being trained and expected to finish their studies by the end of 2013. • Additionally, 5 MSc students are enrolled and expected to finish their studies at the same period	• Pre-assessment of NARS personnel's background of the knowledge of fruit fly and MSW biology and behavior is an important step to guide the course of the training on management of these pests • Active involvement in the selection of the staff to be trained is very essential. • For more effective communication and better out-reach to the growers, it has been realized that farmer to farmer teaching of the technology will add greater value to the IPM package dissemination
Specific Objective 1.5: Develop and create awareness on integrated pest and disease management approaches for key insect pests and diseases of cashew in coastal ecosystems of East and West Africa through collaboration with international and national partners by 2013.				
1. Control agents based on entomopathogenic fungi, botanicals and *soft* insecticides for the control of mired and corid bugs identified 2. Semiochemicals of key insect pests identified 3. Efficacy of weaver ant *Oecophylla longinoda* in the management of mirid and coreid pests evaluated, fine-tuned and disseminated	IPM strategy based on at least 2 components for the control of mirid and coreid bugs formulated by 2013	At least one semiochemical compound identified by 2013	Presence of sex pheromone demonstrated in *H. schoutedeni* and *P. wayi* females.	
		At least 1 biopesticide and 1 botanical evaluated by 2012	Screening of isolates of *Beauveria bassiana* and of *Metarhizium anisopliae* resulted in the selection of *M. anisopliae* isolate ICIPE 69 which was virulent to both *Helopeltis* sp. and *P. wayi*. This isolate is already commercialized as Campaign® for the control of thrips and mealybug. Neem oil was also found to be toxic to *Helopeltis* sp.	
		Reduction in cashew sap-sucking insects following waiver ant colonization of cashew trees.	The impact of density and abundance of *O. Longinoda* on damage by *P. wayi* and *Helopeltis* sp. demonstrated in the field for two seasons. Results published in Pest Management Science journal.	
		No. of peer reviewed publications	Olotu et al. (2012) Pest Management Science.	
		Number of theses	One PhD thesis submitted and defended; one PhD thesis being submitted by the end of April 2013.	

Objective 1:	**Increase horticultural and staple food production by at least 30% by 2020 by reducing pre- and post-harvest quantitative and qualitative losses due to pests in *icipe*'s target areas**			
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
4. Alternatives to management strategies for powdery mildew, leaf and nut blight 5. The impact of new strategies on beneficial pollinators and natural enemy complex determined	Alternative strategies for the control of powdery mildew, and leaf and nut blight in cashew formulated by 2012	At least 1 hyperparasite fungus and 1 environmentally friendly fungicide evaluated by 2012	• No effective eco-friendly alternative to sulfur dusts against powdery mildew disease (PMD) has been found • No negative effect of current fungicides, including sulphur dust, used for the control of PMD on beneficial such as weaver ants.	
		Resistant varieties identified	Two cashew clones (AZA17 and AZ2) found tolerant to *Cryptosporiopsis*	
		No. of peer reviewed publications	Manuscripts in preparation.	
		Number of theses	One PhD thesis in progress.	
6. Training of trainer's programme organised for cashew farmers 7. Ex-ante impact of potential cashew IPM strategies assessed	Awareness on insect pests and diseases of cashew IPM strategy created among at least 50 cashew farmers by 2012	No. of cashew farmers aware of new IPM technologies	• 1 MSc thesis completed and submitted in October 2010 • One paper published: Nyambo B. and Ligate E. 2012, Journal of Agricultural Education and Extension DOI:10.1080/1389224X.2012.746004 • 1 MSc thesis complete and submitted in October 2012	
		Survey tools formulated and field surveys and stakeholder consultations conducted by June 2010		
		Field data collection tool and survey conducted by end of December 2009		

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Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
Specific objective 1.6: Develop and create awareness on integrated pest and disease management approaches using insecticide treated and untreated nets for management of key pest of vegetables in collaboration with international and national partners by 2014.				
1. Circadian behaviour of red spider mite and its predator elucidated in the laboratory 2. Greenhouse and field evaluation of treated and non-treated net placement based on the circadian movement of red spider mite and its predator undertaken 3. PhD and MSc students training on behavioural research with red spider mite and its predators	Understanding on the circadian behaviour of the red spider mite and its predator used by scientific community to refine the use of treated and non-treated nets for pest management in solanaceous vegetables by 2014	• No. of publications • No. of theses At least 1 PhD and 1 MSc student trained by 2014	• Circadian behaviour of red spider mite and its predator evaluated in the lab as a part of Master's thesis • Greenhouse evaluation of treated and non-treated nets undertaken • 1 Ph. D Student and 1 MSc student undergoing training on Behavioural research with spider mites and its predators • 1 MSc student undertook internship in *icipe* to study the effect of treated and non-treated nets on thrips and whiteflies	

Objective 1:	**Increase horticultural and staple food production by at least 30% by 2020 by reducing pre- and post-harvest quantitative and qualitative losses due to pests in *icipe*'s target areas**			
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
Specific objective 1.7: Promote adoption of Push-pull technology for effective management of striga and stemborers infesting maize, sorghum, millet and rice, and also for effective management of cotton insect pests, through collaboration with international and national partners by 2014.				
1. Push-pull technology implemented by over 55,000 farm households and indirectly benefited over 0.5 million people East Africa.	- Food sufficiency and household incomes of 50,000 Push-pull farmers increased by at least 50% by 2013 through higher and sustained crop, fodder and milk yields	- Acreage of farmland under Push-pull - Household income levels attributable to Push-pull - Number of households having cereal food sufficiency - Number of farmers having improved dairy animals - Number of Push-pull farmers utilizing fodder from Push-pull in their dairy production - Number of dissemination channels optimized and employed - Cereal and fodder yields and milk production levels among target farmers - Number of partnerships formed - Number of stakeholders trained	- 2500 ha of land put under Push-pull technology - Push-pull technology farmers are food secure with an average harvest of 3.0 and 2.7 t/ha of maize and sorghum respectively per cropping season - Over 5,000 smallholder farmers dairy farmers feeding their livestock on fodder from Push-pull farms - At least 0.3 million people benefiting from higher sustained crop, fodder and milk yields - Ex ante baseline study undertaken on Push-pull technology's farmers' income levels, livestock and fodder production as well as cereal yields. All these showed significant improvements - Field days, on farm demonstrations, farmer teachers and Participatory video showing effectiveness in enhancing farmer to farmer dissemination of PPT - MoUs signed with local, national and regional partners who as well as extension staff, farmer groups, NGOs and private sector entities engaged in PPT dissemination. **Publications:** - Crop Protection 44: 44-49 (2013) - Quarterly Journal of International Agriculture 51: 1, 51-71 (2012).	- Farmers appreciated the immediate effect of the PPT in controlling striga weed and stem borer, provision of animal fodder and conservation of soil fertility and moisture - Training using practical on farm demonstration and audio-visual channels such as video enhances learning and increases knowledge retention and faster adoption of Push-pull technology. - The collaboration with local farmers' CBOs and NGOs has enabled the project achieve critical pool of farmers to boost farmer to farmer dissemination process in the following ways: - The training of peer farmers/ trainers of trainers (TOT's) and extension staff helped expedite the dissemination process. In addition, the Government extension staffs in the project sites have recommended additional and regular review trainings and field visits in the course of the cropping season as the peer reviews will help to improve performance of the farmer experts. - As technology dissemination pathways are expanded, more farmers express high interest in learning more about the technology so as to benefit - Grain yields of non-Push-pull farmers continue to dwindle to < 1t/ha due to continued striga and stemborer infestation

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Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
2. Push-pull IPM approach for the management of cotton insect pests in Western Kenya and North East Brazil	- Improved cotton productivity and incomes of at least 2,000 farmers by 20% in Western Kenya and North East Brazil by 2013	- Number of cotton farmers using the Push-pull IPM approach in the target areas - Number of Push-pull cotton stakeholder networks in place in Brazil and Kenya - Number of publications in refereed journals - Number of partnerships formed	- Key pests of cotton in smallholder farms in Western Kenya and North East Brazil identified - Colonies of the key pests (bollworms) of cotton established at *icipe* Thomas Odhiambo Campus, Mbita and used for screening and bioassay studies - Research partnerships strengthened within community based groups, farmer groups, national and international agricultural/ research institutions. **Publications:** - Crop Protection 42: 193-201 (2012) - Journal of Chemical Entomology 38:1528-1538 (2012)	- Cotton farmers in Western Kenya are fully conversant with the potential benefits of Push-pull technology in controlling cotton pests - The Brazil IPM project has potential to solve the problem of low productivity of cotton in Western Kenya and North East Brazil
3. An integrated management approach for Napier stunt disease	- Improved incomes and livelihoods of at least 2,000 Napier farmers in Western Kenya by at least 50% through adoption of an integrated Napier stunt disease management strategy, characterised by increased fodder and milk production by 2013	- Quantity of Napier grass and milk produced - Number of alternative fodder grasses in use - Number of farmers using the integrated disease management approach - Number of partnerships formed - Number of stakeholders trained on integrated disease management - Number of peer-reviewed publications	- Screening of over 70 Napier grass cultivars collected from different field sources, only two cultivars (Ouma 2 and South Africa) have shown phytoplasma disease resistance prospects - The two cultivars have been multiplied on-station plots to produce seed planting materials for on farm expansion and15 farmers are currently testing the seed materials on their farms in Western Kenya **Publications:** - Field Crops Research 137: 197-107 (2012) - New Disease Reports 24: 17(2012.) **Manuscript:** - Farmers' Knowledge and Perceptions of Napier Grass Stunt Disease in Smallholder Farming Systems in Western Kenya(Unpublished)	- Based on the farmers' views, the already selected resistant varieties have excellent qualities and should be introduced on farm and seed materials produced in large scale. **Ouma 2** has leaves with fine texture, good biomass, easy to handle and feed livestock whereas **South Africa** grows faster, has wide hairy leaves and produces a lot of biomass. - The disease has impacted negatively on the farmers' income earnings from Napier grass sales and milk production. About 60% of the farmers do not know the cause of the disease other than speculations on soil erosion animals, planting young canes, etc - The disease spread is due to lack of knowledge among the farmers and frontline extension workers

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Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
4. Stemborer management approach developed by exploiting early herbivory traits and plant signalling	- Staple food sufficiency achieved by at least 3,000 farmers in Western Kenya by 2015 though grain yield increases by 30% - Novel scientific knowledge on early herbivory and plant signalling generated and applied in crop protection by scientists, extension agents and policy makers by 2015	- Number of 'smart' maize varieties with early herbivory traits identified - Number of farmers adopting the use of 'smart' maize varieties - Increase in grain yields - Number of food sufficient households as a result of use of 'smart' maize varieties - Number of peer-reviewed publications on early herbivory and plant signalling - Number of stakeholders trained in stemborer control by exploiting inherent plant defence traits	- Research results obtained suggest that oviposition trait is not limited to S. American *Z. mays* germplasm but is also found in some farmers open pollinated varieties (opvs), and that it could be used to increase indirect defense against attack by stemborers **Publications:** - Journal of Chemical Ecology 38:231-234 (2012) - Physiological Entomology 37:2-9 (2012)	- Cereal yield losses ranging from 20 - 80% resulting from stemborer damage - Early herbivory traits exist in some maize landraces from South America and Africa - Plant signalling is reported in a some plant species but has not been fully exploited to protect staple crops
5. Effectiveness of participatory video in disseminating Push-pull technology established by 2013	- Food sufficiency and household incomes of 5,000 Push-pull farmers increased by at least 50% by 2013 through higher and sustained crop, fodder and milk yields	- Number of farmers effectively learning Push-pull through video and computer technology - Number and effectiveness of farmer-generated participatory videos produced - Number of partnerships formed	- Farmer disseminators were trained on PICO handling, conducting interviews, facilitation and communication skills, and questionnaire administration - Farmers trained and produced own videos on Push-pull technology - Farmers produced videos that are currently being used as training material for: • Layout and planting of push-pull plot • First weeding of maize and desmodium • Second weeding of maize and desmodium, • Stemborer life cycle, • Striga biology and parasitisation of cereals, • Sorghum under Push-pull technology, • Weeding of sorghum, and • Utilisation of Napier and desmodium as fodder	Farmers evaluation of the Participatory Videos show that; - Video (Participatory and documentary) technology is more effective than printed material in disseminating knowledge-intensive technology, for example Push-pull, to farmers with low literacy levels; - Access to video documentation from other farmers (participatory video) will enable smallholder farmers to learn more easily, retain knowledge about, adopt and apply PPT to their cereal farming systems; and - Farmers will more readily share knowledge and their own findings if they use participatory video as part of their work.

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Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
6. An integrated management approach developed and implemented for striga control in maize in Western Kenya and Nigeria	- Food sufficiency and livelihoods of at least 15,000 smallholder farmers improved by at least 50% by 2014 through efficient control of striga resulting in increases in maize yields by at least 50%	- Number of farmers practising integrated striga control methods - Acreage under integrated striga control methods - Grain yield increases attributable to integrated striga control - Number of stakeholders trained on integrated striga control - Number of peer-reviewed publications - Number of partnerships formed - Number of partners' joint field days conducted	- National stakeholders identified and awareness created about the striga control technologies among smallholder farmers - Farmers' perceptions collected on striga control technologies - Field day evaluations undertaken in partnership with AATF as a strategy to obtain feedback from farmers on trainings conducted - Partnership platforms established to identify the technology best bets - Partnership initiated with Kenya Seed Company for producing desmodium seeds. So far the company has produced 400 kg of desmodium seeds which has already been distributed to farmers in the region - Public awareness about the best-best striga management technologies was increased through sensitization workshops held in Rachuonyo, Migori, Kisumu, Siaya, Busia, and Teso, and at two KARI centres in Alupe and Kibos	- Strong local partnerships with the farming communities, national extension networks, NGOs and the private sector players (public-private partnerships) are integral in implementing striga control measures in Western Kenya and Nigeria - Components of integrated striga management approach are available and tested - Effective communication strategy ensures effective information and knowledge dissemination to all stakeholders - Linking farmer groups to private sector operators and contributing to the development of the production and market value chains, and encouraging private-sector players like seed companies and agro-dealers to be actively involved in striga elimination is a good business opportunity

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Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
Specific objective 1.8: Scaling-up technologies and successful experiences in biological control of diamondback moth (DBM) in cruciferous crops in Eastern Africa to other African countries				
1. Surveys of DBM and its indigenous natural enemies in Mozambique, Malawi, Zambia and Rwanda conducted by June 2013 and June 2015 respectively 2. Effective and functional rearing facilities and systems for biological control agents of DBM established in Mozambique and Malawi before end of 2013	Functional DBM biocontrol structures established in target countries before end of 2015	• MoUs with respective governments prepared and signed by February 2013 • 2 researchers from each country trained in baseline survey methodology before end of 2012 • Baseline surveys conducted by trained national researchers in Mozambique and Malawi by June 2013 • Baseline surveys conducted jointly by *icipe* and national researchers in Zambia and Rwanda by June 2015 • Mozambique and Malawi (2 from each country) trained in mass rearing of DBM parasitoids • Trained staff members set up mass rearing facilities and production of parasitoids in Mozambique and Malawi by June 2013 • Field releases of DBM parasitoids piloted in selected areas in Mozambique and Malawi before end of 2013	• All MoUs signed by 28th March 2013 • Two researchers trained in baseline survey in December 2012 at ICIPE • Funds released to national coordinators • Mozambique and Malawi has identified pilot project areas and set up national project steering committees • Two nationals from Mozambique and Malawi trained in DBM parasitoids mass rearing in December 2012 • Mozambique set up a DBM mass rearing facility at the University of Eduardo Mondlane and sent a request for *D. semiclausum* pupae for multiplication	

Objective 1:	**Increase horticultural and staple food production by at least 30% by 2020 by reducing pre- and post-harvest quantitative and qualitative losses due to pests in *icipe*'s target areas**			
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
1. Extension agents and farmers trained in locally adapted bio-control IPM approaches for crucifer pests 2. Policy makers and general public sensitized on vegetable IPM methodologies	Locally adapted bio-control IPM technologies promoted in Malawi and Mozambique by 2015	• Country specific report of key crucifer pests and current farmer practices • At least 15 master trainers trained in vegetable IPM in each of Mozambique and Malawi by June 2013 • At least 2,000 farmers trained through at least 80 FFSs by June 2015 • At least 10 field sessions / FFSs conducted during each growing season • Country specific end user friendly IPM information packages produced and distributed by June 2015 • Biological control and locally adapted IPM methodologies that reduce insecticide use and improve food safety promoted by July 2015	• Mozambique initiated awareness campaigns among policy makers and agro-chemical delaers	

Objective 1:	**Increase horticultural and staple food production by at least 30% by 2020 by reducing pre- and post-harvest quantitative and qualitative losses due to pests in *icipe*'s target areas**			
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
1. Impact of *Cotesia plutellae* in semi-arid Eastern province of Kenya assessed and disseminated to other countries 2. Knowledge products developed from field experience in Mozambique and Malawi by end of 2014 3. Preparatory planning for scaling up of the activities in Mozambique, Malawi, Zambia and Rwanda with the IFAD projects and respective Ministries based on lessons learned	Knowledge enhancement for further scaling up of DBM biological control in new areas of project countries compiled by 2015	• Impact assessment data collected and analyzed by end of 2013 • Information shared in stakeholder and annual planning meetings • Awareness material produced and distributed • Updated FFS curriculum • Documented lessons learned from field surveys • Mid-term stakeholder meetings conducted in Rwanda and Zambia with policy makers and IFAD country officers by June 2015 • Annual planning and stakeholder meetings in Mozambique and Malawi • Final regional stakeholders' meeting for sharing of lessons learned and planning of scaling up in July 2015	• *Cotesia plutellae* field surveys started in south coast, Voi, Kibwezi and Kajiado district Kenya in March 2013	

Objective 1:	**Increase horticultural and staple food production by at least 30% by 2020 by reducing pre- and post-harvest quantitative and qualitative losses due to pests in *icipe*'s target areas**			
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
Specific objective 1.9: Responses of tropical insects to global changes.				
Baseline information on Lepidoptera stem borers and parasitoids diversity in Sub-Saharan Africa on Poaceae, Thyphaceae and Cyperaceae, community structure of Lepidoptera stem borers and parasitoids on wild and cultivated habitats, host plant selection mechanisms by Lepidoptera stem borers (Noctuidae), host selection mechanisms by parasitoids (Braconidae). Study of the genetical basis of *Busseola fusca* resistance to the *Bt* maïs	At least four study outcomes utilized by scientists and students by 2015.	Phylogeny of the noctuid stem borer. Descriptions of new Lepidoptera stem borer species and genera. Descriptions of new parasitoid species. Identification and preparation of new pheromone blends of new Lepidoptera stem borer species. Biological control of *Sesamia nonagrioides* in France by a new parasitoid species. Identification of new candidate genes involved in the chemoreception of *S. nonagrioides* and in host acceptance by *Cotesia sesamiae*. Prediction of the spreading of *Busseola fusca* resistance to *Bt* maize First screening of the genetical markers involved.	1 *ex ante* post doc study completed 4 *ex ante* PhD studies completed. 1 *ex ante* PhD to be completed by 2013. 2 PhD studies to be completed by 2015. Results of 8 *ex ante* studies shared with scientists as publications/ thesis.	Training and education are key ingredients for success. A close relationship of senior scientists with biological material is a key ingredient for success.

Objective 2:	**Minimise the vulnerabilities of horticulture and staple crops to climate change-induced pest problems by at least 10% by 2020.**			
Outputs produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
Specific objective 2.1: To eliminate gaps in knowledge of climate change impacts on ecosystem services and food security in Eastern Afromontane Biodiversity Hotspots by 2015.				
Progress toward achieving objective observed: 25 postgraduate training scholars (15 PhD and 10 MSc) recruited into the project and gained admission into their respective universities. Field work underway in all the three research transects in Ethiopia, Kenya and Tanzania. Flight campaigns have been carried out in Jimma, Ethiopia and Taita Hills, Kenya.				
Baseline information on ecosystem services (pollination and pest management, biodiversity, habitats, water resources and economic value) established.	• Selection of study transects across the gradient in Taita Hills, Kenya; Kilimanjaro, Tanzania and Jimma, Ethiopia undertaken.	• Effects of climate change on biodiversity and habitats explored through modelling by 2015.	• Baseline studies on ecosystem services (pollination and pest management, biodiversity, habitats and water resources) established. • 1 MSc student working on pollination services has been recruited. • Laboratory colonies for target pests established and life table studies on insect pests and their natural enemies have commenced. • Collaboration with 2 PhD students from University of Leeds, studying pollination services in the Taita Hills established.	• Collaborations with researchers from other institutions necessary to sufficiently cover research component on pollination services.
Use of Remote Sensing and Geographic Information Systems (GIS) for land cover and land cover change monitoring	• Geospatial datasets developed for the three target areas (Taita Hills in Kenya, Kilimanjaro in Tanzania and Jimma in Ethiopia) are widely utilized by stakeholders by 2015.	• GIS platform established for sharing geospatial datasets among at least 25 East African stakeholder organisations by 2015. • Geospatial datasets developed for target areas on 8 different themes by 2015. • MSc and PhD training on GIS organized for at least 25 staff members of the stakeholder organisations.	• Geonetwork fully operational with uploaded datasets currently in use by stakeholder organizations and scholars within the project • 2 aerial photography campaigns completed by in Jimma, Ethiopia and Taita Hills, Kenya. • 8 high resolution remote sensing datasets produced for the CHIESA research transect areas. • 3 introductory courses on GIS conducted in Tanzania, Kenya and Ethiopia. 1 advanced GIS modeling course conducted in the Taita Hills, Kenya. 54 staff members from stakeholder organizations trained. • 2 sets of GIS course materials produced.	• Trainers also require training on use of GIS data available on CHIESA geonetwork. • More staff and time required to process the high resolution hyperspectral datasets acquired during the aerial photography campaigns.
Modelling and economic valuation of the benefits of ecosystem services	• Beneficiaries and benefits of ecosystem services identified, characterised and quantified, and future scenarios developed for target areas in EABH by 2015	• 4 assessment tools identified • Gender disaggregated stakeholder analysis and reports completed by 2015 • Stock values of ecosystem goods and services defined by 2015 • Students undertaking research on valuation of ecosystem services selected • Training of MSc and PhD students and member of stakeholder organisation on valuation of ecosystem services organised	• Field tools identified, designed and pre tested for suitability for use in the field • Discussions conducted with key informants in 6 villages • Recruitment of all masters and PhD scholars finalized • 2 training courses on Economic Valuation of Ecosystem Services organized in Ethiopia and Tanzania	• It is necessary to identify a resource person to facilitate training on InVEST model and software selected for modelling of ecosystem services using effecting payment approach

Objective 2:	**Minimise the vulnerabilities of horticulture and staple crops to climate change-induced pest problems by at least 10% by 2020.**			
Outputs produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
Effects of climate change and land cover change on biodiversity and habitats explored	• Reliable models and maps for each target area available for stakeholders by 2015.	• Species envelopes completed for three target areas. • Regionally tailored climate change projections completed by 2015. • Maps and models available for all known species for major biodiversity trigger taxa; 4 most important crops (maize, coffee, avocado, and crucifers); carbon storage and sequestration rates; main pollinators and pests by 2015. • Selection of students to undertake research on evaluation of impacts of climate change on biodiversity and habitat undertaken. • Selection of study sites, field surveys and observations completed.	• REMO / Precis model output on climate change projections available for the project. • Information on flora distribution collected from Jimma and partial work completed in Taita and Kilimanjaro. • Data collected from the field and herbaria for the niche-based models. • Existing sources of data on Population Density, Climate, Poverty, Conservation, and Earth Observation Products on Terrestrial Ecosystems, Topography, Infrastructure and Towns, and Administrative Boundaries of study areas acquired. • 4 PhD scholars recruited to undertake research under this component. • Study sites have been selected and field research has commenced in all the study areas. • A R software course and GIS modelling course offered to scholars as a precursor to ecological niche modelling course to available in May. • Scenario building workshop conducted in Jimma Ethiopia.	• Despite repeated chasing with CORDEX- Africa these climate change modelling methods assessed with the Multi-model Ensemble are still in development and may not be available for the project in time.

Objective 2:	**Minimise the vulnerabilities of horticulture and staple crops to climate change-induced pest problems by at least 10% by 2020.**			
Outputs produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
Baseline data and monitoring protocols for functional ecosystem pest management and pollination established along altitudinal gradients in three research areas	• Historical data on pollinators, pests and natural enemies of target crops compiled by 2015. • Species distribution maps available for stakeholders by 2015. • Species composition and abundance on target crops available by 2015. • Predictive models generated by 2015. • Number of MSc and PhD level staff trained, especially females by 2015.	• Identification of study transects across the altitudinal gradient in the Taita Hills, Kilimanjaro and Jimma Highlands undertaken • Field sites for monitoring pest and natural enemy dynamics identified • Selection of 6 PhD Students and 1 MSc student to undertake research on climate change impacts on pest management and pollination selected • Upgrade of laboratory to undertake research on Climate Change with incubators undertaken. • Sites selected for 11 Automatic Weather Stations, MOUs with National Meteorological Agencies signed. • Weather stations placed in four locations of the Taita Hills and three locations on Mt. Kilimanjaro.	• Study transects; approx. 22km long and 2km wide along altitudinal gradients in the Taita Hills, Mt. Kilimanjaro and Jimma Highlands fully identified and established. • Field study plots for monitoring pest and natural enemy dynamics identified in the Taita Hills, Mt. Kilimanjaro and Jimma Highlands. • Life table studies for insect pests and their natural enemies have commenced. • 6 PhD and 2 Masters Students recruited. 1 Masters Students specializing in pollination. • Sites for the location AWS identified and selected in 3 research transects. MOUs with national meteorological departments signed by all the meteorological departments in the 3 countries. • 4 weather stations fully operational in the Taita Hills and 3 in Mt. Kilimanjaro. • 8 tipping bucket rain gauges and 100 thermo-hygrographic data loggers operational in the Taita Hills, Mt. Kilimanjaro and Jimma Highland research transects.	• Farm level data on weather parameters required by scientists and scholars for the established field research sites. • Land tenancy contracts needed in Tanzania with hosting institutions of the weather stations. This has caused a delay in the installation of 1 weather station in the Mt. Kilimanjaro transect • More sensitization of farmers needed on different project activities, especially on the use of traps for insect pest monitoring.
Effects of climate change on water provision services explored and documented	• Likely impacts of climate change on access to water identified and documented with key stakeholders in the three study areas by 2015.	• Water basin maps, hydrological datasets and hydro-meteorological station network established by 2015. • Predictive models for target areas completed by 2015.	• Water basin boundaries for Pangani River basin and Taita Hills have been defined. • Baseline surveys for the defined water basins completed. • Identification of the gaps in existing observations and hydro-meteorological networks and establishment of baseline hydro-meteorological information for these studied water basins. • 2 courses on Integrated Water Resources Management (IWRM) offered to stakeholders in the 2 countries (Tanzania and Ethiopia) • 1 set of IWRM course material developed in 2 languages (English and Kiswahili)	• SWAT (Soil and Water Assessment Tool) model in use to development of predictive hydrological models under different land use/cover for the Pangani Basin in Tanzania.

Objective 2: Minimise the vulnerabilities of horticulture and staple crops to climate change-induced pest problems by at least 10% by 2020.				
Outputs produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
Adaptation strategies to changes in ecosystem services and food security elaborated and Adaptive Management Framework (AMF) tools and vulnerability maps developed	• A set of AMF tools available by 2015. • Tools for vulnerability assessment prioritized, susceptibility index and vulnerability maps completed by 2015. • Action plans and reporting mechanisms completed by 2015.	• 3 MSc students to carry out research on available adaptation strategies to climate change in Taita Taveta selected. • Project website to share information among the partner organisations and other stakeholder developed. • Community sensitization on climate change effects and need for research undertaken.	• Literature review on adaptation strategies completed. • Media Assistant recruited to manage Project website. • Project website fully operational • Prioritization of vulnerability assessment tools carried out. • Vulnerability maps created from secondary data. • 2 community sensitization activities run in Kenya and Tanzania on need for climate change research.	• 2 additional MSc students required to adequately carry out adaptation strategies research in all study areas. • Collaboration between the work packages in community sensitization needed for climate research in the 3 transect areas. • Data on county/village/household level vulnerability is lacking from the statistical data available.
Specific objective 2.2: Adaptation and Dissemination of the Push-Pull Technology (ADOPT): A conservation agriculture approach for smallholder cereal-livestock production in drier areas to withstand climate change				
Push-pull technology adapted to dry weather conditions associated with climate change by smallholder cereal-livestock farmers in eastern Africa.	• Food sufficiency and household incomes of 5,000 smallholder farmers in drier areas vulnerable to effects of climate change increased by at least 50% by 2013, through adoption and practice of climate-smart Push-pull	• Acreage of farmland under climate-smart Push-pull • Number of farmers practicing climate-smart Push-pull • Cereal and fodder yields and incomes among target farmers in drier agro-ecologies	• At least an average of 0.1 acres of land is utilised for push pull technology per practising farmer i.e. approximately 400 acres under push-pull from about 4000 farmers in East Africa. • Continued partnerships and collaboration with: Heifer International Kenya, Heifer International Tanzania, Institute of Sustainable Development and EIAR (Ethiopia), Rothamsted Research (UK), KARI (Kenya) and LZARDI (Tanzania)	• About 81% of the farmers using adapted push-pull indicated that the level of striga infestation reduced significantly. Whereas 94% indicated that the level of stemborers infestation reduced, 84% experienced increased soil fertility, 84% had an increase in crop yield and 81% had increased fodder production.
Identification and utilisation of drought-tolerant companion plants for Push-pull technology	• At least three outcomes of the technology adaptation process utilised by scientists, policy makers and other stakeholders by 2013	• Number of stakeholders trained • Number of partnership formed • Number of publications on farmer perception of the adapted Push-pull technology	• Brachiaria cv mulato and *Desmodium intortum* (green leaf) have been identified as drought-tolerant companion plants and are being used in farmers' fields • The new companion plants were also shown to increase availability of high quality fodder at the farms. This increased the productivity of livestock fed on the fodder while the surplus fodder was preserved as hay	• *icipe's* past experience in constructing a push-pull integrated pest management strategy and past development experiences of farmers, Rothamsted Research, NARIs, and NGOs is key in building research and dissemination processes

Objective 2:	**Minimise the vulnerabilities of horticulture and staple crops to climate change-induced pest problems by at least 10% by 2020.**			
Outputs produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
Specific objective 2.3: Predicting climate change that induced vulnerability of African agricultural systems to major insect pests through advanced insect phenology modelling, and decision aid development for adaptation planning				
Baseline information on pests' life table according to the temperatures, on maize stem borer communities densities along altitudinal gradients, on soil and plant silicon levels influencing the stem borer density and communities, stem borer competitions, soil characteristics along altitudinal gradients, farmer practices and their impacts on agro-ecosystem.	At least three study outcomes utilized by scientists and students by 2015.	Development of predicting models combining different parameters evaluated by the group by 2015.	3 PhD studies to be completed by 2015. 2 MSc studies to be completed by 2013. Results of 5 *ex ante* studies shared with scientists as publications/thesis by 2015.	Training and education are key ingredients for success. A strong follow-up of senior scientists with technical staffs is a key ingredient for success.

Objective 3: Post harvest research and development programme initiated in *icipe* by 2013				
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
Specific objective 3.1: Provide evidence Postharvest Losses of various commodities in Sub-Saharan Africa and to help decision-makers in governments to optimize their post-production policies and strategies in order to prevent food losses at different levels of the supply chain				
Progress toward achieving objective observed: Reviews were conducted and technical reports produced for the six countries involved (Benin, Ghana, Kenya, Malawi, Mozambique and Tanzania)				
Postharvest Losses (PHLs) review conducted in six countries Benin, Ghana, Kenya, Malawi, Mozambique and Tanzania)	Evidences on PHLs provided	One technical report of the review completed	6 reviews conducted in six countries in Africa (Benin, Ghana, Kenya, Malawi, Mozambique and Tanzania)	
	At least one manuscript of journal article completed	Manuscript of journal article submitted	6 drafts of manuscript prepared for Benin, Ghana, Kenya, Malawi, Mozambique and Tanzania	
	At least one policy brief completed	Policy brief	Information available for the production of six policy briefs (one for each country: Benin, Ghana, Kenya, Malawi, Mozambique and Tanzania)	
	At least one working paper on methodology of PHL completed	Working paper	First draft of the working paper produced	
Specific objective 3.2: Provide evidence for alternative uses of Purdue Improved Cowpea Storage (PICS) bags				
Progress toward achieving objective observed: Experiments were conducted in Kenya and Mozambique on Maize *(Zea mays L.),* Pigeon pea (*Cajanus cajan),* Green grams (*Vigna radiata*) and Common bean (*Phaseolus vulgaris L.*)				
Performance of PICS bag tested and documented	At least 4 commodities are tested for storage in PICS bag in at least 2 countries At least 02 manuscripts of journal article completed	Research reports Manuscripts of journal article submitted	Experiments conducted on Maize *(Zea mays L.)* infested with *Prostephanus truncatus*, and *Sitophilus spp.* in Kenya and Mozambique Experiments conducted on Pigeon pea (*Cajanus cajan)* and Green grams (*Vigna radiata*) infested with *Callosobruchus maculatus* in Kenya Experiments conducted on Common bean (*Phaseolus vulgaris L.*) infested with *Acanthoscelides Obtetus* in Kenya and Mozambique	

B. Integrated Vector and Disease Management Outcomes

Under this thematic area, as mentioned, *icipe* has combined the animal and human health R&D activities to enhance disciplinary inter-relationships as well as create synergies. The rationale behind this theme is that, some diseases e.g. trypanosomiasis and rift valley fever (RVF) among others, do affect both animals and human beings and addressing them jointly has a scientific advantage. We, however retain the focus of each for clarity in reporting.

(i) Animal Health Results Based Management (RBM) Framework

Overall objective for Animal Health: Contribute to the improvement of livestock health and productivity through the development of integrated strategies and tools for livestock disease vectors' control and adoption by development partners, thus leading to greater availability of meat and milk, hides and draught power and thereby assisting livestock owners to get out of the poverty trap.

Specific 2012 RBM Framework Outcomes:

Objective 1: Reduce trypanosomiasis risk by 50% in cattle of pastoralists and agro pastoralists by 2013 by development and optimisation of tsetse repellent technology				
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
1. Robust dispensers developed for field use for both synthetic and waterbuck repellent blend (WRB). 2. Patent application for identified WRB. 3. Patent application for dispensers	Tsetse repellent technology patented by 2012	• 2 patents awarded • Favourable assessment undertaken by participating livestock keepers • Publications produced	• 2 Patent Applications ready for submission	
4. Repellents and their dispensers evaluated	Drug use by farmers and disease incidence in cattle reduced by > 50% using tsetse repellent technology by 2013	• 50% decrease in drug use • 50% decrease in disease incidence • Favourable assessment by participating livestock keepers and veterinary staff • Publications produced	• Disease incidence reduced by >90%. • Drug use reduced by >90% • Livestock farmers assessment very positive and demand for technology very high • 1 paper published	
5. Awareness created among stakeholders to support introduction of repellent products and their application in integrated control strategies at regional level	Agreement signed with at least three key stakeholders for wider dissemination and trials of repellent technology in other African countries by the end of 2013	• No. of MoU's signed • No. of stakeholder workshops held • No. of Technical Advisory Notes (TANs) produced • Media articles • No. of workshops held • No. of training courses held >400 farmers attend dissemination sessions	• Stakeholders meeting held with more than 40 participants from 3 different countries and representing 32 organizations represented. Event covered by international and local journalists. Lead article on repellent technology published in Frankfurter Allgemeine Sonntagszeitung newspaper in Germany. • 12 Journalists from European Journalism Centre specifically came to cover project activities and articles published in more than 6 different countries • 2 brochures produced for wider dissemination	• Importance of Media Coverage and Public Relations understood for wider dissemination

Objective 1: Reduce trypanosomiasis risk by 50% in cattle of pastoralists and agro pastoralists by 2013 by development and optimisation of tsetse repellent technology				
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
1. Training farmers in use of repellent technology 2. Training manuals and brochures produced	>50% of trained farmers willing to adopt tsetse repellent technology in Kenya and Uganda by 2013	• No. of farmers trained • Training reports • Assessment reports • No. of training manuals and brochures produced	• 380 farmers trained • 2 brochures produced • Assessment Report produced and project evaluated and given an 'A' rating	
3. Technology for large-scale production of dispensers and repellent compounds passed over to local entrepreneurs	Number of agreements signed with entrepreneurs for commercialisation of tsetse repellent technology by 2013	• No. of expressions of interest from commercial/local companies to explore development of dispensers and repellents • No. of agreements signed • No. of meetings held with entrepreneurs	• Nondisclosure Agreements signed with Ticona GmbH Company and Novartis.	

Objective 2: Reduce by 50% the disease constraints caused by vectors of livestock by 2014 by development of site-specific animal health packages in different livestock production systems in selected countries in West and East Africa				
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
1 Animal health package to protect dairy cows in zero grazing units from vectors of livestock developed	Milk production in zero grazing units doubled in two selected areas in Kenya by 2013	• Documentation on animal health package made available • No. of on-farm trials undertaken • Cases and technical reports produced • Milk production doubled • Up-scaling and replication of package in other production systems • Publications produced	• 3 FAO technical reports produced • Milk yield increased to 2-3x • Units up-scaled to 100 in Kisii	
2 Animal health package to protect livestock from biting flies developed in selected countries	Biting fly populations in zero grazing units reduced by 80% by 2012	• Documentation on animal health package made available • No. of on-farm trials undertaken • Cases and technical reports produced • Biting flies population reduced by 80% • Up-scaling and replication of package in different production systems • Publications produced	• Fly and mosquito populations reduced by >90%	
3 Training of farmers and NARES in management of zero grazing units to minimize vector-borne diseases	400 farmers trained in eastern and western Africa in management of zero grazing units by the end of 2013	• No. of farmers, rural communities and NARES participating in project activities in different countries • No. of training courses held • No. of trained farmers and community leaders • No. of women trained	• 354 farmers trained • Training of 12 Animal health and production officers from 4 different countries undertaken • Training manual production underway	

Objective 3: Develop molecular tools for identifying sources of blood meals in tsetse flies (Diptera: Glossinidae) by 2012				
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
New tools for identifying tsetse fly blood meals developed	A new tool for identifying bloodmeal sources in hematophagous vectors available for field use	One peer reviewed publication available and project report complete.	Evidence of use of tools in different countries.	Some challenges reported in the use of these tools. Continued improvement of protocols and dissemination of these should continue.
		A number of students projects are applying the tools for their studies	As at March 2013, at least one citation in a peer reviewed journal for a study in Cameroun.	

(ii) Human Health Results Based Management (RBM) Framework

Overall objective for Human Health: Contribute to the reduction of malaria and other vector borne-diseases by developing tools and strategies that control the vectors and break the cycle of transmission, and which can be integrated with other disease management efforts.

Specific 2012 RBM Framework Outcomes:

Objective 1: Contribute towards malaria elimination through the development of effective vector control strategies and public health initiatives by 2020.				
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
Understanding of the link between livelihoods, ecosystem health and malaria in 50% of target community populations developed by 2020	• At least 30% of the community members are embedding safety measures in their livelihood seeking activities	• Presence of malaria self-help groups • Increased demand of education about malaria control • Agenda for taking collective action against malaria, through adoption of safer livelihood practices • Peer-reviewed publications • Books	• A new grant from the National Council of Science and Technology • A comprehensive status of malaria on Rusinga Island, showing a relationship between prevalence and occupation, obtained	• Since livelihoods of rural communities are linked to satiating immediate day-to-day survival needs, disease control efforts that advocate for change of livelihoods should take on board mechanisms that guarantee provision of basic survival needs.
A comprehensive evaluation of ongoing IVM sub-projects undertaken and a 5-year (2013-2017) strategic plan for a new IVM programme developed Development of a proposal to explore funding for the new IVM programme.	• At least 30% increased awareness on IVM strategies for vector borne disease control. • At least 200 stakeholder workshops held on mosquito and malaria control • At least 10 IVM outreach meetings/activities targeting countries in the East and Central Africa. • At least 50% decrease in mosquito densities.	• Comprehensive evaluation report of *icipe* IVM projects in Kenya and Ethiopia; • *icipe* Malaria IVM Strategic Plan 2013-2018; • Proposal document entitled: Integrated Vector Management (IVM) for Sustainable Malaria Control in Eastern Africa	• A comprehensive evaluation of ongoing IVM sub-projects was carried out in May 2012 to assess progress, achievements and challenges, and to develop a 5-year (2013-2017) strategic plan for a new IVM programme • A new grant approved to fund *icipe*'s new IVM Programme for 3 years from 2013-2015.	• Consolidating IVM sub-projects into a programme will facilitate an updating of the expected outcomes in 2013 and enhance the exploration of funds with which to scale up activities.
A potent lure derived from screening three mosquito preferred plants developed	• Field trial of lure executed at one malaria endemic site in Kenya	• One peer publication available • Project progress report • Lure in use by project scientist	• Cooperation of local communities	• Sensitization of local community prior to field testing essential for project success
At least five scientists based at *icipe* working on aspects of mosquito vector competence with regard to malaria by 2015	• At least 4 scientists able to compete for research grants in GMM • At least 20% of human health research at *icipe* in the area of *Anopheles* mosquito vector competence	• Number of proposals • Number of peer-reviewed publications • Number of employees • Number of funded studies • Graduate theses	• Collaboration has been established with a team from Institut Pasteur, France. Start up research aimed at determining the genetic basis of *Anopheles gambiae* vector competence in progress; • Four new colonies of *An. gambiae* colonies have been established. • It is now possible to use (at *icipe*-Mbita) *Plasmodium falciparum* and entomopathogenic fungi (*Metarhizium anisopliae*) as probes to determine the immune response of *An. gambiae*. • The genetic diversity of *An. gambiae* mosquitoes being reared at the *icipe*-Mbita insectary equals that of field populations from where parental colony material was initially obtained.	• It is very challenging to obtain *Plasmodium falciparum* infection of *An. gambiae* with gametocyte carriers in Mbita.

Objective 1: Contribute towards malaria elimination through the development of effective vector control strategies and public health initiatives by 2020.				
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
At least two chemical-based technologies for surveillance and/or disruption of malaria transmission developed by 2015	• Odour-baited traps used for malaria control in at least one community • Use of odour-baited traps for mosquito surveillance by at least five locally active government and/or non-governmental agencies	• Presence/use of attractant baited traps by researchers and national malaria control programmes • Availability of a potent spatial mosquito repellent or repellent principle • Presence of a working push-pull concept for mosquito control • Number of publications in peer reviewed journals • Project progress reports • Theses, Posters	• A prototype mosquito trap has been developed and tested in western Kenya (Ahero and Rusinga Island) • Several malaria mosquito attractants developed • New MSc student recruited • One PhD student completed research • New research grant obtained. • A research proposal to GEF developed • 4 research papers produced	• The financial and logistical cost of using carbon dioxide-based attractants are insurmountable • Any one mosquito attractants may not be useful in trapping all the different types of malaria vectors • Provide a social benefit (namely lighting up traditional houses with solar power) increasing community acceptance/ participation in research
Understanding of oviposition response of *An. Gambiae* to aquatic habitats that differ in their chemical and bacterial profiles for vector control purposes developed by 2015	• Synthetic or bacteria-derived semiochemicals used by national vector control agencies for surveillance of oviposition site seeking • Synthetic or bacteria-derived attractants used for malaria/ mosquito control targeting oviposition site seeking mosquitoes and their offspring (larvae) • Larval control strategies targeted in space and/or time based on females habitat preferences developed	• Presence/use of attractant- baited traps by national malaria control programmes (NMCPs) • Peer-reviewed publications • Books • Theses	• Attractive and repellent oviposition semiochemicals of *Anophles gambiae* identified in behavioural assays and through GC-MS analyses. • Attractive and repellent natural infusions identified in behavioural assays and in semi-field systems. • A new gravid trap developed for the collection of gravid *An. gambiae* • Elecetrecuting nets evaluated as a new tool for studying the oviposition behavior of malaria vectors • Three months field work completed to evaluate the environmental characteristics and bacteria fauna associated with aquatic habitats containing malaria vectors and those without. • One manuscript published: *Sisay Dugassa, Jenny M Lindh, Steve J Torr, Florence Oyieke, Steven W Lindsay, Ulrike Fillinger: Electric nets and sticky materials for analysing oviposition behaviour of gravid malaria vectors. Malaria Journal 2012, 11:374 (14 November 2012)* • Three manuscripts in their final drafting stage	• Limited mosquito production in insecatry significantly limits success in achieving goals, • Large sample sizes required to produce robust results due to high variability in mosquito response (large replication slows progress)

Objective 1: Contribute towards malaria elimination through the development of effective vector control strategies and public health initiatives by 2020.				
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
Innovative application strategies of novel, persistent insecticides for *An. Gambiae* developed by 2020	• Optimum concentration of insecticides for malaria control used by the communities in western Kenya • An 'attract and kill' strategy adapted by combining oviposition attractants with long-lasting larvicides developed and used by communities	• Increased interest in larval source management by national malaria control programmes (NMCPs) • Rationalised larval source management strategies for malaria control • Use of novel insecticides in national programmes • No. peer-reviewed publications • Books • No. theses produced	Minimum and optimum dosages identified for two novel mosquito larvicides (Sumilarv & Aquatain) in dose-response and standardized field tests One year evaluation of field efficacy of Sumilar completed in the western Kenya Highlands. New tools developed for monitoring the impact of insect growth regulators in the field. Impact of sub-lethal Sumilarv concentrations assessed on fecundity and fertility of malaria vectors. One manuscript published: Mbare O, Lindsay SW, Fillinger U: Dose-response tests and semi-field evaluation of lethal and sub-lethal effects of slow release pyriproxyfen granules (Sumilarv®0.5G) for the control of the malaria vectors *Anopheles gambiae* sensu lato. *Malaria Journal* 2013, 12:94 (14 March 2013). One manuscript in its final drafting stage.	• Limited mosquito production in insectary significantly limits success in achieving goals, • Large sample sizes required to produce robust results due to high variability in mosquito response (large replication slows progress)

Objective 2: Develop a clear understanding of circulation and maintenance of arboviruses that contribute to human, wildlife and livestock disease in East Africa to inform public health and disease surveillance and mitigation approaches by 2020.

Outputs Produced (Activities run)	*Expected Outcomes as per plan*	*Performance Indicator of Outcome*	*Progress Observed in Obtaining Outcomes*	*Lessons Learned*
An arborviral surveillance and response system for early warning and response in East Africa established by 2013	• Network of surveillance partners in Kenya, now engaging with *icipe* on multiple surveillance projects	• Surveillance data generated, additional surveillance projects brought on board	Sequencing support for regional groups done including response to RVF outbreak in South Africa. **Publication**: *Tchouassi DP, Sang R, Sole CL, Bastos AD, Teal PE, Borgemeister C, Torto B. Common host-derived chemicals increase catches of disease-transmitting mosquitoes and can improve early warning systems for Rift Valley fever virus. PLoS Negl Trop Dis. 2013 Jan;7(1):e2007. doi: 10.1371/journal.pntd.0002007. Epub 2013 Jan 10. PubMed PMID: 23326620; PubMed Central PMCID: PMC3542179.*	• Networking with local and international arbovirus groups key • Achieving this milestone with mass tag was not possible due to failure to implement the sample screening on time.
20 field and Lab officers from East African countries trained on lab diagnostics, field sampling and biobanking by 2012.	• Awareness created on the arbovirus diagnostic platforms available in *icipe* and their applications in 5 East African countries. Enhanced collaboration	• Inquiries on use of platforms for research	Phase 1 of training (field sampling and biobanking) of 15 people was successfully completed on 15th November 2010. Phase 2-(Laboratory training on multiplex PCR and second generation sequencing) was completed on 10th October 2012 where 10 laboratory personnel from E. Africa were also trained	• Enhancing collaboration
20 known (arbo-) viruses and variants detected, 10,000 samples screened by multiplex PCR or ELISA by 2015	• Over 70 virus isolates identified from mosquitoes and ticks, 66 of which are known viruses of public health significance. Sequence data available for 40 strains	• Three peer reviewed publications accepted. • Thesis and capacity built.	**PATHOGEN DETECTION** Screening samples for viruses (by cell culture and PCR). 5,520 pools of mosquito and tick homogenates and 2,548 human serum samples have been tested. 55 known virus isolates and 25 unidentified from mosquito pools and 72 known viruses and 64 unknowns from tick pools have been obtained. Seroprevalence of RVF, CCHF and selected Alphaviruses at the implementation sites has been determined. 5,000 sentinel herd and 650 wildlife samples screened for RVF exposure, by ELISA and/or PCR. **SEQUENCING** One Rift Valley fever virus, 2 new *Theileria parva* strains, 4 equine encephalosis virus, 2 Ndumu strains, 1 Newcastle disease and 1 *Mycoplasma* strain have been sequenced fully. Five nearly complete genome sequences (2 Semliki forest virus, one dugbe virus, 1 Bunyamwera virus and 1 Babanki virus) have been submitted to GenBank (see milestone 2.d). Thus, 16 nearly full genomes were sequenced. In addition, sequence reads from another 19 pathogens are available.	• Noted active transmission of arboviruses in the areas under study. • Local stakeholder participation/information vital.

Objective 2: Develop a clear understanding of circulation and maintenance of arboviruses that contribute to human, wildlife and livestock disease in East Africa to inform public health and disease surveillance and mitigation approaches by 2020.				
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
A vector map associated with the transmission of different arboviruses in different East African regions developed by 2014	• Virus detections and associated vectors mapping in process.		Linked field and laboratory data in a GIS database: Work in progress. Vector maps being worked out. Pathogen maps to be completed after virus identification is complete.	

Objective 3: Contribute to an improved Rift Valley fever (RVF) forecasting and response plan by improving understanding of RVF virus maintenance, and epidemic transmission dynamics in East Africa by 2020.				
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
Odour-bait trapping system for RVF vectors developed	• Utilisation of trapping system for surveillance and monitoring of RVF vectors by stakeholders in RVF research by 2015	• Peer reviewed publications available • Project progress reports • Thesis available • Lure available for use by scientists	• Vertebrate skin-derived lure for trapping RVF mosquito vectors successfully field tested **Publication**: *David P. Tchouassi, Rosemary Sang, Catherine L. Sole, Armanda D.S. Bastos, Klaus Mithoefer, Baldwyn Torto. Sheep Skin Odor Improves Trap Captures of Mosquito Vectors of Rift Valley Fever. PLoS Negl Trop Dis (2012) 6(11): e1879.* • A potent mosquito-specific trapping system developed **Publications:** *David P. Tchouassi, Rosemary Sang, Catherine L. Sole, Armanda D.S. Bastos, Lee W. Cohnstaedt, Baldwyn Torto. Trapping of Rift Valley Fever (RVF) vectors using Light Emitting Diode (LED) CDC traps in two arboviral disease hot spots in Kenya. Parasites & Vectors 2012, 5:94.*	• Sensitization of local community essential to ensure success of project • Cooperation by local communities and National research partners

C. Adaptation To Climate Change & Ecosystem Services Outcomes

Environmental Health Results Based Management (RBM) Framework

Overall objective for Environmental Health: Conservation and sustainable utilization of the agricultural production base and important natural ecosystems, by encouraging and utilizing arthropod diversity, cataloguing and sharing biodiversity data, and discovering endemic wealth by bio-prospecting for useful natural products.

Specific 2012 RBM Framework Outcomes:

Objective 1: Control of the aquatic plant pest, *Hydrilla verticillata*, in East Africa by wild *Polypedilum* (Chironomidae) species by 2012				
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
Dissemination of information among weed-control professionals in Hydrilla-infested areas by 2012.	Hydrilla control, national, and Florida, USA pest-management agencies incorporate project conclusions into work and research plans by 2013.	Reports and publications of weed-control specialists include references to use of *Polypedilum* in Hydrilla control.	Partially completed; reports sent to weed-control and water boards in southeastern USA. One published paper also sent. The other 4 papers have not yet been published. Detailed reports of investigations into the potential use of Chironomidae for Hydrilla control were delivered to the U.S. EPA, affected Florida Water Management Districts, as well as the Florida Department of Environmental Protection and Florida Fish and Wildlife Commission. Additionally, two non-refereed publications and numerous presentations at extension and scientific conferences have been made.	

Objective 2: Taxonomic information of major African pests and vectors used by scientists, students and public by 2020.				
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
5,000 DNA barcodes generated for the iBol database	Scientists use the DNA-barcode library for the African pest and vector insects to identify pest species with DNA techniques DNA Barcoding becomes a routine part of the taxonomic enterprise	Number of barcodes generated	• 3325 specimens submitted to International Barcode of Life Project (Guelph) for barcoding. • Too early to expect appearance of barcodes in the literature. • Three peer reviewed publications in 2012, and further progress in 2013. • Taxonomic information available on the international Barcode of Life Database.	Community members have the ability to learn, appreciate and adopt environmental monitoring technologies. For good effect, holistic training is needed (from sampling, through processing to databasing and dissemination). The absence of this leads to skewed uptake of valuable technology
	A taxonomic evaluation of poorly understood taxa, like stingless bees and African silk moth species	Number of trainees passing examination	• Three PhD and one MSc student at *icipe* applied DNA Barcoding to their projects, resulting in theses and publications.	
2.1 Three trainings per year for 10–15 students and staff 2.2 Number of teaching modules available on intranet	Students and staff know and apply modern taxonomic techniques, including morphological identification, preparation and DNA techniques to identify insects	Number of students and staff members trained	• 12 ARPPIS students successfully complete Insect Taxonomy course • Increasing application of molecular tools in taxonomy by students and projects	
3 African Insect Taxonomy Toolkit (http://taxonomy.icipe.org)	Scientists and others make periodic use of taxonomic literature and tools	External access rates are monitored	Website updated 2 times	
4 At least four projects with relevant taxonomic perspective developed and submitted by 2012	At least two projects with taxonomic component are funded.	Number of projects funded	• Three projects with taxonomic components funded; Biovision Kakamega water quality, Mohamed bin Zayed Species Conservation Fund (Mormotomyia), and Base Titanium water quality.	
5 By 2012, aquatic insects of streams in Kakamega forest are identified and local groups are trained in their identification	Local groups of KEEP and Muliru Farmers are capable of identifying these insects, and can monitor the quality of streams	Number of community members trained.	• Checklist representing 8 orders and 15 families of aquatic insects from Kakamega generated. • 29 local community members adjacent to Kakamega forest trained in sampling aquatic insects and identifying them to family level and on pollinators.	

Objective 3: At least 6 new eco-friendly, nature-based products for pest control adopted for improvement of livelihoods of rural and wider community members by the year 2020.				
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
Progress toward achieving objective observed: 3 new eco-friendly, nature-based products with potential for disease vector control for improvement of livelihoods of rural and wider community members formulated and found to be effective under semi-field conditions.				
3.1.1. Candidate repellent plants and constituents identified based on efficacy, safety and ease of cultivation. 3.1.2. Two repellent plant-derived products formulated and packaged. 3.1.3. One repellent product submitted for registration with relevant bodies. 3.1.4. Community based-domestication and cultivation of a repellent plant initiated. 3.1.5. A community-based facility established for processing repellent plants. 3.1.6. Production of mosquito repellent products initiated through private sector.	• One new nature-based mosquito repellent product adopted for commercial production and in use by 2014. • At least 3 papers published in international journals.	• Number of products produced and used. • Number of participating community members. • Number of reports and publications.	• Community-based domestication and cultivation of a repellent plant undertaken by 710 households in Kenya and Tanzania. • Two community-based facilities for processing the repellent plant operational in Kenya and Tanzania. • 1000 mosquito repellent product produced through private sector for market testing. • 4 MSc. students under training on identification of mosquito repellents from indigenous plants.	Plants have a potential for use in vector control particularly with rural community participation.
3.2.1. At least 4 new potential insecticidal products identified from plants based on efficacy, safety and ease of application. 3.2.2. Two insecticidal plant-derived products formulated and packaged. 3.2.3. Community-based cultivation of selected insecticidal plants initiated. 3.2.4. Community-based production and use of plant-derived insecticidal products initiated in at least one project site. 3.2.5. One PhD and two MSc. Students trained. 3.2.6. At least three papers prepared and submitted to international journals.	• One plant-derived insecticidal product adopted for use in pest control by a local community by 2013. • Three papers on potential insecticidal products published by 2013.	• Number of products produced and used. • Number of community members using the insecticidal products. • Number of reports and publications. • Number of students trained.	• 3 effective insecticidal plant-derived products formulated for mosquito larval control. • Community-based cultivation of 2 insecticidal plants undertaken. • One PhD student trained • One paper published and two accepted for publication in international journals.	Plants have a potential for use in disease vector control particularly with rural community participation.

Objective 3: At least 6 new eco-friendly, nature-based products for pest control adopted for improvement of livelihoods of rural and wider community members by the year 2020.				
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
3.3.1. Two plants with bioactivity against honey bee pests/ diseases identified. 3.3.2. One plant-derived product formulated and evaluated for control of a honey bee pest/disease. 3.3.3. The bee pest/disease control product submitted for registration with relevant bodies. 3.3.4. Protocols for production of the bee pest/disease control product established.	• One plant-derived product for honey bee pests/diseases control adopted for production and in use by 2015. • Two papers/utility model/patent on potential honey bee pest control products published by 2014.	• Number of products produced and used. • Number of reports and publications	• Project accepted for funding and work to begin in 2013.	

Objective 4:	**Geographic information systems are fully integrated as a strategic research tool for *icipe* by 2020.**			
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
Progress toward achieving objective observed: Extensive progress has been made to make the geo-spatial data available to *icipe* scientists through setting up and expanding the GIS unit's geospatial data server. A new ***strategic outlook*** is formulated for GIS science in *icipe* that will work towards increasing the utility of remote sensing and GIS data products within icipe's working and research agenda.				
1.1 Geospatial data server expanded	GIS and increasingly remote sensing data variables are accessible and usable to scientists within *icipe*	GIS data server available to all *icipe* staff 2 new remote sensing data sets were processed and uploaded	Significant progress has been made, especially in processing and making available of time-series satellite data	The propagation of the utility and potential of newly generated Geospatial data has to be increased within *icipe,* using marketing and outreach activities
1.2 GIS and remote sensing training courses set up and given to students and resource managers	The percentage of students who use GIS and remote sensing solutions in *icipe* increased by 25% in 2012, when compared to 2011.	5 out of 12 ARPIS students use GIS in their work in 2012. 10 students attended A PhD level remote sensing course that was given at KNUST University in Ghana 2 peer reviewed papers on the use of GIS and remote sensing in climate change studies were published	Progress has been made in training students to utilize GIS and remote sensing in their working agenda 2 more PhD students are being supervised by the GIS unit	There is a need to supervise and include MSC students in projects and training courses There is a need to include staff members from "other" CGIAR centers (CIAT, ILRI, etc) in training courses
1.3 The GIS and Remote Sensing e-learning platform is developed			The e-learning course is currently being developed and set for completion in 2013	The course should also include a module on "basic remote sensing"
2.1 Conceptualizing and submitting proposals on Ecosystem Services and spatial epidemiology mapping	Remote sensing and GIS is an integral part of the MANGROVAL proposal on ESS, submitted in 2012	One proposal on ESS submitted	Using GIS and Remote Sensing for ESS assessment work in new in *icipe*	Combining spatial data for ESS assessment is an important future prospect
2.2 Efforts undertaken to increase the use of GIS in new and existing projects	The IDRC project uses GIS tracking data for RVF assessment, CERNVEC has a GIS component to train scientist to use GIS in health sciences	One more *icipe* project, funded by SIDA, is set to use GIS as a working tool for RVF research	The number of projects that use GIS and remote sensing *increased* in 2012	The animal tracking work can be extended for future research projects on *wildlife and human conflicts* in the context of Climate Change

Objective 5: Increasing honey and silk production by 20% in selected African farming communities by 2020.				
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
Potential and healthy silk and bee races identified for enterprise development in Africa by 2012. Healthy silk and bee races are distributed to 3000 trainers for the farmer groups. Atleast 15 PhD and 10 MSc. Students trained. At least 50 peer reviewed papers and 5 books/proceedings published in international journals.	50% of the farmers use improved bee and silk races.	Number of farmers using improved races	• 5 Potential and healthy wild and mulberry silk races and 7 stingless and 6 honey bee races identified for enterprise development in Africa in 2012. • Healthy silk and bee races distributed to 2000 trainers for the farmer groups in 12 African countries. • 4 PhD and 2 MSc. Students trained. • 13 peer reviewed papers and 1 proceedings published in international journals. • One case study published: *icipe - Linking insects to forest conservation through honey and silk* was published by EIARD. http://www.eiard.org/key-documents/impact-case-studies/2013/	Trained community accepts the silk and honey enterprise for additional income and pollination services
Training material developed. Training sessions held for 2,000 trainers.	Knowledge of sericulture and apiculture is applied by at least 750 farmer groups (each 50 to 100).	Numbers of farmers trained, number of certificates (exam), numbers of farmers applying their new knowledge.	• 800 farmers trained in apiculture and sericulture in 7 African countries • 800 examination certificates presented • 80% of the farmers applying their new knowledge.	
Business model developed using value chain approach.	Business model and business responsibility adopted by at least 400 farmer groups.	Number of enterprises registered.	• 5 Business models developed and owned by the community in 5 countries in Africa • Business responsibility adopted by at least 40 farmer groups.	
Establish 16 to 20 market places [honey and silk harvesting, processing and selling units].	25% Increase in honey and silk quantity by 2013.	• DC registry • Production records	• 5 new market places establish in 4 countries for honey and silk harvesting, processing and selling units.	
Supplying modern bee hives to farmers and establish rearing houses (silk moth).	500 beehives supplied to farmers by 2013	• Project records	• 3000 stingless and honey bee hives supplied to farmers in 5 countries • 7 Rearing houses (silk moth) established and operational in 5 countries.	
Internal Control System (ICS) training for 3,000 trainers.	Percentage of communities producing honey and silk to EU standards increases from 20% to 40% by 2013.	• Honey and silk quality assessed and certified	• Internal Control System (ICS) training undertaken for 1100 trainers in Kenya and Ethiopia.	

Objective 6: To develop innovative strategies to reduce populations of honey bee pests by 20% in *icipe* target beekeeping areas by 2020.				
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
Key honeybee pests identified, and maps of their occurrence and distribution in Kenya developed	Documentation of honeybee pests, maps available and utilized by 40% of stakeholders for training beekeepers	No. of stakeholders using maps. Peer-reviewed publication	Project approved and commencing in 2013	
Knowledge of honeybee-pest interaction increased among researchers and bee extensionists	Honeybee-pest interaction understood and applied by 30% of bee extensionists by 2013	Number of bee extensionists applying new knowledge Peer-reviewed publication		
Innovative integrated honeybee pest control strategies developed.	Use of honeybee integrated pest control strategies increased by 20% by 2013	Number of beekeepers trained, Number of beekeepers applying new knowledge Peer-reviewed publication		

D. Capacity Building and Institutional Development Outcomes

Capacity Building and Institutional Development Results Based Management (RBM) Framework

Overall objective for Capacity building: To develop well-trained and highly motivated human capacity, and strengthen institutional and policy making capacity and capability required to respond to the arthropod-related development challenges in Africa.

Specific 2012 RBM Framework Outcomes:

Specific Objective 1: To increase the number of high quality researchers and middle level practitioners required to respond to arthropod-related research and development challenges in Africa by 2020.				
Outputs Produced (Activities run)	***Expected Outcomes as per plan 2011 -2020***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
6 PhD and 36 MSc (10 women) postgraduates trained in arthropod-related sciences trained in research and development and working in NARS, universities and the private sector in Africa	At least 80% of graduates (200 PhD and MSc) trained in research and development working in NARS, RECs, SROs, CGIARs, and universities in Africa by 2013	Number of scientists trained at *icipe* engaged (>50% of their work time) in African institutions led research Number of research activities/projects implemented in Africa by African institutions	100% of PhD trained and 30% of MSc are effectively employed in NARS, universities and the private sector.	Graduates trained in Africa are mostly retained in Africa to fill capacity gaps in national and sub-regional programmes. Graduates trained in agriculture will continue to contribute to reducing the "brain-drain" problem associated with young Africans leaving the continent to study and develop their careers in the North
	At least 50% graduates trained involved in research dealing with food security and poverty reduction issues	Number of graduates involved in research leading public & private organisations/enterprises in Africa	80% of graduates are involved in research leading public & private organisations/enterprises in Africa. During the training the occasional lack of specific facilities available at university level, delays in conducting experiments and sampling, the absence of a clear thesis evaluation mechanism at *icipe* resulted in a long delay in graduating from registered universities.	The specificity of *icipe's* trainings equips scholars with appropriate scientific skills that can be applied to solve specific problems that confront the African continent.

Specific Objective 1: To increase the number of high quality researchers and middle level practitioners required to respond to arthropod-related research and development challenges in Africa by 2020.				
Outputs Produced (Activities run)	***Expected Outcomes as per plan 2011 -2020***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
58 publications of research results (theses, book chapters, peer-reviewed journal, brochures, etc) published	At least 80% of research results disseminated in relevant formats at scientific community and policy makers levels in Africa by 2013	Number of research results shared with the scientific community and policy makers Number of citations in peer reviewed publications	Publications made by young scientists: i)reinforced capacity to provide better service to end users ii) advanced scientific skills and knowledge applicable in Africa and globally iii) improved credibility and improved competitiveness and global achievements iv) enhanced learning proves and exposure to international research arena	The number and quality of publications tends to depend on the commitment of individual universities, supervisors, and scientists involved
32 PhD class 2008, 2009, 2010 and 2011 participated in scientific conferences and international meetings		Quality and relevance of *icipe* led-research results shared with scientific community	100% of research results shared with the scientific community and policy makers and more than 10 citations The participation to conferences allowed scholars to interact and network at a high level, gain valuable knowledge and new skills	The participation to scientific conferences that combines the excellence of African research organisations with the academic experience of African and overseas universities are essential ingredients for producing highly qualified *in-situ* graduates with the capability to compete nationally, regionally and internationally

Specific Objective 1: To increase the number of high quality researchers and middle level practitioners required to respond to arthropod-related research and development challenges in Africa by 2020.				
Outputs Produced (Activities run)	***Expected Outcomes as per plan 2011 -2020***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
201 mid-level practitioners and extension workers from 27 national systems in Africa trained in non-degree professional development courses	200 mid-level practitioners and extension workers from 30 national systems in Africa trained in non-degree professional development courses At least 50% of trained middle-level practitioners applying their knowledge and expertise in NARS in Africa by 2013	Number of new technologies produced and adopted	At least 50% of 201 trained middle-level practitioners applying their knowledge and expertise in NARS in Africa The training was effective in expanding the network of research colleagues sharing and disseminating research information in providing new technological skills	Training of mid-level practitioners and extension workers and internship opportunities offered at *icipe* contribute to solve specific problems that confront research result end-user
55 undergraduate interns trained	20% of trained undergraduate interns progressing to research and development careers	% of trained undergraduate interns progressing to research and development careers		
1 network with national and regional research and higher education institutions established, 4 MoAs signed between University of Somalia, Sheikh School, IGAD and AFAAS, 1 MoA renegotiated with TWAS)	2 new projects developed with national and regional partners in Somaliland and Sub-Saharan Africa 5 mid-level trainees resulting from these networks for an average period of 3 months 3 *icipe* technologies and out-scaling in NARS in Somaliland	Number of technologies adopted by research results users Number of joint research projects funded Number of innovative field of research in insect sciences disseminated with partners 40% of research results disseminated in relevant formats at scientific community and policy makers levels in Africa (e.g. fruit fly, thrips, push-pull related technologies)	The only way to ensure the sustainability of the programme is through the consolidation of the existing alumnus network, and its revival through the involvement of its members in devising future *icipe* development strategies. The respondents felt that the main benefits derived from the collaborations were use of facilities and equipment at *icipe* expansion of network of colleagues, the exchanges of ideas and knowledge expansion	Effective collaborative agreements with participating universities and sub-regional organisations proved to be successful in providing a vehicle for continued production of the next generation of insect scientists in Africa Continued efforts in fostering collaboration with research organisation and universities in Africa and worldwide are contributing to the creation of more opportunities in Africa for early-career African scientists.

Specific Objective 1: To increase the number of high quality researchers and middle level practitioners required to respond to arthropod-related research and development challenges in Africa by 2020.				
Outputs Produced (Activities run)	***Expected Outcomes as per plan 2011 -2020***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
3 career development opportunities provided to 2 PDFs and 1 visiting scientist from Nigeria	65% of graduates contribute to research and development at *icipe* and Kenyatta University. At least 50% of graduates attract competitive research grants	Number of grants received by 2015	Two post doctoral fellows and visiting scientists trained 58 publications in peer reviewed journals.	Careers developed at *icipe* in insect sciences are bringing considerable rewards to African scientists

ANNEX: LIST OF REFEREED JOURNAL ARTICLES

16 MAY 2012 – 12 APRIL 2013 PUBLICATIONS LIST

2012

1. *Akutse K.S.*, Owusu E. O. and Afreh-Nuamah K. (2012) Perception of farmers' management strategies for termites control in Ghana. *Journal of Applied Biosciences* 49, 3394–3405.

2. *Amanuel T.*, Getu E., Jembere B. and Bruce T.J.A. (2012) Effects of temperature and relative humidity on the development and fecundity of *Chilo partellus* (Swinhoe) (Lepidoptera: Crambidae). *Bulletin of Entomological Research* 102, 9–15.

3. *Amwayi P.W.*, *Masiga D.K.*, Govender P., Teal P.E.A. and *Torto B.* (2012) Mass spectral determination of phenylacetonitrile (PAN) levels in body tissues of adult desert locust, *Schistocerca gregaria*. *Journal of Insect Physiology* 58, 1037–1041.

4. *Birithia R.*, *Subramanian S.*, *Villinger J.*, Muthomi J.W., Narla R.D. and Pappu H.R. (2012) First report of *Tomato yellow ring virus* (*Tospovirus*, Bunyaviridae) infecting tomato in Kenya. *Plant Disease* 96, 1384.

5. *Birithia R.*, Waceke W., Lomo P. and *Masiga D.* (2012) Identification of root-knot nematode species occurring on tomatoes in Kenya: Use of isozyme phenotypes and PCR-RFLP. *International Journal of Tropical Insect Science* 32, 78–84.

6. Birkholtz L.-M., Bornman R., Focke W., *Mutero C.* and de Jager C. (2012) Sustainable malaria control: transdisciplinary approaches for translational applications. *Malaria Journal* 11, 431.

7. Cock M.J.W., Biesmeijer J.C., Cannon R.J.C., Gerard P.J., Gillespie D., Jiménez J.J., Lavelle P.M. and *Raina S.K.* (2012) The positive contribution of invertebrates to sustainable agriculture and food security. *CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources* 7(43), 27 pp.

8. *Copeland R. S.*, Gidudu B., Wanda F., Epler J. H., Cuda J. P. and Overholt W. A. (2012) Chironomidae (Insecta: Diptera) collected from *Hydrilla verticillata* (Hydrocharitaceae) and other submersed aquatic macrophytes in Lake Bisina and other Ugandan lakes. *Journal of East African Natural History* 101, 29–66.

9. *Copeland R. S.*, Nkubaye E., Nzigidahera B., Epler J. H., Cuda J. P. and Overholt W. A. (2012) The diversity of Chironomidae (Diptera) associated with *Hydrilla verticillata* (Alismatales: Hydrocharitaceae) and other aquatic macrophytes in Lake Tanganyika, Burundi. *Annals of the Entomological Society of America* 105, 206–224.

10. Dugassa S., Lindh J.M., Torr S. J., Oyieke F., Lindsay S.W. and *Fillinger U.* (2012) Electric nets and sticky materials for analysing oviposition behaviour of gravid malaria vectors. *Malaria journal* 11, 374.

11. *Fiaboe K.K.M.*, Peterson A.T., Kairo M.T. and Roda A.L. (2012) Predicting the potential worldwide distribution of the red palm weevil *Rhynchophorus ferrugineus* (Olivier) (Coleoptera: Curculionidae) using ecological niche modeling. *Florida Entomologist* 95, 659–673.

12. *Fombong A.*, *Mumoki F.*, *Muli E.*, *Masiga D.*, Arbogast R.T., Teal P.E.A. and *Torto B.* (2012) Occurrence, diversity and pattern of damage of *Oplostomus* species (Coleoptera: Scarabaeidae), honey bee pests in Kenya. *Apidologie* 44, 11–20.

13. *Fombong A.T.*, *Haas F.*, Ndegwa P.N. and Irungu L.W. (2012) Life history of *Oplostomus haroldi* (Coleoptera: Scarabaeidae) under laboratory conditions and a description of its third instar larva. *International Journal of Tropical Insect Science* 32, 56–63.

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