2013 icipe CORE ANNUAL REPORT BASED ON RESULTS BASED MANAGEMENT REPORTING

April 2014

icipe

African Insect Science for Food and Health

International Centre of Insect Physiology and Ecology

P. O. Box 30772-00100 Nairobi, Kenya
Phone: +254 (20) 8632000 | Fax: +254 (20) 8632001/2
Email: *icipe*@*icipe*.org | Website: www.*icipe*.org

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2013 BRIEF OF *icipe* KEY ACHIEVEMENTS

SECTION 1: 2013 icipe ANNUAL RESULTS BASED MANAGEMENT CORE REPORT ACHIEVEMENTS

icipe Brief Background

The International Centre of Insect Physiology and Ecology (*icipe*) (www.icipe.org) is a 44-year-old pan-African, non-governmental and non-profit Centre of Excellence for research, development and capacity building headquartered in Nairobi with over 400 scientific and support staff. The Centre works on a 4-H (Health) paradigm, including human, animal, plant and environmental health with arthropods as the common denominator to help alleviate poverty, and ensure food and nutritional security for smallholders in Africa. *icipe* focuses on green and sustainable pest control and is presently engaged in 30 African countries, and has thriving partnerships and excellent networks with many universities and research organisations in Europe and North America.

Founded by a renowned Kenyan entomologist, Prof. Thomas Risley Odhiambo, the Centre's mandate is to research and develop alternative and environmentally friendly pest and vector management strategies that are effective, selective, non-polluting, non-resistance inducing, and are affordable to resource-limited rural and urban communities. *icipe*'s thematic clusters are Integrated Pest Management (IPM), Integrated Vector and Disease Management (IVDM), and Adaptation to Climate Change & Ecosystem Services (ACCES), which support training of young African scientists. Some of the Centre's flagship programmes include : Push–pull: A novel farming system for ending hunger and poverty in sub-Saharan Africa (http://www.push-pull.net/), Validation and initiation of diffusion of pro-poor and poor environment tsetse repellent technology (http://www.icipe.org/index.php/animal-health/307-validation-and-initiation-of-diffusion-of-pro-poor-and-poor-environment-tsetse-repellent-technology.html); African fruit fly (http://www.icipe.org/africanfruitfly/) and Climate Change Impacts on Ecosystem Services and Food Security in Eastern Africa (http://chiesa.icipe.org/).

The Centre has outstanding research facilities including Food and Agriculture Organisation of the United Nations (FAO) accredited quarantine facilities as well as a Good Manufacturing Practices (GMP)-compliant enhanced Biosafety level 2/3 laboratory (the Martin Lüscher Emerging Infectious Diseases Laboratory), which is a great statement towards increasing the preparedness and response to emerging infectious diseases in the region.

Additionally, *icipe* is a founding member of the Association of International Research and Development Centers for Agriculture, a nine-member alliance that was established in 2012, which is focused on improving global food security by supporting smallholder agriculture within healthy, sustainable and climate-smart landscapes (www.airca.org), and is hosted on its Duduville Campus. The Centre is a designated 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. As well, since 2010, *icipe* is a UNEP Stockholm Convention regional centre on Persistent Organic Pollutants (POPs). The Stockholm Convention is a United Nations international environmental treaty that aims to protect people, animals and the environment from chemicals.

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 utilisation of the agricultural production base and important natural ecosystems, by encouraging and utilising 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

The *icipe* journey towards Results Based Management (RBM) started in early 2010, when *icipe*'s Governing Council (GC) and Management, in consultation with its core donors, agreed to develop a RBM framework to support the Centre's Strategic Priorities, Policies and Guidelines for insect science research and development. Initially, *icipe* used the Medium Term Plan Framework but like

many other international organisations, introduced RBM in early 2011 as its new strategic planning and management tool. *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 its goals and objectives.

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 weaknesses in implementation plans. Periodic and targeted information helps the GC and *icipe* Management recognise those activities that generate the highest pay-offs in terms of results, or those that 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 thus reach targeted decisions to improve performance on an ongoing basis. Process monitoring takes place on an ongoing basis to monitor 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 a developed RBM framework. All projects entail knowledge management and learning, which are the main components for any organisation dealing with research and development (R&D) like *icipe*. The R&D *icipe* Thematic Clusters and Capacity Building frameworks encompass a cycle of planning, periodic performance assessment and organisational 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.

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

SECTION 2: *icipe* CORPORATE EVENTS UNDERTAKEN IN 2013

1. *icipe*'s New Governing Council Chair Takes Office

Professor Dr Bill S. Hansson became Chair of the icipe Governing Council in November 2013. Prof. Hansson assumed the position from the former Chair, Prof. John A. Pickett CBE, DSc, FRS, whom we thank most sincerely for his years of service and dedication to icipe in that same role.

Prof. Hansson was born in 1959 in Jonstorp, Sweden. His basic biology training with an emphasis on zoology and ecology took place at Lund University, Sweden from 1979–1982. In 1983, he began his Doctorate studies. In 1988, he defended his PhD thesis "Reproductive isolation by sex pheromones in some moth species — an electrophysiological approach". During 1989/90 he was based in the United States, where he worked as a postdoctoral fellow at the Arizona Research Laboratories of the University of Arizona in Tucson, in the Neurobiology division. In 1990, he returned to Lund University as an Assistant Professor.

In 1992, Prof. Hansson became Associate Professor in the Department of Ecology, Lund University, and he gained tenure in 1995. In 2000, He earned a full professorship in the Division of Chemical Ecology.

In 2001, Prof. Hansson moved to the Swedish University of Agricultural Sciences in Alnarp, where he assumed the position of Head of the Division of Chemical Ecology. From 2003 until 2005, he also took on the added role of Associate Dean and shaped the new Faculty of Landscape Planning, Horticulture and Agricultural Science at the university.

In 2006, he became Director at the Max Planck Institute for Chemical Ecology in Jena, Germany, where he built the Department of Evolutionary Neuroethology.

Prof. Hansson then became the Managing Director of the Max Planck Institute for Chemical Ecology in 2011, the position he continues to hold today. His research focuses on the neuroethological aspects of insect–insect and insect–plant interactions. He focuses mainly on insect olfaction, exploring principal questions such as: How is semiochemical information (odour) detected by the antennae and processed in the insect brain?, How did these detection and processing systems evolve?, and How does olfaction guide insect behaviour? He also compares these systems to other land-living arthropods, such as the giant robber crab on Christmas Island.

The Chairman of the Governing Council is elected by other members of the Council, for a maximum of four years, or two consecutive terms of two years.

2. Ethiopian Scientist, Dr Segenet Kelemu, Appointed 4th Director General of *icipe*

Dr Segenet Kelemu, an Ethiopian scientist, was appointed the new Director General of icipe on 1st November 2013, taking over from Prof. Christian Borgemeister, who had been at

the helm of the Centre for eight years. Dr Kelemu became the fourth chief executive officer, and the first woman to head icipe.

Announcing Dr Kelemu's appointment, *icipe* Governing Council Chairman, Prof. John Pickett, said: "We are extremely confident that Dr Kelemu will ably advance the Centre's overall mission of improving food security and the health of people in Africa. She has immense experience in agricultural research, in capacity building and in managing research for development. Indeed, over the past two decades, her own research and that of teams under her leadership has contributed to addressing a variety of key agricultural constraints in Africa, Asia, Latin America and North America."

Prior to her appointment, Dr Kelemu was the Vice President for Programmes at the Alliance for a Green Revolution in Africa (AGRA). She joined AGRA from the International Livestock Research Institute (ILRI), where she served as Director of the Biosciences eastern and central Africa (BecA) hub. Previously, Dr Kelemu was a Senior Scientist, and later the Leader of Crop and Agroecosystem Health Management, at the International Centre for Tropical Agriculture (CIAT) in Cali, Colombia. She has also worked as a researcher at Cornell University, and at Montana and Kansas State universities, in the USA.

Dr Kelemu has received many international accolades, including CIAT's Outstanding Senior Scientist Award, for her numerous contributions to the Centre and its mission, and the prestigious Friendship Award granted by the People's Republic of China, for outstanding contributions to China's economic and social development. In 2011, Dr Kelemu, jointly with *icipe* scientist Prof. Zeyaur Khan, was awarded the *TWAS Prize for Agricultural Sciences*, by TWAS, The World Academy of Sciences.

She is actively engaged within the global scientific community, having published widely in refereed publications and throughout her professional services, as an editor of peer reviewed journals and a member of a variety of international committees focusing on research for development.

More information: http://www.icipe.org/index.php/news/738-ethiopian-scientist-appointed-4th-director-general-of-icipe.html

3. *icipe*'s Accomplishments During the Tenure of Christian Borgemeister

On 30 September 2013, Prof. Christian Borgemeister left icipe after eight years as the Centre's Director General. In this interview, he discusses the various accomplishments under his tenure

Q. What do you consider to be *icipe's* biggest achievement during your tenure as Director General?

A. In the past eight years, *icipe* has obtained more funding, and therefore better stability as an organisation. The Centre's finances have tripled, from USD 9.5 million in 2005 to a projected USD 30 million at the end of 2013. 35% of this funding is unrestricted core grants, provided by the Governments of Denmark (until 2011), Aid for Africa, Kenya, France, Sweden, Switzerland, Germany and

the UK. The remaining 65% is restricted grants, which stem from various donors both development-oriented as well as science-focused. This has enabled us to greatly increase *icipe*'s R&D and capacity building activities across Africa.

Q. How has this success been achieved?
A. Primarily, we have built on the foundation laid by my two predecessors, Prof. Thomas Risley Odhiambo, the founding director of *icipe*, and my immediate predecessor Dr Hans Rudolf Herren.

The accomplishments in the past eight years are also largely as a result of *icipe*'s uniqueness, which is based on three factors. First, *icipe* is an independent African-based, African-owned organisation with an African identity. There are not many institutions that have those characteristics.

Second, *icipe*'s research cuts across agriculture and health, and also incorporates the environment. This thematic mix is particularly unique, as most often research and development organisations focus on one single theme.

The third factor is *icipe*'s track record, which is based on a number of key assets. The Centre has always had a dual mission of conducting fundamental scientific research while providing practical solutions that make a real change in the lives of people in Africa, primarily the rural and urban poor. In other words, *icipe* embraces the developmental aspect while not sacrificing science. As a result, the Centre is able to gain support from more development-oriented organisations as well as those more focused on science.

Moreover, *icipe* has maintained the idea of partnerships with institutions in Africa and beyond, as one of its key strategies. Closely linked to this, is the incorporation of an interdisciplinary approach to research. Traditionally, *icipe* has primarily been a natural sciences institution. However, in the past several years, the Centre has acknowledged social sciences as a vital component of its activities. In 2011, *icipe* re-established a socio-economic unit, which now provides a platform for systematic impact assessments, learning and knowledge sharing for all the Centre's projects.

Lastly, *icipe* has built a solid reputation among funders in regard to its financial management. Since 2009 the Centre's external auditors have not issued a management letter, thus in effect giving the Centre a clean bill of health in terms of its financial reporting.

Q. What are some examples of how these factors have come together?
A. A good illustration of the convergence of these factors is the push–pull technology, which illustrates how collaboration between *icipe*, research, development and private sector partners can open up opportunities for the improvement of income and nutritional security of smallholder farmers.

Push–pull, an innovative technology that uses crop intercrops to simultaneously combat the key constraints of cereal production in Africa, i.e. stemborer pests, the parasitic striga weed and poor soil fertility, was developed by *icipe* in collaboration with UK's Rothamsted Research and national research institutes in Kenya. Through support from community-based organisations, donors and private sector partners, over 60,000 farmers in East Africa are now using push–pull.

Moreover, some of the crops used in push–pull, for instance desmodium and Napier grass, are high quality, perennial animal fodder plants. Therefore, an important benefit of the technology is the provision of year-round quality fodder. Consequently, *icipe* has formed a close collaboration with Heifer International to incorporate animal husbandry within push–pull. This partnership includes assisting farmers to acquire improved livestock breeds and training them on proper animal care.

A second example is in regard to the commercialisation of isolates developed through *icipe*'s long-standing research on fungi that attack crop pests, through agreements signed with Real IPM, a pan-African, Kenya-based producer of biopesticides. As a result, *Metarhizium anisopliae* ICIPE 69 isolate, is now registered for control of mealybugs in papaya and marketed as Campaign™ in Ghana, and for microbial control of other pests in Kenya, where it is marketed as Real *Metarhizium,* and in Ethiopia, Mozambique and the Republic of South Africa. In addition, the *Metarhizium anisopliae* ICIPE 78 isolate is being marketed as Achieve™ in Kenya, Ethiopia and South Africa, and is effective against a range of economically important mites.

A third example is *icipe*'s growing international recognition, aptly illustrated by the designation in September 2012, as a Food and Agriculture Organisation of the United Nations (FAO) Reference Centre for vectors and vector-borne animal diseases. FAO Reference Centres are institutions selected by FAO's Director General to provide specific, independent technical or scientific advice on issues related to its mandate. The Centres are chosen on the basis of their high level scientific expertise, their commitment to capacity building and provision of services. The designation is also based on prior collaboration with FAO and contribution to the organisation's programmes. Selected institutions must also have demonstrated ability to contribute to capacity building in their areas of expertise.

Q. How has *icipe* contributed to the advancement of scientific capacity in Africa?
A. Capacity building is indeed one of the most important aspects of *icipe*'s activities, and a goal that the Centre has continued to advance from a number of perspectives in the past eight years. Overall, the Centre's approach is to enable researchers to take leadership in seeking solutions to Africa's development problems while gaining recognition within the international scientific community.

The flagship of *icipe*'s capacity building activities is the training of young academics, primarily through the African Regional Postgraduate Programme in Insect Science (ARPPIS) and the Dissertation Research Internship Programme (DRIP). By 2012, a total of 350 PhD students had been trained by *icipe* and their university partners, and most of them have remained in Africa, where they are working for a range of organisations.

In the past eight years, *icipe* has also enhanced its role as a Centre of Excellence, which provides Africa's finest talent with the right opportunities and infrastructure. Currently, *icipe* employs around 60 scientists, half of whom are African nationals, working alongside peers from Asia, Europe and North America. The Centre's scientists publish more than 100 peer-refereed scientific articles per year, which demonstrates their own, and in effect Africa's, contribution to global scientific knowledge.

icipe also provides training to farmers as well as technical and extension workers to strengthen their capacity in applying the Centre's technologies and to provide them with the knowledge and information that they require to define solutions for challenges related to food and health.

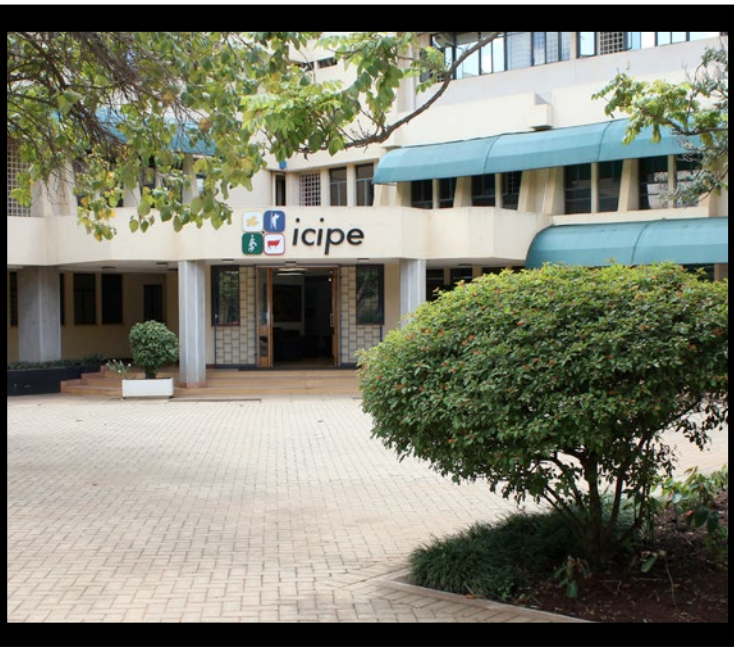
Beyond the human resources, *icipe* has also significantly contributed towards strengthening Africa's scientific infrastructure. For instance, the Martin Lüscher Emerging Infectious Diseases (EID) Laboratory, which was launched in November 2011 at *icipe*'s headquarters in Kasarani, Nairobi, provides a specialised platform to undertake studies that will improve risk detection, early warning and response capabilities, to outbreaks of vector-borne infectious diseases of national programmes in Kenya, and Africa in general. This facility is one of the few existing laboratories on the continent that provide such a resource.

Moreover, as *icipe* has increased its programmatic activities across Africa, now extending to 20 countries, it has in effect contributed towards making the scientific capacity—human and infrastructural—stronger. Currently, the Centre has field Centres in Ethiopia and Sudan. The rest of *icipe's* activities are administered under national research institutes in the respective countries. In the past several years, *icipe* has also become particularly involved in supporting institutions in post-conflict countries. For instance, we are supporting the University of Somalia in Mogadishu to develop their curriculum.
More information: http://www.icipe.org/index.php/news/740-farewell-interview-with-icipe-outgoing-director-general-prof-christian-borgemeister.html

4. Greening of the Centre

The International Centre of Insect Physiology and Ecology (icipe) initiated a Green Project with support from Swiss Agency for Development Cooperation (SDC).

Simple changes in our everyday lives can help slow climate change — including reducing our energy consumption, choosing to travel sustainably, and being conscious of what we purchase. *icipe* with the major support of Swiss Francs five million one hundred and fifty-five thousand (CHF 5.155 million) from the SDC made a conscious decision to go "green" and minimise the Centre's carbon footprint. The implementation of the initiative, approved in 2013 and that begins in 2014, would first reduce the Centre's energy consumption and then rely heavily on solar energy for electrical needs. It would also allow *icipe* to harvest, reuse and recycle water used on its two main campuses at its headquarters in Nairobi and Mbita Station on the shores of Lake Victoria.



In addition to the environmental benefits *icipe* would reap, there are also long term operational and financial benefits that would accrue from the greening of the Centre. This strategy will also dovetail in the Government of Kenya's objectives on renewable energy. Since January 2010, a revised feed-in tariff policy aims to encourage private investment in electricity generation from renewable energy. Unfortunately the policy implementation is still a challenge. Nonetheless in 2012 several

high profile projects have been initiated in Kenya; namely, the British Government aid to Kenya on Green Energy Initiatives and a newly constructed United Nations Environment Programme (UNEP) building at the UN complex in Nairobi.

The 'going-green' project will be implemented through a period of three (3) years and will entail reduction of energy consumption by means of intelligent energy saving measures; sustainable energy supply and reduction of diesel fuel dependency by using solar photovoltaic systems and solar thermal systems; and reduction of clean water consumption by using rain water.

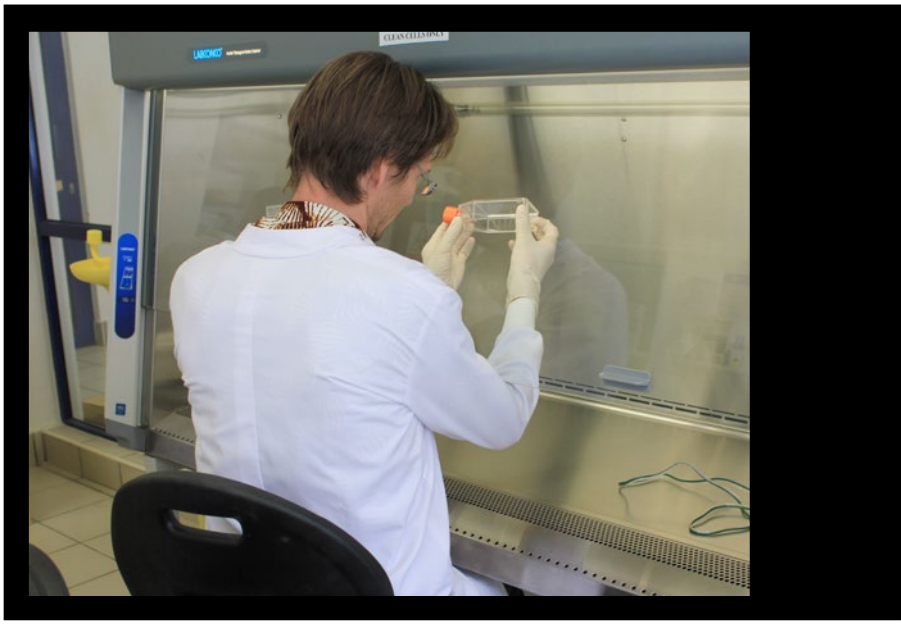
The greening of the Centre represents a great opportunity to reduce *icipe*'s carbon footprint and get partway to carbon neutrality and reduce climate impact.

5. Good Laboratory Practices (GLP) Accreditation

The Organisation for Economic Co-operation and Development (OECD) - Good Laboratory Practice (GLP) Accreditation Efforts at icipe Boosted by the Swedish International Development Cooperation Agency (Sida)

The Centre's chemistry laboratories are unique and often referred to as ***the*** reference laboratory in sub-Saharan Africa as they are equipped for analytical and organic chemistry research. As a pan-African organisation, *icipe* receives various samples for analysis and requests for training at all levels across the continent (postgraduate, internship and advanced training for professionals, both from public and private institutions).

To better meet these increasing demands, the Centre has embarked on OECD-GLP accreditation with generous support of Swedish Krona ten million (SEK 10 million) from the Sida. Presently, OECD-GLP accreditation on the continent is limited to only South Africa. As a Food and Agriculture Organization of the United Nations (FAO) Reference Centre and a UNEP Stockholm Convention Regional Centre, there is an urgent need for *icipe* to meet this compliance and to be at par with similar Centres around the world. With the funding from Sida, the Centre has embarked on upgrading its analytical infrastructure to allow for the provision of services including analysis of pesticide residues, toxins, air, water, and soil and food contaminants.



The primary objective of the OECD Principles of GLP is to ensure the generation of high quality and reliable test data related to the safety of industrial chemical substances and preparations in the framework of harmonising testing procedures for the Mutual Acceptance of Data (MAD). It is envisaged that this upgrade will constitute a tremendous opportunity for *icipe* and its partners and collaborators across Africa, as the Centre would become the first such accredited institution outside the Republic of South Africa.

6. The UK Government Grants Support to *icipe*'s Agricultural R&D Interventions

icipe's capability in research-for-development is rewarded.

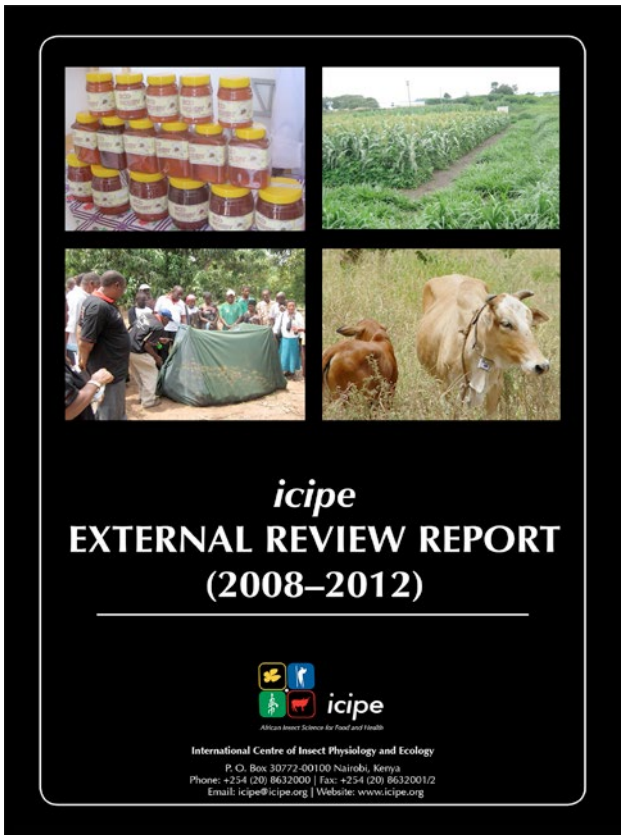
In 2013, the Department for International Development (DFID), under its contribution to international agricultural research Centres (IARCs), granted *icipe* support for strategic scaling-up of technologies and new ways of working with the private sector on innovation, and generating evidence from *icipe*'s experience on what works in getting research into use.

Part of the supported activities is an extension of *icipe*'s conservation agricultural approach known as 'push–pull' technology (http://www.push-pull.net/) that has been developed for integrated management of stemborers, striga parasitic weed and soil fertility, in Uganda. Further, in partnership with the private sector, *icipe* will develop innovative control strategies for cattle ticks. This public–private partnership envisages developing a strategic plan that centres on the development of a biopesticide for the livestock sector as an alternative to the currently used synthetic acaricides. Finally, in harnessing and nurturing Africa's own, the Centre will prioritise a new initiative to offer young African scientists at the postdoctoral level an opportunity to undertake research activities aimed at reinforcing and broadening the young scientists' skills and offering prospects to develop collaborative research programmes, the aim being to build a critical mass of African researchers undertaking relevant research-for-development for the betterment of the continent.

7. Review of *icipe*'s R&D, Capacity Building and Management Programmes Report

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 2013 review was much broader and covered the entire operations of *icipe*, including management, internal organisation, administration, policies and partnerships of the Centre.

The 2013 external review involved a study of relevant documentation, 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 report on *icipe*'s External Programme and Management Review (2008 – 2012) is now publicly available. The reviewers highly commended the Centre for creating a superb portfolio of innovative research and development which they considered to be of high to highest quality, a fact supported by the large number of peer-reviewed articles published through the review period. Furthermore, the reviewers noted that the research is undertaken in a reasonably cost effective manner; the production of one peer reviewed article costing ca. 250,000 USD, which compares favourably with, e.g. 239,000 USD (average 2008 – 2012) for a paper produced at The Swedish University of Agricultural Sciences (SLU) (The 2009 OECD-HERD average is 180,000 USD per paper). The reviewers observed that *icipe* has performed excellently, typified by a strong involvement with national, public and private partners.

In its institutional goal(s) stated in the *Vision and Strategy 2007 – 2012* document, *icipe* aspires to "Develop, introduce and adapt new tools and strategies for arthropod management that are environmentally safe, affordable, appropriate, socially acceptable and applicable by the target end-users, with full community participation. Eventually, the outputs of *icipe*'s research work will contribute to policy development in areas that are relevant to the Centre's mandate". In almost all areas the review team considered that *icipe* has indeed gone a long way to fulfilling these aspirations.

Access the full report: http://www.icipe.org/index.php/external-review/788.html

8. *icipe* Demonstrating Excellence 2007–2012 Report

In addition to the External Review Report, icipe prepared a comprehensive summary report of its key R&D results over the last 5 years. The Report incorporates all the desk material that was compiled by icipe scientists and management for the review team.

As an organisation based in Africa, *icipe* recognises that excellence must also have another dimension, which is the ability to respond to the critical developmental needs facing the continent. As illustrated in this publication, which focuses on *icipe*'s activities between 2007 and 2012, the Centre has strongly responded to the range of developmental challenges, while adhering to the highest level of globally accepted standards of scientific practice.

The Report showcases *icipe*'s excellence during that period along three themes: providing **better health** for people and livestock, helping to achieve **better yields** for crops and contributing towards a **better environment** for the sustainability of ecosystems and livelihoods. This publication demonstrates the Centre's success towards these three goals between 2007 and 2012.

On the goal of **better health**, *icipe* has scaled-up its highly successful community-based methods for the control of malaria and mosquitoes to new sites in Kenya and Ethiopia. While addressing the intricate linkage between malaria and livelihoods, the Centre has provided communities with information, education and communication materials, to empower them to make informed decisions and take the right action against the disease. On the goal of **better yields**, *icipe* has significantly contributed to the improvement of cereal production around three programmes. First, the Centre has made its phenomenally successful push–pull technology accessible to more smallholder farmers across East Africa. Second, *icipe* has conducted extensive collaborative research with the Institut de Recherche pour le Développement (IRD) on stemborers and their natural enemies. Third, *icipe* is spearheading studies on postharvest losses of cereals and other crops, investigating better storage strategies, and helping to compile systematic evidence that will assist decision-makers to optimise post-production policies and strategies. On the goal of **better environment**, *icipe* has advanced its strategy of protecting Africa's rich biodiversity resources while improving the livelihoods of the people who live adjacent to them. The Centre has disseminated a variety of tools, which combine modern science, traditional knowledge and practices, partnerships with local communities, development partners and the private sector, for the sustainable exploitation of biodiversity. *icipe*'s activities focus on beekeeping and silk farming technologies, and the domestication and commercialisation of plants with insecticidal, medicinal or aromatic properties.

icipe's excellence during the period covered in this Report is supported by the recognition of the Centre's staff and activities by local and global partners. More information: http://www.icipe.org/images/stories/icipe/publications/icipe_demonstrating_excellence_web.pdf

SECTION 3: icipe 2013 SELECTED 4-H PROGRAMMES AND CAPACITY BUILDING ACHIEVEMENTS

1. Plant Health:

The following are the achievements accomplished in *icipe*'s Plant Health Research.

Development of integrated pest management (IPM) strategies for key pests of staple food, horticultural and plantation crops

Staple food crops IPM: The staple food crops IPM activities included: (i) development of IPM strategies for key pests such as *Maruca* (bean pod borers) and bean flower thrips infesting cowpea and other legumes in East Africa; (ii) promotion of the push–pull technology for management of striga and stemborers infesting maize, sorghum, millets and rice; (iii) developing integrated disease management strategies for Napier stunt disease; and (iv) understanding the role of biological control of Lepidopteran stemborers of cereals as impacted by the diversity of host crops, landscapes, and biophysical properties. A significant number of farmers benefitted from various IPM technologies for staple food crops. More than 64,077 farmers have adopted push–pull technology in Ethiopia, Kenya, Tanzania and Uganda, and 13,369 dairy farmers have benefited from fodder produced from push–pull technology). Capacity building among NARS to disseminate and implement IPM strategies was also a key focus during the reporting period. For example, more than 2100 stakeholders were trained to identify key pests of cotton and use a push–pull IPM approach.

The various activities also resulted in the training of 2 PhD students, 5 on-going PhD studies, 2 on-going post-doc training, and publication of 13 peer reviewed papers (Niassy et al. *Bulletin of Entomological Research* - accepted pending minor revisions; *Crop Protection*; *Plant Pathology*; *Journal of Chemical Ecology*; *Ecology Letters*; Félix et al. 2013. *Ann. Soc. Entomol. Fr.*; Ong'amo et al. 2013. *Arthopod-Plant Interactions*; Jancek et al. 2013. *PLoS One*; Campagne et al. 2013. *PLoS One*; Glaser et al. 2013. *Int. J. Biol. Sci.*; Juma et al. 2013. *Bull. Entomol. Res.*; Moolman et al. 2013. *Phytoparasitica*) and 1 book published on "Insect-Plant Interactions" in French for students and teachers.

The activities also focused on product development. Two (2) pheromone components for *Maruca* were been identified, one (1) biopesticide product for *Maruca* management was identified and two (2) resistant Napier cultivars for Napier stunt disease were identified.

Horticultural and plantation crops IPM: The Horticultural and Plantation Crops IPM activities included development of IPM strategies for pests such as thrips (and the tospoviruses they transmit), leafminers, diamondback moth, *Tuta absoluta* (inflicting significant damage to vegetables such as onion, French bean, tomato, snowpea and crucifers

in Africa). IPM strategies for fruit flies, mango seed weevil, false codling moths and thrips (inflicting significant damage to fruit crops such as mango and avocado) and key pests and diseases of cashew were developed and disseminated. During the implementation, significant numbers of farmers have been sensitised to the various IPM technologies. More than 10,000 farmers were trained on fruit fly IPM technologies and more than 70% adopted it, thus enhancing mango yields by 30%. Capacity building among NARS to disseminate and implement IPM strategies was also a key focus during the reporting period. More than 320 plant quarantine officers and extension functionaries were trained on thrips, leafminers and fruit fly IPM technologies.

The various activities also resulted in the graduation of 5 PhD students, 8 ongoing PhD studies, 16 MSc students trained, 9 on-going MSc students, 2 on-going post-docs in training and 26 peer-reviewed publications (Birithia et al., *Plant Pathology*; Nyasani et al. *Journal of Pest Science*; Nyasani et al. *Journal of Applied Entomology*; Niassy et al., 2013 *BioMed Research International*; Niassy et al. 2014, *BioMed Research International*; Chabi-Olaye et al., 2013, *Biological Control*; Akutse et al., 2013 *Fungal Ecology*; Azandémè-Hounmalon et al. 2014, *PLoS ONE*, Martin et al. 2013, *Journal of Economic Entomology*; Martin et al. 2014, *Journal of Economic Entomology*.

The activities also focused on product development. Two (2) biopesticide products have been commercialised for thrips and fruit fly management, more than 5 fungal isolates with significant antagonism to thrips and leafminers were identified, 3 highly resistant onion lines to thrips were identified, 5 parasitoids for management of invasive leafminers and fruit flies have been released, and 2 clones of cashew tolerant to *Cryptosporiopsis* fungi were identified. A Google App for information and identification of thrips and their natural enemies was developed and is available for free download.

Eliminating gaps in knowledge on climate-induced pest problems

Climate change impacts on ecosystem services and food security in Eastern Afromontane Biodiversity Hotspots of Taita, Jimma and Kilimanjaro: Key achievements of the CHIESA project include the set up of 11 automatic weather stations along the Jimma, Mt. Kilimanjaro and the Taita Hills transects that are linked to the Meterological agencies in Kenya, Tanzania and Ethiopia, thus enhancing the available capacity for weather monitoring. Remote sensing datasets for the three transects (such as SPOT image, Landsat images and hyperspectral remote sensing data) have been obtained and made available through the CHIESA GeoNetwork. Two Participatory Stakeholder Analysis and Mapping campaigns were organised and successfully implemented in Taita Hills and Mount Kilimanjaro with over 240 stakeholder participants. Five PhD and 3 MSc studies, mainly on assessing the impacts of climate change on pest of maize, crucifers, avocado, and diseases of coffee, and on assessing soil carbon sequestrations were carefully chosen. The students are selected from NARS for the sustainability of the project activities and outcomes. Six MSc students (2 from each country are carrying out studies on household vulnerability assessment for 1400 households in the identified study transects.

Adaptation and Dissemination of the Push–Pull Technology (ADOPT) to withstand climate change and develop advanced insect phenology modelling, and decision aid development for adaptation planning to climate change: In the ADOPT project, out of 75,297 push–pull adopters, 18,940 households have adopted the climate-smart push–pull technology in drier agro-ecologies of Ethiopia, Kenya, Tanzania, and Uganda, translating into about 180,000 direct beneficiaries, thus covering an additional 4735 ha. Farmers numbering 3788 kept dairy cows under zero grazing units and fed them on *Brachiaria* and *Desmodium* grasses, thus yielding 5 litres of milk per day. Similarly 2841 farmers kept dairy goats yielding 3.5 litres per day. *Desmodium intortum* and *D. uncinatum* are incorporated as potential repellent plants in the climate-smart Push–pull technology. Project partners, including Heifer Kenya, Heifer Tanzania, Institute of Sustainable Development (ISD-Ethiopia), Kenya Agricultural Research Institute (KARI), Ethiopian Institute of Agricultural Research (EIAR) and Lake Zone Agricultural Research and Development Institute (LZARDI-Tanzania) participated in technology development and dissemination to over 25,000 farmers.

In the development of advanced insect phenology modelling, and decision aid development for adaptation planning to climate change, two satellite data sets were processed for eastern Africa. Over the last 12 years, vegetation productivity and land surface temperature have been assessed in eastern Africa. Four MSc-level and postgraduate training courses were conducted, on the utility of the satellite data sets. Vegetation chlorophyll activity and LST datasets for years 2000 to 2012 were pre-processed and uploaded to the CHIESA GeoNetwork. Two PhD and two MSc-level trainings are ongoing to predict the potential change in distribution of cereal stemborer pests and their main larval parasitoids, according to different expected climate change scenarios in East and sub-Saharan Africa.

Initiating a postharvest research programme at *icipe*

Evidence of postharvest losses of various commodities in sub-Saharan Africa, to help decision-makers: Key achievements of in specific objective 1 included the release of six policy briefs and one working paper that clearly outlined that postharvest research and innovation has focused more strongly on cereals under smallholder settings. Fruits and vegetables have received less research attention, while milk and meat were least represented. Further, the evaluation also revealed that losses are often economic rather than physical product losses. Technologies for loss mitigation fail to address dynamics of supply chains. One peer-reviewed journal article is under review in *World Development Journal*.

Evidence for alternative uses of Purdue Improved Crop Storage (PICS) bags: In assessment of the hermetic triple-layer bag (PICS™ bag) for storage of mung bean (green gram) and pigeonpea grains, it was found that PICS bags are superior to Actellic Super® treatment and they stopped losses due to cowpea bruchids and preserved the quality of mung beans and pigeonpeas. One MSc study has been completed and 2 journal articles are in press within the *Journal of Stored Products Research*.

Initiative to Address Pest Problems in African Indigenous Vegetables Underway at *icipe* with funding from the German Federal Ministry for Economic Cooperation and Development (BMZ):

icipe has partnered with AVRDC - The World Vegetable Center, to jointly address biotic constraints on African indigenous vegetables with a grant of euros one million two hundred (€1.2 million) from BMZ through The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) mainly operating on behalf of BMZ. The collaboration is a collective effort that plans to develop and implement, in cooperation with international and national partners, sustainable and environmentally friendly integrated pest management approaches for major arthropod and nematode pests of 3 African indigenous vegetables (AIVs) – amaranth, leafy cowpea and nightshades beginning January 2014. These AIVs are among the most important vegetables produced and traded in rural, peri-urban and urban markets for underprivileged groups (e.g. women, victims of HIV/AIDS etc.) for income-generation and improvement in food and nutritional security.

However, despite the increasing importance and demand for AIVs, the yield and quality of the crops remain far below their potential largely due to numerous abiotic and biotic constraints. The most important biotic constraints include arthropod pests (webworm, amaranth weevils, leaf beetles, pod borers, aphids, mites, etc.) and root-knot nematodes.

It is expected that with the introduction of sustainable integrated pest management strategies, reliance on chemical pesticides will be reduced, and the major biotic constraints that limit the productivity and decrease quality of indigenous vegetables will be overcome.

***Stories of Our Success: Positive Outcomes from Push-–Farming Systems* Published:**

A report titled *Stories of Our Success: Positive Outcomes from Push–pull Farming Systems*, which chronicles the partnership between the Centre, farmers, national and international research institutes, donors, government agricultural officials, community-based and non-governmental organisations and the private sector, towards improving agricultural sustainability, food security and overall livelihoods in East Africa, has been published by icipe. More information: http://www.push-pull.net/stories-of-our-success.shtml

Push-pull *(www.push-pull.net)* is a technology that addresses the main constraints of cereal production in sub-Saharan Africa, which are stemborers, the parasitic *Striga* weed and soil fertility. To-date, the technology has been adopted by about 68,000 farmers in Kenya, Ethiopia, Tanzania and Uganda.

In the recently published Report, farmers share their experiences with push–pull, revealing the direct results of the technology, which include substantial cereal yield increases, additional significant benefit for dairy farming, and its overall impact on household incomes.

The Report also discusses the specific ways in which push–pull has contributed to the millennium development goals (MDGs), in particular MDG 1: eradicating extreme poverty and hunger, and more broadly MDGs 2, 3 and 7, which respectively focus on universal primary education, promoting gender equality and ensuring environmental sustainability.

Further, *Stories of Our Success: Positive Outcomes from Push–pull Farming Systems*, looks ahead and beyond the MDGs, which are due to expire in 2015. The Report shares experiences and important lessons from push–pull, which could be useful in the development and implementation of a set of sustainable development goals (SDGs), envisioned globally as the post-2015 approach development pathway.

***icipe*'s Successful Leafminer R&D Intervention Scaled Up:** *icipe*'s Leafminer Flies (LMF) programme, "Expanding the rational and biological control of invasive *Liriomyza* leafmining flies to major horticultural production systems of East Africa" was initiated in 2006 with funding from the German Federal Ministry for Economic Cooperation and Development (BMZ). The first phase of the project was concluded in March 2010 and the second phase is ongoing.

Surveys conducted during the initial phase indicated that the most devastating *Liriomyza* leafminer flies in Kenya are *Liriomyza huidobrensis, L. sativae* and *L. trifolii,* that are characterised by their high degree of polyphagy (the habit of feeding on many different kinds of food) representing >99.8% of the total *Liriomyza* collected both in the cultivated and wild habitats. The pests cause yield losses of 50–100% and constitute a major quarantine limitation for exports to the European market. Presently, the pests are primarily controlled by frequent applications of synthetic insecticides, leading to resistance in the pests and pollution of the environment. Natural enemies are important in regulating *Liriomyza* leafminers in their native and invaded areas. Yet the impact of native parasitoids in Kenya is low (with parasitism <5%), necessitating the introduction of exotic parasitoids.

icipe in partnership with the International Potato Center (CIP) and the Kenya Plant Health Inspectorate Service (KEPHIS) identified, introduced and successfully established in *icipe*'s quarantine facilities, populations of three Peruvian parasitoids (*Phaedrotoma scabriventris*, *Halticoptera arduine* and *Chrysocharis flacilla*). Following the first releases of *P. scabriventris* rates of parasitism in LMF populations have risen from 5% to between 30–60%. This remarkable success encouraged the subsequent releases of *H. arduine* with establishment and impact studies conducted in 2013.

icipe work on LMF management in Kenya has been well received by the government and local farmers. For instance, Dr Wilson Songa, Secretary of Agriculture in the Ministry of Agriculture, has praised the Centre's approach in tackling these highly destructive vegetable pests.
More information contained in Results Based Management Tables presented in Section 5A

2. Animal Health:

The following are the achievements accomplished in *icipe*'s Animal Health Research.

Reducing trypanosomosis risk by 50% in cattle of pastoralists and agro-pastoralists cattle herds by 2013 by development and optimisation of tsetse repellent technology: Validation and optimisation of tsetse repellent technology has been ongoing on the outskirts of Shimba Hills Game Reserve in Kwale district Kenya Coast with over 260 farmers and over 1500 cattle herders

involved. The trials have been very successful and disease incidence in cattle protected with repellent collars has been reduced by >80%. This has resulted in reduction in drug use by >60%. Protected bulls plough more land and as a result average area ploughed has increased by 48% in areas where cattle have repellent collars with the waterbuck repellent blend as a compared to only 13% in unprotected areas or 29% with traps alone. This increase in area ploughed has had a significant impact on food security of the households as more crops are grown not only for home consumption but also for sale. PCT patent application on the waterbuck repellent blend has been submitted. Awareness has been created among stakeholders for introduction of repellent products and their application in integrated tsetse and trypanosomosis control strategies. Two brochures were produced for wider dissemination and nearly 500 farmers have been trained in dissemination sessions. Farmers' perceptions of the technology are very positive and 99% of them are willing to buy the repellent collars indicating that the potential for adoption is extremely high. Visibility of the project has also been considerable with eight media articles published worldwide. For upscaling and mass production of the repellent collars, agreements with the private sector through public–private partnerships are being pursued.

Reducing 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: Livestock production targeted for development of animal health packages in Kenya focuses on enhancement of milk productivity in zero-grazing units (with Livestock Protective Net Fence [LPNF]) as an essential component of the animal health package. Milk yields have increased in protected units by 2–3x, mastitis cases reduced by >50% in protected units and fly and mosquito populations reduced by >70%. Project impact was filmed by FAO and is available on FAO website http://www.youtube.com/watch?v=eD6Ve_SjW08. One media article in the local press has also been published. Nearly 500 farmers of which nearly 60% are women have been trained on use of LPNFs through 4 training courses. These packages continue to be optimised for upscaling in other districts to enhance milk production.

***icipe* tsetse repellent technology featured on DEVEX.com:** Eliza Villarino, senior news producer of Devex interviewed Dr Rajinder Saini, Principal Scientist and Investigator of the European Union-funded tsetse repellent collar project on the innovation and its impact. This interview was featured on DEVEX.com in an article titled "Bug off: A new way to ward off tsetse". Devex is a popular international development website which has a readership of more than 500,000, including 1000 funding agencies worldwide. In the article, Dr Saini outlines *icipe*'s future plans to improve the performance of the tsetse repellent technology and to disseminate it more widely, to meet rising demands. Full details are available on https://www.devex.com/en/news/bug-off-a-new-way-ward-off-tsetse/81784

How the stink of a waterbuck could prevent sleeping sickness in Kenya: A collar worn by livestock containing animal odour repellent to the tsetse fly could transform the lives of farmers in Africa. The tsetse fly, found in 37 countries in sub-Saharan Africa, can be a curse for smallholder farmers and their families. The flies carry the trypanosome parasite that can cause sleeping sickness in humans and nagana in livestock. However, as reported in the *Guardian*, a group of *icipe* scientists has developed a powerful insect repellent

using the stench of waterbucks, a common antelope in the savannahs of East Africa that tsetse avoid. For more information - http://www.icipe.org/index.php/news/657-how-the-stink-of-a-waterbuck-could-prevent-sleeping-sickness-in-kenya.html

More information contained in Results Based Management Tables presented in Section 5B(i)

3. Human Health:

The following achievements were accomplished in *icipe*'s Human Health Research.

Understanding the relationship between livelihoods, ecosystem health and malaria: It was noted that small-scale trading and farming plus traditional capture fishery activities aggravate malaria. In addition, outcome mapping is a convenient means of tracking behavioural change in target communities through boundary partners.

Comprehensive evaluation of *icipe*'s ongoing integrated vector management (IVM) sub-projects: Evaluation of IVM project implementation and impact is crucial for developing new grant proposals. A strategic plan needs to be regularly reviewed and updated through exhaustive consultations among researchers. One IVM proposal was developed and funded by Biovision Foundation for IVM operational research in Kenya and Ethiopia from 2013–2015 and another proposal for IVM was solicited from *icipe* by WHO-AFRO for demonstration of IVM and strengthening of IVM capacity at national and regional levels.

Integrated Vector Management (IVM) for Sustainable Malaria Control in Eastern Africa: Active participation in an IVM project by researchers with diverse expertise, including vector biology and behaviour as well as social science disciplines, creates powerful synergy for development of transdisciplinary projects with potential for impact and development of appropriate methods for its assessment. A reduction of more than 60% of *Anopheles* and *Culex* larvae in sites treated with bio-larvicides (Bti) in western Kenya was recorded. Integrated vector management related income-generating activities (IGAs) ongoing in IVM sites in western Kenya including planting of 200 mulberry trees for silkworm rearing and production of 6000 bricks for building have the potential to contribute to malaria reduction. About 2000 school children in Malindi, Kenya were informed and sensitised with mosquito control messages during the mosquito walks and education in school clubs. A total of 3600 community members in Tolay, Ethiopia have received awareness messages on malaria IVM activities during meetings. The team has formulated a new effective bio-pesticide for control of mosquito larvae. An estimate of 675 community members, 450 male and 225 female, have been trained and 12,700 seedlings planted in the community nursery at the Tolay project site. Fifteen (15) participants from 9 different ministries and organisations attended an IVM workshop for policy makers held in Ethiopia in November 2013. Similarly, another 22 participants from 8 different ministries and organisations attended an IVM workshop for policy makers held in Kenya in December 2013. A total of 4350 households were interviewed for

collection of baseline socio-economic data at IVM sites in Kenya and Ethiopia.

Understanding the role plant odours play in mosquito attraction: Plant-based lures can compete with human/animal-derived lures in attracting mosquitoes and three candidate plant-based lures are available. This opens up the prospect of using chemical attractants to further understand mosquito behavioural ecology, and hence development of new control tools. Some of this work is published (Nyasembe and Torto, 2013. *Phytochemistry Letters*).

Building internal capacity for mosquito vector competence and genetic control research: Working through government healthcare systems enhances acceptance, ownership and adoption of innovations. Community Health Workers (CHWs) affiliated to different government health facilities have been trained and officially assumed the role of carrying out monthly malaria mosquito surveys. Execution of project activities with close consultation of regulators helps to streamline and keep operations on course. For example draft national Arthropod level-2 (ACL2) containment guidelines have been co-developed and construction of an ACL-2 facility subsequently initiated at *icipe*- Thomas Odhiambo Campus with approval from the National Biosafety Authority (NBA). Key staff have seen the need for and attended an international level 1 Biosafety practitioner course. Good relationship management facilitates success in external and internal operational environments.

Development of chemical-based tools for surveillance and/or disruption of malaria transmission: The project has noted that there is a shift in species composition of malaria vectors. The Community Advisory Board (CAB) is a critical and safe interface for reaching target communities and simultaneous roll out of routine Health Demographic Surveillance Systems (HDSS), social science, parasitological and entomological surveys, and is key to studying epidemiological outcomes of disease.

Understanding *Anopheles* oviposition behaviour in diverse aquatic habitats: High variability in mosquito responses demand large sample sizes to produce robust results. One manuscript has been published following this research (Dugassa et al. 2013, *PLoS One*). In addition, a PhD level scientist (Sisay Dugassa) completed his thesis entitled 'Development of a gravid mosquito trap for surveillance of the malaria vector *Anopheles gambiae s.l.* Giles (Diptera: Culicidae)'.

Development of innovative application strategies of novel, persistent mosquito insecticides: Difficulty to expose gravid malaria vectors to pyriproxyfen under semi-field conditions necessitates rethinking of auto-dissemination approaches. This work has been published (Mbare et al., 2013, *Malaria Journal*.

Understanding circulation and maintenance of arboviruses that contribute to human, wildlife and livestock disease in East Africa: Over 70 arbovirus strains (including those of public health importance) were detected and isolated from ticks and mosquitoes, indicating active transmission to human and animal populations. One paper was published (by Lwande et al. in *Vector-Borne and Zoonotic Diseases*). Additional funding after locating an improved network of partners to undertake further studies with *icipe* was obtained to undertake further studies in Rift Valley fever endemic region and on preventing and controlling eco-health.

Contributing to an improved Rift Valley fever (RVF) forecasting and response: Improved trapping of RVF vectors using specific lures was developed by the chemical ecology team, and one more paper published (by Tchouassi et al in *PLoS Neglected Tropical Diseases*). Additional funding was obtained to conduct studies on utilisation of the trapping system for surveillance and monitoring of RVF vectors through community participation, to start in 2014.

***icipe* researcher featured on GEF's Film *"Mission – Planet De-Tox"*:** On 8 May 2013 at the Extraordinary Conference of the Parties (EXCOP) meeting, in Geneva, the Global Environment Facility (GEF) premiered a documentary film titled *Mission - Planet De-Tox*, now available for free around the world, focusing on GEF-funded projects that address toxic chemical pollution on three continents – Africa, Asia and South America.

An audience of several hundred delegates, observers, and guests watched the GEF film during the Meeting. The documentary depicts the amazing people working hard to rid the planet of the chemicals that threaten human health and the environment. It captures the images and voices of the beneficiaries and project teams involved in some of the 300 projects GEF has funded all over the world. The film has an important section on integrated vector management (IVM) activities undertaken by *icipe* that was narrated by *icipe* scientist Dr Clifford Mutero. Dr Mutero showcased a GEF/ UNEP/ WHO-AFRO project in the rice irrigation scheme in Mwea, Kenya where more than 3000 families live adjacent to the rice paddies. The rice paddies are submerged for at least six months of the year, providing an ideal habitat for mosquito breeding, resulting in reoccurring malaria outbreaks. Conventional control efforts have been unsuccessful. In the past, dichloro-diphenyl-trichloroethane (DDT), a colourless, crystalline, tasteless and almost odorless organochloride known for its insecticidal properties, worked well to kill the vectors but because of the risks DDT poses to human health and the environment, as well as widespread DDT resistance in mosquito populations, *icipe* is advocating and implementing IVM because it provides long-term, cost-effective and healthier solutions.

For more information: http://www.icipe.org/index.php/news/720-icipe-researcher-featured-on-gefs-planet-detox.html and http://www.thegef.org/gef/greenline/april13/kenya-1.html

***icipe* signs MoU with a Malindi community-driven organisation - Punguza Mbu Malindi (PUMMA):** Punguza Mbu Malindi (PUMMA), Swahili for "Reduce Mosquitoes in Malindi" signed a memorandum of understanding (MoU) with the *icipe*–KEMRI Malaria Project in mid-2013, which is aimed at fostering self-sufficiency and sustainability in malaria control.

"There can be no effective answer to the malaria problem without control of mosquito breeding sites and any efforts should be homemade and community-driven. Controlling mosquito breeding areas using simple, environmentally friendly methods has been a success in Malindi town", explained *icipe*/KEMRI scientist Dr Charles Mbogo. For effective implementation of integrated vector management methods, community participation is important. In Malindi PUMMA is using simple yet effective vector control methods in tackling the mosquitoes. Mosquito larvae are eliminated by simply spreading sawdust from local neem trees on stagnant water in pools and puddles. "This

method is not only simple, but is also cheap and effective in controlling mosquito larvae and does not harm the environment," explains Dr Mbogo.

More information contained in Results Based Management Tables presented in Section 5B(ii)

4. Environmental Health:

The following achievements were accomplished in *icipe*'s Environmental Health Research.

Control of the aquatic plant pest, *Hydrilla verticillata*, in East Africa by wild *Polypedilum* (Chironomidae) midge species highlights the utility of *Polypedilum* to control *Hydrilla*: Six (6) non-target plants were identified, and *Polypedilum* species reared from *Hydrilla* and other aquatic plants. *Polypedilum* species proved refractory to colonisation in large indoor and outdoor cages. One paper was published.

Taxonomic information of major African insect pests and vectors was provided to the end users using the DNA-barcode library: Over 7000 specimens were submitted to International Barcode of Life Project (Guelph) for barcoding. First paper published assigning DNA barcodes with microlepidopteran pests of fruits.

Bioprospecting projects. Three (3) eco-friendly, nature-based products with potential for disease vector control for improvement of livelihoods of rural and wider community members use were formulated and found effective under semi-field conditions. The farming community members (approx. 1100 households) in Kenya and Tanzania have adopted the domestication, cultivation, processing and packaging methods for one repellent plant (*Ocimum kilimandscharicum*). At least 1400 mosquito repellent products were produced through the private sector. Four (4) MSc and two (2) PhD scholars were trained. Five papers have been published (Mokua et al., 2013, *Acta Tropica;* Samita et al., 2013, *Beilstein Journal of Organic Chemistry*).

GIS Unit: Geo-spatial data were made available to *icipe* scientists through setting of geospatial data server. Two new datasets were produced and are available. More than 50 participants from various backgrounds trained in GIS, remote sensing and modelling. One paper was published. A conference presentation on spatial assessment of stemborers in maize was given at AfricaGIS 2013 in Addis Ababa. The method was taught in a species-diversity modelling workshop.

Commercial Insects Programme: Six (6) potential and healthy wild and 5 mulberry silk races, and 7 stingless and 4 carpenter bee races were identified for enterprise development in Africa. Healthy silk and bee races were distributed to 2000 trainers for the farmer groups in 12 African countries. Four (4) PhD and two (2) MSc students were trained. Four (4) peer reviewed papers

and 1 proceeding book were published. Eight hundred (800) farmers were trained in apiculture and sericulture in 7 African countries. Five (5) business models were developed and owned by the community in Ethiopia, The Sudan, Kenya, Yemen and South Sudan. Business responsibility was adopted by at least 40 farmer groups. Five (5) new marketplaces were established in Ethiopia, The Sudan, Kenya and South Sudan for honey and silk harvesting, processing and selling. Stingless and honey bee hives (3000) were supplied to farmers in Ethiopia, The Sudan, Kenya, Yemen, Uganda and South Sudan. Seven (7) rearing houses (silkmoth) were established and are operational in Kenya, Uganda, The Sudan and Ethiopia. Internal control wystem (ICS) training was undertaken for 1100 trainers in Kenya and Ethiopia. Three papers have been published (Kiatoko, *et. al.,* 2013, *Entomological Science*; Kebede *et al.,* 2013, *International Journal of Tropical Insect Science*; Cock *et al.,* 2013, *CAB Reviews*).

Development of innovative strategies to reduce populations of honeybee pests and diseases for food security through pollination services and better bee health in Africa under the European Union-funded project (Commercial Insects Programme): Surveillance of bee pests and diseases in 5 geographical zones in Kenya was completed. The major pests identified were hive beetles and varroa mites. Establishment of a Reference lab and 4 Satellite stations was initiated. Two major trainings covering 15 African countries were held in Uganda, Somaliland, Congo, Tanzania, Ethiopia, Sudan, Cameroon, Ghana, Sudan, Kenya, Egypt, Burkina Faso, Liberia, Madagascar and Yemen. Collection of wild plants and bioassay development for biopesticides were initiated.

Contribution to critical manual for honeybee research by *icipe* Scientists:
icipe scientists Drs Baldwyn Torto and Ayuka Fombong are among bee specialists who have contributed to the COLOSS BEEBOOK, a unique and innovative practical manual that will, for the first time, provide standardised methodologies for researchers studying the honeybee, *Apis mellifera*. COLOSS, which stands for *C*olony *Loss*es, is a global network of bee research scientists working together to share information on the decline of bees and how to reverse the situation.

The COLOSS BEEBOOK manual has been published online in the *Journal of Apicultural Research* and is available at: http://www.ibra.org.uk/articles/The-COLOSS-BEEBOOK, and as a hard copy book for use at the laboratory bench, available at: http://ibrastore.org.uk/index.php?main_page=advanced_search_result&search_in_description=1&keyword=beebook.

The COLOSS BEEBOOK compiles standard methods in all fields of research on the honeybee, and will become the definitive, yet evolving, research manual. The book chapter by Dr Torto and Dr Fombong, which is co-authored with colleagues from the USA, Italy and Israel, provides guidelines on standard methods for chemical ecology research on the honeybee.

***icipe* awarded two Grants by The European Union to implement "The management of pollinator bee diseases and pests for food security in Africa" as well "Sustainable peri-urban milk value chain development in Somaliland":** Bee Health Management in Africa — The joint € 12.3 *icipe* and African Union's Inter-African Bureau for Animal Resources (AU-IBAR) initiative — was

launched in June 2013. The regional initiative aims at establishing an African reference laboratory and 4 satellite stations in Senegal, Burkina Faso, Cameroon and Ethiopia for the management of diseases and pests of bees for food security. It involves strategic partnership and networking in bee health and pollination services in Africa, with the 4 satellite stations and a central reference laboratory at *icipe*'s HQs in Nairobi. Strong partnerships have been established with farmers' federations, regional economic commissions (RECs) and sub-regional organisations (SROs); institutional capacity of target institutions and organisations will be reinforced; and research linked to honey value chain/pollination services established. The purpose of the bee health programme is to improve bee products and pollination services through control of bee diseases and pests, and enhanced markets access. In recent years, the serious decline of honeybee populations, commonly referred to as the colony collapse disorder (CCD), has alarmed governments, conservationists and the private sector for its serious impact on biodiversity and forest cover, nutritional aspects, agricultural practices and incomes especially for the poorest population. Yet the impact and potential effects of the CCD in Africa are poorly understood. This project will substantially contribute to the sustainable conservation of honeybees for the benefit of millions of rural resource-poor farmers on the continent.

For more information: EU – *icipe* Bee health signing ceremony Press Release: http://eeas.europa.eu/delegations/kenya/documents/press_corner/20130610_1.pdf

On-line media article: *icipe* – EU sign KSh 1.4b deal to boost bee farming: http://www.standardmedia.co.ke/?articleID=2000085747&story_title=international-centre-of-insect-physiology-and-ecology-european-union-sign-sh1-4b-deal-to-boost-bee-farming&pageNo=1

***icipe* Bee health Project funded by the European Union (EU) Gaining International Recognition:** An article (http://www.icipe.org/images/stories/icipe/news_and_events/2013/Bee-article-in-newspaper_pdf.pdf) published by the *International New York Times* (26 – 27 October 2013) unreservedly recognises the *icipe*/African Union - InterAfrican Bureau for Animal Resources (AU-IBAR) EU funded Bee Health project as a critical component of the global effort to protect bee colonies.

Titled 'Bee Survival in Europe', the article observes that the funding of the African bee health project, whose aim is to enhance food security and protect biodiversity in Africa, is in line with other efforts the EU has instituted to mitigate the threats that affect bee populations.

Milk value chain development in Somaliland: A € 4.4 million milk value chain programme developed by *icipe* together with FAO and the Sheik Training Veterinary School (STVS) in Hargeisa was approved in June 2013 by the EU – Somalia Delegation. The initiative aims at enhancing the performance of the milk value chain, with an aim to contribute to promoting resilience and reduced food insecurity in Somaliland.

Contact signalling in beetles: Researchers from *icipe* and partners at the United States Department of Agriculture/Agricultural Research Service (USDA/ARS), Gainesville, Florida, have identified

critical chemical signals in an African beetle that invades beehives in the East African region, which enable the pest to circumvent the barriers imposed by honeybees to prevent communication among the beetle nest invaders.

The study, which was published as the cover article of the December 2012 issue of the *Journal of Chemical Ecology*, provides evidence that the beetle, which is known as the large hive beetle, or by its scientific name, *Oplostomus haroldi*, utilises a contact pheromone, rather than a volatile one, for mating.

"We identified contact cues on the bodies of the female beetles, which are perceived by the males through sensory cells on the palps of their mouth. In effect, all a male has to do is lick the body of another beetle to discern its sex within seconds," explained *icipe* scientist, Dr Baldwyn Torto.

The contact cues place the beetle in an advantageous position, as they reduce the amount of energy it uses to dispense and perceive a volatile cue in the crowded and smelly hive environment. They also enable the beetle to easily find mating partners in this challenging environment.

"Our findings represent the first evidence of the existence of contact signalling in this family of beetles. They also suggest the evolution of contact signalling as a survival strategy among nest invaders of social insects. Further, this implies the divergence of smell and taste functions to different body organs, culminating in precise and fast processing of communication signals in insects, which can be exploited for control of the ones which are pests such as the large hive beetle," Dr Torto further noted.

***icipe*-led study selected by *PLoS* among most influential on "The Ecological Impacts of Climate Change":** An article by scientists from *icipe*, in collaboration with colleagues from the UK and USA, has been selected as one of the 16 most influential and prescient, published so far by *PLoS ONE* or *PLoS Biology* on the subject of "The Ecological Impacts of Climate Change".

Titled 'Some Like It Hot: The Influence and Implications of Climate Change on Coffee Berry Borer (*Hypothenemus hampei*) and Coffee Production in East Africa', the publication has now been curated under a new PLoS Collection, formally launched on Monday, August 5th, 2013 and now available at http://www.ploscollections.org/.

In the publication, the *icipe*-led team observes that just two years after predicting the likely impacts of climate change on coffee and the coffee berry borer (*Hypothenemus hampei*), what they considered a worst-case scenario is already occurring.

icipe Principal Investigator (PI) and main author of the study Dr Juliana Jaramillo explains: "In 2009, we found that climate change would make coffee production more difficult and unpredictable, resulting in alternating periods of over- and underproduction. In particular, our studies estimated serious consequences in areas where the high quality *Coffea arabica* is produced. Our model forecasted that a 1–2°C increase could lead to an increased number of generations, dispersion and damage by the coffee berry borer. We also observed that a rise in temperature of 2°C and above could lead to shifts in altitudinal and latitudinal distribution of the pest," she explains.

More information: http://www.icipe.org/index.php/news/739-icipe-led-study-selected-by-plos-among-most-influential-on-qthe-ecological-impacts-of-climate-changeq.html"

***icipe* research makes key breakthrough in decoding the chemical signals that attract the coffee berry borer:** A study by researchers from *icipe* in collaboration with colleagues from Germany has made a significant contribution towards decoding the chemical signals that attract the coffee berry borer, *Hypothenemus hampei*, the most important pest of coffee worldwide. In a paper published in the *PLoS ONE* journal on 20 September 2013, the scientists have, for the first time, revealed the chemical signals released by coffee berries that attract the pest, enabling it to locate and colonise them. The findings further show that the coffee berry borer also responds to signals, and is in effect repelled, from other plants that it does not use as hosts.

Based on this knowledge, the *icipe* study proposes a management strategy for the coffee berry borer based on a 'push–pull' tactic. The researchers suggest that, instead of the current practice of monocultures, coffee could be intercropped with plants that produce chemicals that are repellent to the pest, in a manner similar to the way that the crop naturally grows in the forests of Africa. More information on: http://www.icipe.org/index.php/news/751-icipe-research-makes-key-breakthrough-in-decoding-the-chemical-signals-that-attract-the-coffee-berry-borer-.html

More information contained in Results Based Management Tables presented in Section 5C

5. Capacity Building:

icipe's capacity building approach has been to acclimatise researchers such that they can function and perform within the African context, yet remain competitive within the global research and development marketplace. *icipe*'s capacity building effort has always been intricately in-built into its research and development programmes. These span the whole continuum, from basic strategic research to technology development and validation, and ultimately community-based adaptation. The Centre continues to make significant impact in key areas in capacity and institutional building activities.

High-level manpower training at postgraduate level for leadership in scientific research and policy formulation: In 2013, the programme offered support to a total of fifteen (15) post-doctoral level researchers at icipe for research activities within the Centre's various programmes.

In addition, fourteen (14) new PhD scholars enrolled for research studies and 30 MSc scholars (of whom 13 were women), were offered short-term internships at *icipe*. Seven (7) of the new PhD scholars were offered 3-year full-time research fellowships under The African Regional Postgraduate Programme in Insect Science (ARPPIS) programme, after a merit-based selection process. The other PhD scholars are project-supported and are attached for different time periods, from 3 months to 3 years, depending on their specific training requirements. In furtherance, training support continued for 28 full-time ARPPIS PhD scholars at different stages of their ongoing research studies.

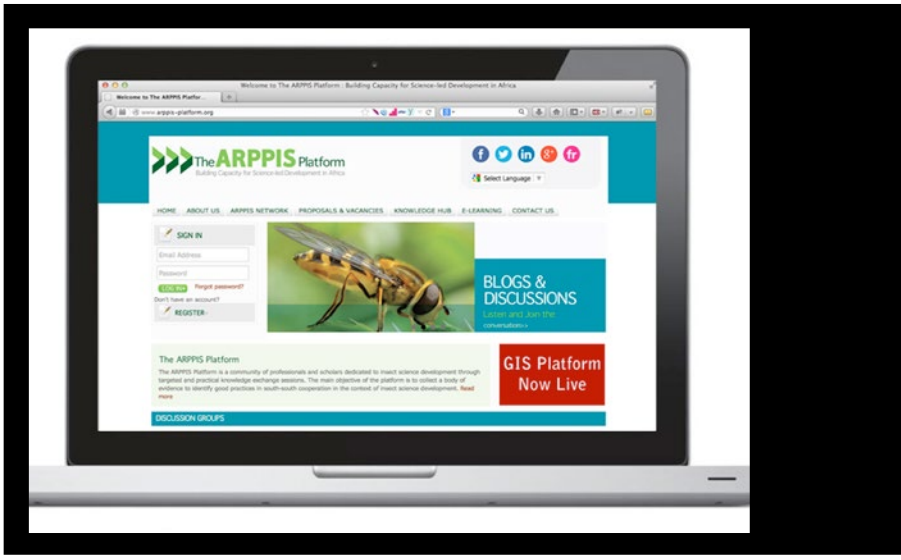
The capacity building programme also offered 45 interns short-term training attachments as part of their ongoing undergraduate and technical training programmes. These students proceeded with studies at respective universities and technical colleges after completion of their attachment studies at *icipe*.

Dissemination of technologies to national agricultural and health research and extension systems through group training courses: As part of efforts towards increasing the number of high quality researchers and middle level practitioners, various group-training courses were undertaken. Training courses are organised by *icipe* (within and between the plant, animal, environmental and human health divisions) and/or participation of *icipe* staff in training courses organised by other institutions.

During the reporting period, *icipe* scholars and scientists published a total of 99 peer-reviewed publications (See the 13 April 2013 – 31 March 2014 Publication List in the Annex).

Institutional development by nurturing and strengthening of African organisations and institutions: The ARPPIS alumni online platform (www.arppis-platform.org) continued to receive support in 2013. The platform has the potential to effectively contribute to building strong partnerships and linkages and by facilitating collaborative partnerships between *icipe*, partner universities and affiliated institutions where ARPPIS alumni presently work. It will develop two directories, the first being restricted to alumni only, consisting of pages created by individual members. The second directory will be open to the general public. The platform represents a knowledge hub driven by ARPPIS alumni, in essence a one-stop shop of the 4H thematic areas of *icipe*. Partner links will be added to organisations such as the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), The World Academy of Sciences (TWAS), Forum for Agricultural Research in Africa (FARA) and The Regional Universities Forum for Capacity Building in Agriculture (RUFORUM).

All *icipe* research programmes implemented various training activities in the project sites and also distributed information, and educational and communication printed materials. For wider dissemination, information materials on specific research activities were also translated in respective languages as per the countries/locations where the concerned project is implemented. For instance, a tomato leafminer brochure was translated into five (5) languages—Swahili, French, Amharic, Afaan-Oromo and Somali.



More information contained in Results Based Management Tables presented in Section 5D

icipe Seed Grants Initiative on Innovative Project Ideas for Core Funding Operationalised

During the 2012 *icipe* Annual Budget meeting, it was resolved that *icipe* should set up an internal Competitive Fund (Seed Grants) for innovative project ideas, which would be issued in grants of US$ 25,000 – 50,000 each, for a year maximum. It was agreed that this would be a revolving fund and finances would be budgeted annually for this Call. This process was initiated in September 2013. *icipe* Management invited applications from its scientists for innovative project ideas for core funding consideration. The process that was followed in evaluating and allocating the funds was as per the new *icipe* Policy on core Funded Projects available on the *icipe* intranet at the following link:
http://intranet.icipe.org:8000/intranet/images/stories/f_and_a/finance/documents/core_funded_projects_policy.pdf.

Twenty-one (21) applications were received by the *icipe* Review Panel that evaluated and scored them based on their relevance, innovativeness and scientific merit. The top five applications were selected and funded in the first phase for the period October 2013 to September 2014. This initiative targets to generate relevant data that will be used by the Centre scientists to competitively respond and apply for external calls and grants.

SECTION 4: CENTRE-WIDE INSTITUTIONAL 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 exceptional support and contribution from *icipe* donors and strategic collaborations with our partners is significant to the Centre'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

***icipe* Stockholm Convention Regional Centre on Persistent Organic Pollutants awarded a "special mention certificate" in EXCOP 2013 Meeting**

As the Regional Centre for Africa for the Stockholm Convention on Persistent Organic Pollutants (POPs) (which is hosted by UNEP), *icipe* participated in the ordinary and extraordinary meetings of the Conferences of the Parties to the Basel, Rotterdam and Stockholm Conventions in April/May, 2013 in Geneva, Switzerland.

Stockholm Convention on POPs currently regulates 23 toxic substances that are persistent, travel long distances, bio-accumulate in organisms and are toxic. Thirteen (13) of these are pesticides, an important reason why *icipe* became a Stockholm Convention Regional Centre in 2011.

A Regional Fair, termed 'Synergies through regional delivery', was also held from 1 to 3 May 2013 to exhibit the work of the Regional Centres located in Africa, Asia and the Pacific, Western Europe, Latin America and the Caribbean, and Central and Eastern Europe. *icipe*'s booth was awarded a "special mention certificate" in recognition of its set-up and design.

2. Solar energy holds vital key to sustainable exploitation of Aloe species: *icipe* study

A study led by researchers from icipe and its partners has demonstrated the superiority of solar concentrating technology in comparison to other conventional methods, in the processing of *Aloe secundiflora*.

According to *icipe* scientist Dr Wilber Lwande, the findings of the research, which was funded by the Critical Ecosystem Partnership Fund (CEPF) and the Swiss-based Biovision Foundation, present a major breakthrough towards unlocking the full commercial potential of *A. secundiflora*, a succulent perennial herb that is one of about 450 species of the genus *Aloe*.

"The *A. secundiflora* species, which is found in the arid and semi-arid regions in Kenya, southern Ethiopia, Rwanda and Tanzania, is a significant source of livelihood for marginalised communities. Indeed, based on its potential in that regard, various programmes have been initiated by a variety of organisations to promote the cultivation and processing of *A. secundiflora*. For instance, in Kenya, the Kenya Wildlife Service (KWS), has established regulations and developed a long term strategy for the sustainable exploitation of *Aloe* species," explains Dr. Lwande.

He, however, observes that the unsustainable and environmentally destructive methods currently used in the processing of *A. secundiflora* pose a major drawback in its exploitation.

The main source of the commercial value of *A. secundiflora*, Dr Lwande explains, is a yellow bitter sap paste, which is used in the manufacture of pharmaceutical and cosmetic products and in alcoholic beverages. Local communities cut the leaves of the plant at the base and drain the sap, which they then sell to dealers who process it into a rock-hard dark green paste, primarily for export.

"The sap from the leaves of *A. secundiflora* has a high percentage of water, which has to be removed to form a stable paste. Local dealers process the sap into paste by heating it in drums mounted on traditional three-stone fuelwood cooking stoves. The *icipe*-led study found that this processing method utilises approximately 4.1 tonnes (4100 kilogrammes) of fuelwood to process one tonne of paste," notes Dr Lwande.

Given that about 11 tonnes of *A. secundiflora* paste is produced annually in Kenya, its processing therefore consumes an estimated 45 tonnes of fuelwood, which is sourced from the meager vegetation resources in the semi-arid areas. Such large quantities of fuelwood not only contribute to deforestation and loss of biodiversity but also to carbon dioxide greenhouse gas emissions, whose long term effects include environmental and land degradation and climate change respectively, observes Dr Lwande.

However, the *icipe*-led researchers found that the required temperature range of 90 to 100 °C is easily attainable using solar cookers, utilising solar energy that is free and abundant, especially in the arid and semi-arid areas of Africa where *A. secundiflora* grows, Dr Lwande further explains.

The researchers also established that the paste obtained from *A. secundiflora* sap using solar concentrating technology was more stable and of higher quality and value. For instance, the paste had a higher content of Aloin A, compared to that produced using either electricity or fuelwood. Aloin A (or Barbaloin) is an anthraquinone glycoside, a bitter, yellow-brown coloured compound found in the exudates of *Aloe* species. The compound is used as a stimulant laxative in treating constipation and as

a bittering agent in commercial alcoholic beverages. Aloin content is generally used as a standard measure of the quality of *Aloe* extracts.

"The variations in Aloin content in *A. secundiflora* paste produced using solar, electricity and fuelwood energy could be attributed to possible changes in thermo-chemical reactions in the sap. For instance, the use of fuelwood could result in overheating, while solar energy provides a more gentle heating process. We also found solar energy to be more efficient in reducing the water content of *A. secundiflora* leaf sap as compared to electricity and fuelwood energy, thereby providing a more stable paste," explains *icipe* scientist, Dr Wilber Lwande.

"Based on the results of the study, we conclude that solar concentration technology is an attractive alternative to using fuelwood to process *A. secundiflora* leaf sap into paste. In the long term, the use of solar energy as a substitute for fuelwood energy would contribute to reduced deforestation, environmental degradation, global warming and climate change. It would also improve biodiversity conservation and reduce the burden on women and children associated with collecting and transporting fuelwood," concludes Dr Lwande.

3. *icipe* presents and showcases its research and development activities in conferences and meetings

The 2nd Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) General Assembly and Scientific Conference in Bujumbura, Burundi

The 2nd ASARECA General Assembly and Scientific Conference themed "Transforming Agriculture for Economic Growth in Eastern and Central Africa" took place in Bujumbura, Burundi from 8th – 14th December 2013. The event attracted over 450 participants including several Ministers of Agriculture and representatives from the eleven (11) ASARECA participating countries, sub-regional organisations (SROs), international agricultural research centres (IARCs), NGOs, national programs, universities and the private sector. The weeklong Conference included an exhibition arena that hosted various national, international, and private sector organisations. *icipe* exhibited its research and development products and also gave a presentation.

icipe's Director General, Dr Segenet Kelemu gave a presentation entitled "Contribution of *icipe* in agricultural transformation". The presentation highlighted the Centre's research and innovations and received great interest from the audience. Quite a number of the ASARECA delegates visited the *icipe* booth, among them, the Ministers of Agriculture from Rwanda, Eritrea, and South Sudan and were all impressed with the Centre's research and innovation products.

The 2nd FARA General Assembly and 6th Science Week in Accra, Ghana

icipe was among the 1300 delegates from a varied background of participants including ministers, parliamentarians, scientific researchers, farmers, extension practitioners, and civil society partners with strong presence of the CGIAR and development partners who attended the 2nd Forum for Agricultural Research in Africa (FARA) General Assembly and the 6th Africa Agriculture Science Week (AASW), hosted by FARA, in collaboration with the Government of Ghana on 15th – 20th July 2013.

Through side-events, exhibitions and plenary sessions the Week focused on the theme of "Africa Feeding Africa through Agricultural Science and Innovation" and examined the sub-themes of education and human resource development, innovations to improve productivity and resilience, moving from competition to collaboration and innovative financing and investment in agriculture.

Under subtheme 1 – Education and human resource development and subtheme 2 – Innovations to improve productivity and resilience, *icipe*'s side-events entitled "Building capacity for insect science development in Africa" and "Science innovation for better livelihoods", respectively, were well attended and attracted media attention: "Push meets pull in agricultural innovation" http://aasw6.wordpress.com/2013/07/19/push-meets-pull-in-agricultural-innovation/; "Kill the killer fly" on http://aasw6.wordpress.com/2013/07/18/kill-the-killer-fly/; "A plate of worms, please!" on http://aasw6.wordpress.com/2013/07/17/a-plate-of-worms-please/; and "When push comes to shove in pest management" on http://aasw6.wordpress.com/2013/07/17/when-push-comes-to-shove-in-pest-management/.

The 2nd National Science, Technology and Innovation (ST&I) week

icipe participated and showcased its R&D initiatives during the 2nd National Science, Technology and Innovation (ST&I) Week, organised by the Ministry of Higher Education, Science and Technology (MOHEST) and the National Council for Science and Technology (NCST) from 13th – 17th May 2013. The Conference was convened as a platform to publicise Kenya's achievements and breakthroughs in ST&I, create awareness and promote science, technology and innovation and its accomplishments, and to enhance the communal understanding on the benefits and consequences of scientific inventions and innovations. *icipe* was invited to give a keynote address and participate in the weeklong exhibition.

icipe's talk entitled "Insect Science Matters for Innovation and Development" delved into the role *icipe* plays in insect science to safeguard the livestock and horticulture industries, human and environmental health sector, and capacity building.

The *icipe* exhibition booth was particularly popular with farmers and scholars who wanted to know more about the Centre's research and capacity building activities. The tsetse repellent collar and commercial insects and bioprospecting products on display attracted many participants to the stand.

4. Private Sector–*icipe* Involvement

***icipe*'s fungal isolates developed as biopesticides**

icipe has been developing innovative technologies based on the use of naturally-occurring microbes (fungi, bacteria, viruses) as biological control agents. These new biopesticides are host-specific, so they do not have negative effects on other organisms. In comparison with chemical pesticides which increase greenhouse gas emissions, they can help preserve biodiversity, thus promoting environmental resilience. They are compatible with other components of integrated pest management and can be produced locally using low-input technology.

icipe has formed a unique public-private partnership with a local Kenya-based business, Real IPM Ltd. This partnership has resulted in three biopesticide products that have been registered and are being commercialized in Africa where they are making significant impact. *Metarhizium anisopliae* ICIPE 69 is registered in Ghana where it is marketed as Campaign® for the control of mealybugs in papaya. In Kenya and Ethiopia ICIPE 69 is marketed as Real *Metarhizium* for the control of mealybugs in roses. ICIPE 69 is also effective against fruit flies, thrips, whiteflies, caterpillars, beetles and weevils. It is already registered in South Africa against fruit flies and mealybugs. Registrations are in progress for ICIPE 69 in Tanzania and Mozambique. ICIPE 78 is marketed as Achieve™ in Kenya, Ethiopia and South Africa. *Metarhizium anisopliae* ICIPE 62 has obtained provisional registration in Kenya for the control of aphids. These isolates are effective against target pests without being harmful to non-target organisms including beneficials.

These biopesticides are helping farmers to respond to pest problems, which can devastate horticultural production. Over 20,000 growers are already benefitting from their applications on important food crops in Africa. For more information see: http://www.icipe.org/index.php/news/700-status-of-icipes-fungal-isolates-developed-as-biopesticides.html and www.realipm.com

***icipe* flagship programmes (Push–Pull Technology, Fruit Fly Management and Control as well as Commercial Insects Programme) featured on TV**

In 2013, in collaboration with Mediae Company several *icipe* technologies were featured on "*Shamba Shape Up*" (http://www.shambashapeup.com/), a highly popular reality TV series in Kenya and other African countries through digital satellite TV stations. Programmes featured included fruit fly, commercial insects and push–pull technologies: http://www.shambashapeup.com/search?q=push+pull

5. Research infrastructure

icipe is taking a leadership role towards securing bee colonies in Africa, through a European Union funded Central Reference Laboratory (CRL), for research and capacity building on bee health, which is under construction at *icipe*'s headquarters in Kasarani, Nairobi, and four bee health satellite stations in Burkina Faso, Cameroon, Ethiopia and Liberia. With the generous support and contribution from the European Union, the construction of a central reference laboratory (CRL) for bee diseases and pests in Africa started mid-2013.

The CRL is informed by and built on *icipe*'s experience with earlier beekeeping initiatives conducted in East, West, North, South and Central Africa with farmers' associations. These initiatives aimed at strengthening and modernising research and development in African beekeeping, offering an opportunity for income diversification for rural resource-poor farmers, while stimulating positive natural resource management that maintains the integrity of ecosystems. Africa continues to lose its natural resources due to increasing human population pressure, agricultural expansion, climate change, landscape degradation and urbanisation. This, together with poor management of natural resources and the lack of appropriate or harmonised policies, has led to irreversible loss of pollinators' biodiversity.

The CRL research and training centre in Kenya, hosted by *icipe* will serve as a reference laboratory for training of scientists from various parts of the continent and as a hub for novel research and biotechnology in honeybee and other pollinators' diseases. It will also be a centre of excellence for bee health research in Africa.

6. *icipe* hosts The First International Conference on Pesticidal Plants

The First International Conference on Pesticidal Plants (1st ICPP) was hosted by *icipe* on 21st–24th January 2013. The theme of the three-day conference was "Harnessing Pesticidal Plant Technologies for Improved Livelihoods". The conference was organised jointly by Egerton University Kenya, African Academy of Sciences (AAS), TWAS-ROSSA (Academy of Sciences for the Developing World - Regional Office for sub-Saharan Africa) and African Dryland Alliance for Pesticidal Plant Technologies (ADAPPT) network.

ADAPPT, a network for optimising and promoting the use of pesticidal plants for food security and poverty alleviation in Africa, with funding from the European Commission EuropeAid ACP S&T Programme, involving the Natural Resources Institute (UK) as the lead partner institution and partners from 7 African countries (Ghana, Kenya, Malawi, South Africa, Tanzania, Zambia and Zimbabwe), has as its overall objective, to strengthen scientific and technological capacity of African nations to exploit and promote pesticidal plants for agricultural development and poverty alleviation.

A prearranged output from ADAPPT was the convening of this scientific conference to help improve networking and build scientific expertise. The ADAPPT partners had unanimously voted to hold the 1st ICPP scientific conference in Kenya. Egerton University's involvement in ADAPPT as a leader of dissemination activities made it a natural primary host institution for the conference, with Egerton convening a national organising committee (NOC) that identified *icipe* as the perfect place to host the ICPP because of its location, excellent facilities and long history of research on pesticidal plants and chemical ecology.

ICPP attracted 108 talks, 30 posters and 10 displays, with delegates arriving from more than 25 countries, representing researchers, scholars, traditional herbalists, farmer organisations, NGOs/CBOs, industry and suppliers (scientific and general).

7. Prizes: *icipe* Staff and Projects

Two *icipe* Scientists appointed African Academy of Science (AAS) Fellows

In November 2013, *icipe*'s Director General, Dr. Segenet Kelemu, and Dr. Baldwyn Torto, Head of the Behavioural and Chemical Ecology Department were appointed Fellows of the AAS, the continent's premier honorific society, whose primary aim is to honour internationally renowned African scientists. This now brings the number of *icipe* scientists in the AAS Fellowship to a total of four, including previously elected Fellows, the immediate former Director General of *icipe*, Prof. Christian Borgemeister, and Prof. Zeyaur Khan, the Centre's leader of the push–pull programme.

■ Dr Segenet Kelemu ■ Dr Baldwyn Torto

Celebrating *icipe* Director General, Dr. Segenet Kelemu on Ada Lovelace Day

On 15th October 2013, *icipe*'s then incoming Director General, Dr Segenet Kelemu, was among the scientists celebrated globally on Ada Lovelace Day. Commemorated every 15th October, the purpose of this occasion is to raise the profiles of women scientists by sharing their inspirational stories, in order to create new role models for girls and women in male-dominated fields. Dr Kelemu's remarkable story was highlighted by UK-based *Green Ink*, one of the world leaders in communicating science for sustainable development in natural resources and related fields (http://www.greenink.co.uk/blog/celebrating-dr-segenet-kelemu-ada-lovelace-day).

Prof. Zeyaur Khan Elected a World Academy of Sciences (TWAS) Fellow

At the 24th General Meeting of the TWAS held in Buenos Aires, Argentina on 1st October 2013, the members attending elected Prof. Zeyaur Khan as a Fellow of TWAS, The World Academy of Sciences for the advancement of science in developing countries. This award was in recognition of Prof. Khan's outstanding contribution to science and its promotion in the developing world. For more information - http://www.push-pull.net/decades-of-dedication.shtml

Former *icipe* Director General, Dr Hans R. Herren wins the 2013 Right Livelihood Award

Dr Hans R. Herren, a former Director General of *icipe* and one of the world's leading experts on sustainable agriculture, received the Right Livelihood Award, which honours "outstanding vision and work on behalf of the planet and its people". The jury of the Award, which is also known as the alternative Nobel Prize, said the decision to award Dr Herren is based on "his expertise and pioneering work in promoting safe, secure and sustainable global food supply".

As the Chief Executive Officer of *icipe* from 1994 to 2005, Dr Herren conceptualised *icipe*'s 4Hs paradigm, which places emphasis on a holistic and integrated approach across human, animal, plant and environmental health, as the framework for the Centre's research and training programmes, towards facilitating sustainable development for farmers and rural communities in general.

Receiving the Award, Dr Herren stated: "I see this recognition as an important endorsement of my vision of a world which can provide all 9 billion people expected to live on our planet in 2050 with sufficient healthy food. This has to happen without overstepping planetary boundaries. This will only be possible if we invest in smallholder structures with sustainable and efficient ecological cultivation methods and move away from the paradigm of industrial agriculture, which overuses natural resources and destroys biodiversity."

More information: http://www.icipe.org/index.php/news/752-former-icipe-director-general-dr-hans-r-herren-wins-the-right-livelihood-award.html

8. New Strategic Alliances and External Relations

***icipe* signs Memorandum of Understanding with Gollis University to Facilitate Capacity Building**

Gollis University (GU) and *icipe* signed a Memorandum of Understanding on 29th November 2013.

Gollis University, an institute of higher education in Hargesia, the capital of the northwestern Somaliland region of Somalia, is committed to excellence in education in addition to fostering an environment that enables students to assume roles of responsibility and leadership. This cooperation will serve a rapidly growing population of younger generations and learners in Somaliland who desire to complete their degrees through innovative and relevant programmes designed to address the needs of a developing country. The two institutions have mutually agreed to collaborate in scientific research, cultural and knowledge exchange, capacity and institutional development.

***icipe* formalises collaboration with the Partnership for Economic Policy, Inc**.

In September 2013, *icipe* formalised its collaboration and hosting of the Partnership for Economic Policy (PEP), a non-profit international organisation supporting evidence-based economic policy analysis, engagement and capacity development in Africa and other developing regions. This partnership will facilitate collaboration to advance agriculture sector performance, rural incomes and food security through better and pro-poor technologies and policy and institutional innovations. The two institutions will cooperate in the conduct and promotion of mutual scientific research and development, and capacity and institutional building in areas of agriculture, nutrition, health, gender, livelihood assets, population and livelihood security, natural resources and sustainable development. PEP operates as an international network of institutions, researchers and experts in economic and development policy analysis to build and to promote the capacity of local researchers in developing countries.

***icipe* and Send A Cow, UK enter into Partnership**

In an effort to promote scientific research that is geared towards alleviating poverty amongst the subsistence farming rural community through transfer of technology to improve farming techniques, *icipe* and Send a Cow (SAC), an international charity based in UK signed an MoU in September 2013. In particular, the two organisations mutually agreed to work together to disseminate appropriate research developed by *icipe* to farmers within SAC's African programmes, review the effectiveness of farmers practical application of this research and impact on their livelihoods, collaborate on improving research effectiveness when applied practically in an everyday farming environment, and jointly explore concepts for other research projects for *icipe* research that would have benefit for SAC farmers.

The Associates for International Management Services (AIMS) evaluates *icipe* on behalf of Sida

icipe participated in an online survey administered by the Associates for International Management Services (AIMS) on behalf of Sida. Further, an AIMS team visited and reviewed the result of Sida's Research Support to *icipe* on 11 July 2013. The purpose of the review was to meet *icipe* senior management and to collect information on how Sida's research cooperation has helped the Centre. The field visits were used as follow up on the survey data collected online and to obtain

additional information where possible. Nairobi was specially chosen for field visits given the significance Sida attaches to this important hub in Africa.

DFID's officials Dr Rachel Lambert and Dr Maggie Gill visit to *icipe* on 4–5 July 2013

During the visit, the officials had an opportunity to visit *icipe*'s push–pull programme in western Kenya on 4th and on 5th, and additionally came to Kasarani where they held discussions with *icipe* postdoctoral fellows, interacted with the scientists and toured the fruit fly labs and the Martin Lüscher Emerging Infectious Disease Laboratory. During the wrap-up meeting, the DFID delegates appreciated the visit both in western Kenya and at HQs as this helped them gain insights to the question "How do we (scientists in research centres & the CGIAR) step up the impact pathways as we scale up technologies?".

Founders of the COmON Foundation visit *icipe* to learn more about the "Solar power for malaria eradication" project as well as tour the Centre's facilities

On 27–28th June, *icipe* hosted Mr and Mrs Pon, the founders of the COmON Foundation, the main supporter of *icipe* and Wageningen University Solarmal project (http://www.comonstichting.org/en/education-projects/34-combatting-malaria-in-kenya).

In collaboration with Wageningen University, The Netherlands, *icipe* is implementing a project, "Solar power for malaria eradication", known as SolarMal. The project aims to develop and evaluate an effective non-toxic method for controlling malaria. It targets all residents of Rusinga Island, a 44 square km island just off the east coast of Lake Victoria, in western Kenya, principally comprising of a rural community that relies on fishing and agriculture for their sustenance and livelihoods. 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 season. The project targets to demonstrate a proof-of-principle for the elimination of malaria from Rusinga Island using the nation-wide adopted strategy, augmented with mass trapping of mosquito vectors.

The two guests first visited The Thomas Risley Odhiambbo (TRO) campus in Mbita Point where they were briefed on the progress of the Solarmal project and visited several households on Rusinga Island to witness installation of Solar Powered Mosquito Traps (SMoTs), mosquitoes trapped in SMoTs, and get direct views of villagers about the SolarMal project. Thereafter they spent a day at *icipe*'s HQs in Kasarani. Mrs and Mr Pons, owners of one of the biggest industrial conglomerates in The Netherlands, were extremely impressed by R&D achievements of *icipe* scientists in Africa.

***icipe* hosts Officials from The Swiss Agency for Development and Cooperation (SDC)**

On 4th June 2013, the Centre was delighted to host Dr Gerhard Siegfried, Head of East and Southern Africa Region, SDC and Mrs Ines Islamshah, Development Consultant, Embassy of Switzerland, Nairobi who visited the Centre to have an overview of icipe's Research & Development and Capacity Building activities and tour the icipe research facilities.

The UK Government's Independent Commission for Aid (ICAI) team visits to review *icipe* on behalf of DFID on 5th June 2013

The UK Government's ICAI team visited and reviewed DFID's Agricultural Research Spending by *icipe*. The reviewers were Steve Jones (Team Leader), Amir Kassam (Agricultural Research Specialist), Nabila Jiwaji (Financial Management) and Maria Quattri (Impact Evaluation). They met and discussed with the Director General and senior scientists (from the Fruit fly Programme, Novel Tick Biopesticide Development Programme, Impact Assessment Programme and Capacity Building Programme) to help DFID gain a strategic overview of *icipe*, including the value of DFID's support. They additionally reviewed *icipe* financial management for them to understand the overall budget of *icipe*, DFID's contribution and how it is spent.

United Nations' Food and Agriculture Organization Representatives visit icipe

FAO Representative in Kenya Mr Dan Rugabira and Dr Paul Omanga, FAO Crop Production Officer, visited *icipe* (3 April 2013) and held discussions with *icipe*'s Directors Prof. Christian Borgemeister and Mr Roger Finan. The deliberations largely focused on partnership strategies for the management of maize lethal necrosis (MLN), a new devastating plant disease that emerged in Kenya in 2011. The disease is caused by a combination of two viruses, the sugarcane mosaic virus (SCMV) and the maize chlorotic mottle virus (MCMV), both believed to be transmitted by insects. Infected maize plants show discoloring and drying of the leaves and form small cobs with few or no grains. The viral disease was first reported in Bomet County in Kenya's South Rift before it spread to other parts of the country. New reports indicate that it has also been spotted in some neighbouring countries.

To date MCMV has reduced maize production by as much as 60% in south, central and eastern Kenya. A study by the FAO in July 2012 observed that MLN has affected more than 16,000 ha, with the potential of destroying up to 80% of Kenya's maize crop.

The visiting FAO officials were very impressed by the high level of existing partnership linkages between FAO and *icipe*, notably the collaborative efforts in the development of integrated animal health packages (*icipe* is an FAO Reference Centre for vectors and vector-borne animal diseases) as well as the surveillance and management of invasive fruit flies in East Africa.

It was agreed that the two organisations would join hand in the fight against the deadly MLN disease in Kenya and beyond.

Visit to *icipe* by Swiss Agency for Development and Cooperation (SDC) officials

On 1st February 2013, Dr Philippe Monteil, from SDC's HQs in Berne, Switzerland and Dr Katharina Jenny of SDC's regional office in Rwanda visited *icipe*.

SDC has a longstanding research and development partnership with *icipe* providing the Centre with core funding and restricted programme support. The two visitors were very impressed by the ongoing R&D interventions and were happy to learn about the wide array of projects being implemented by *icipe* and its partners. They noted that *icipe* was undertaking excellent work that was contributing towards food security and adaptation to climate change, by means of a holistic

and integrated approach, through the 4Hs paradigm—human, animal, plant and environmental health.

Integrated Vector Management activity with BioRe® Foundation

In January 2013, Dr Christa Suter, the CEO of BioRe® Foundation requested *icipe* expertise to evaluate the applicability of IVM within the area of coverage of BioRe® Tanzania Limited in the Meatu District. The partnership was initiated by BioVision Foundation, Switzerland who linked *icipe* with BioRe® Foundation, for discussions on the possibility of undertaking the IVM feasibility study in Tanzania. A final report of the findings is available.

9. *icipe* hosts The Association of Independent Research and Development Centres for Agriculture (AIRCA) and Innovation Transfer into Agriculture / Adaptation to Climate Change (ITAACC) on its Duduville Campus

The Association of Independent Research and Development Centres for Agriculture (AIRCA) (www.airca.org) began its operations in March 2012. Effective December 2013, AIRCA Secretariat was established at *icipe*. This partnership of nine centres, including *icipe*, aims at reinforced cooperation to contribute more effectively to the elimination of global poverty and malnutrition with a view to making a greater contribution to the attainment of the millennium development goals. The Association will work intensively to develop a new collaborative programme addressing the multi-faceted aspects of flooding, drought, salinity, soil infertility, pests and diseases and their impact on human diets, health and prosperity. The combined expertise of these centres covers a large spectrum of the research for development continuum including integrated pest management, agroforestry, drought-tolerant crops, agrobiodiversity, natural resource management and the conservation and use of underutilised species. The Centres are promoting changes in farming practices and sustainable intensification. Their work complements the work of the CGIAR International Agricultural Research Centres (IARCs) and national programmes with respect to staple crops, and add global expertise in development opportunities for species with high economic, social, nutritional and ecological value.

In October 2013, *icipe* formally began hosting Innovation Transfer into Agriculture/Adaptation to Climate Change (ITAACC), a GIZ (German Agency for International Cooperation) programme on the Centre's Duduville campus. This is a new initiative of *icipe*, ILRI, ICRAF and GIZ. ITAACC will provide African farmers access to innovation and technologies from research done at IARCs through an established knowledge technology transfer system and partnerships with the private sector and donors.

ITAACC (http://www.icipe.org/itaacc/) supports various innovation transfer projects and closely integrates agricultural scientists and practitioners in Africa. The projects are designed in collaboration with international agricultural research centres and realised in conjunction with various partners, including the private sector and non-governmental organisations.

The basis for this is a knowledge transfer platform that matches offers to agricultural demand. All ITAACC projects are embedded in at least one of the following international programmes:

- Comprehensive Africa Agriculture Development Programme (CAADP) of the African Union;
- CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS); and
- G8 New Alliance for Food Security.

This means that practical innovations for agriculture can be made available quickly across the entire continent.

SECTION 5: PROGRAMMATIC RESULTS BASED MANAGEMENT REPORTING FOR 2013

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. *icipe* is pleased to inform that, in line with itsVision and Strategy focus, its 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, icipe thematically aligned the 4-H as follows:

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

In the following sections, we present the Centre's achievements in 2013 in each of the specific 4-Hs and Capacity Building Frameworks.

A. INTEGRATED PEST MANAGEMENT OUTCOMES

Plant Health Results Based Management Framework

Overall objective for Plant Health: Contribute to stabilising 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 2013 RBM Framework Outcomes:

Outputs Produced (Activities run)	*Expected Outcomes as per plan*	*Performance Indicator of Outcome*	*2013 Progress Observed in Obtaining Outcomes*	*2013 Lessons Learned*
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				
1. Baseline information on pest status, farmer practices and their impacts on ecosystems 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	• 2 *ex-ante* studies completed by the leafminer IPM programme in Nyeri, Kenya and Arusha, Tanzania • 1 *ex-ante* study on key pests of cashew carried out in southern Tanzania • 2 *ex-ante* studies on impact of fruit flies on mango and technological uptake carried out in Cameroon and Kenya • 1 *ex-ante* study on thrips infesting French bean carried out in Naivasha, Nakuru, Embu and Thika in Kenya Results of 6 ex-ante studies shared with scientists as publications/dissertations, and shared with other stakeholders through training of agricultural extension and plant quarantine officers	• Training and education are key ingredients for success
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.				
2. Biocontrol agents identified 3. *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 pheromone compounds identified and undergoing field evaluation • One fungal-based biopesticide (Campaign) and 1 biorational evaluated and found to be effective for managing *Maruca*. • Several manuscripts are at various stages of review	• Long-term donor commitment necessary for developing a comprehensive management strategy
4. Training of trainer's programme organised for 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	• Farmers' awareness campaigns could not be conducted since all the management components necessary for IPM implementation are still continuing	• Long-term donor commitment necessary for developing a comprehensive management strategy

5. Training materials and curricula developed 6. IPM technology adapted and validated with cowpea farmers				
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 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	• Thrips and tospovirus management strategies for French bean, onion, 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	• *Metarhizium anisopliae* strain ICIPE 69 commercialised under the trade names 'Campaign' and 'Real Metarhizium' in 5 African countries (South Africa, Mozambique, Kenya, Ethiopia and Ghana) • 10 isolates of endophytic fungi from a number of diseased plants identified and characterised, and three have shown promising neutralising action against thrips and tospoviruses	• The three isolates with promising antagonistic effects against thrips and tospoviruses can be candidates for commercialisation • Apart from thrips control the influence of intercropping on the interplant species competition needs to be considered carefully • Three highly resistant onion accessions hold promise for further cultivar development
		• At least 1 intercropping strategy for thrips control in French beans, grain legumes and onion evaluated by 2013	• French beans intercropped with maize/baby corn at upto a 1:8 ratio and application of ICIPE 69 reduced thrips damage, conserved natural enemies and enhanced the French bean yields by 2.5-fold as compared to untreated controls • Intercropping onions with spiderplant from two seasons trials was not effective in reducing *Thrips tabaci* numbers • Survey of East African cowpea growers indicated that more than 90% adopt intercropping/mixed cropping of legumes with cereals such as maize. On-farm evaluation planned for 2014	

7. *Ex-ante* and *ex-post* assessment of the introduced thrips and tospovirus management strategies carried out		• At least one tospovirus-resistant cultivar of onion and tomato identified by 2014	• Onion cultivars Bombay Red and Texas Grano are moderately resistant to thrips and *Iris yellow spot virus* (IYSV) • Out of 49 onion accessions tested 3 were highly resistant to thrips and IYSV • Screening of tomato accessions for tospovirus resistance underway	
		• 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	• Field efficacy of ICIPE 69 for thrips management tested in farmers' fields in Mwea, Naivasha and Kibwezi regions in Kenya • Spatial separation of thrips attractants and biopesticides for enhanced compatibility • Ecological and insect morphological evidence for aggregation behaviour of bean flower thrips collected. Identification of aggregation pheromones of BFT ongoing • Further large-scale field implementations planned in 2014	
		• Reduction in use of synthetic pesticides by at least 20% by 2014	• Application of biopesticides was equally effective and affordable for thrips management in French beans and onions. Large-scale implementation of biopesticides can significantly reduce pesticide use	
		• No. of peer reviewed publications	• 5 peer-reviewed publications: Birithia et al., *Plant Pathology* 62, 1407–1414; Nyasani et al. *Journal of Pest Science* 86, 515–523; Nyasani et al. *Journal of Applied Entomology* 137, 204–213; Niassy et al., 2013 *BioMed Research International*, vol. 2013, Article ID 465213; Niassy et al., *BioMed Research International*, vol. 2014, Article ID 731017)	
		• Number of theses	• Three PhD students and one MSc student graduated; one postdoctoral research fellow in training; 3 PhD students, 2 MSc studies ongoing	
		• Awareness among at least 150 agricultural extension officers/ plant quarantine inspectors enhanced on thrips and tospovirus monitoring and management by 2013 • 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 • No. of training reports	• Todate the project website has received over 100,000 hits • More than 200 grain legume farmers from 8 districts of Eastern province surveyed to assess their knowledge on thrips management in 2013 • Awareness among 120 plant quarantine officers/Agricultural extension officers of East Africa enhanced on thrips and tospovirus monitoring and management in 2013 • Further training activities are planned in 2014 • *Ex-ante* assessment of thrips and tospovirus management undertaken in Mwea and Loitokitok, Kenya involving more than 200 onion, tomato and French bean farmers • Information and identification tool for pest thrips of East Africa published to a CD-ROM and as a Google App that is free for download by interested users	

		• 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	• Posters highlighting the thrips constraints and their management printed in English (500) and Kiswahili (1000) and over 90% of the English and 30% of the Kiswahili posters distributed • 6 conference proceedings (1 - TROPENTAG, Germany; 1 - International Symposium on Plant Virus Epidemiology; 1 - 45TH Annual Meeting of the Society for Invertebrate Pathology; 3 – 20th AAIS Conference) • One MSc study underway	
Specific Objective 1.3: Develop and implement integrated pest management approaches for invasive agromyzid 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 2. LMF natural enemies introduced and released 3. LMF IPM strategies based on use of intercropping, botanicals, biopesticides, trapping and biorationals developed	• Agromyzid leafminer IPM strategies that encompass at least three IPM components formulated by 2014	• The role of at least 1 indigenous parasitoid species in Kenya, Uganda and Tanzania characterised by 2013 • At least 2 exotic leafminer parasitoid species released by 2013	• A total of 16,800 *Opius dissitus* parasitoids were mass reared and released in 36 farmers' fields in 3 selected villages from 3 districts of Tanzania (Madiira village in Meru District, Kilemapofo village in Moshi Rural District and Mungushi village in Hai District) • *Phaedrotoma scabriventris* released in three altitude levels (Nyeri, Oloitokitok and Kibwezi) in Kenya successfully established with increased parasitism over the years. *Halticoptera arduine,* also released in the three altitude levels and established in 67% of release sites within 9 months post release. KEPHIS granted open field release permit for both the parasitoids • Release permit was obtained for *Chrysocharis flacilla* in 2013 and released in pilot sites similar to *P. scabriventris* and *H. arduine*. Recovery activities are scheduled for 2014 • Survey activities carried out in December 2013 indicated that *P. scabriventris* and *H. arduine* 2 years and 9 months post release had spread to 50 and 10 km, respectively from release points • Tritrophic studies revealed that while *H. arduine* showed a learning habit and preferred the host plant on which it was reared, *C. flacilla* performed better on potato infested with *L. huidobrensis* independently of rearing host plant	
		• At least 1 microbial biopesticide identified against LMF by 2013	• Two of the efficient endophytic fungi isolates identified in previous years [F3ST1 (*Hypocrea lixii*) G1LU3, (*Beauveria bassiana*)] significantly reduced LMF damage under field conditions at Sagana and Narumoru in Kenya • Autoinoculative devices containing the entomopathogenic fungus (EPF) [*Metarhizium anisopliae* (ICIPE 20)] induced high infection rates of LMF in the field • Studies on compatibility between the entomopathogenic nematode (EPN) *Heterorhabditis indica* and the parasitoid *Diglyphus begini* indicated that *D. begini* recognises and avoids EPN-infected LMF larvae; the EPN preferred parasitized larvae	

		• At least one botanical evaluated by 2013	• Pyrethrum and 2 neem products (Achook and Neemroc) were efficient against LMF with limited effect on parasitoids	
		• At least 1 intercropping strategy evaluated by 2013	• Experiments on the use of faba bean as trap crop with pesticide use in potato crop indicated that faba bean as trap crop did not have any beneficial impact in the control of LMF	
		• 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 significant difference in LMF incidence and importance of its parasitoids in three countries. In Kenya and Tanzania, *Liriomyza huidobrensis* was the dominant LMF species in all 3 altitude levels while in Uganda *L. huidobrensis* was the most abundant only at high altitude while *L. sativae* was the most abundant at low and mid altitudes as well as countrywide • While in Uganda no differences were found in parasitism rates across altitude levels, in Kenya, higher parasitism rates were obtained at low and mid altitudes while in Tanzania highest parasitism was at high altitude	
		• 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 could control LMF • Pesticide use was assessed in the different agroecological zones and its implications on parasitism rates of indigenous and exotic parasitoids is ongoing	
		• No. Peer reviewed publications	• Two peer reviewed publications: Chabi-Olaye *et al*., 2013, *Biological Control* 65: 1–5;	
4. Training of trainers conducted. 5. Training of French bean, faba bean, rosecoco bean, cowpea, tomato, snow peas, sugar snap peas and chrysanthemum for farmer's conducted. 6. Training materials and curricula developed.	Awareness on agromizid leafminers IPM strategies created among agricultural extension officers, plant quarantine inspectors and French bean, faba bean, rosecoco bean, snow pea, sugar snap peas, tomato and chrysanthemum farmers by 2014	Awareness created among at least 100 agricultural extension officers and plant quarantine inspectors by 2013	• Total of 61 farmers trained in Meru, Moshi and Hai districts in Tanzania on augmentative and conservation biological control • Total of 141 farmers trained in Narumoru, Sagana, Kabaru, Kibwezi and Oloitokitok in Kenya on environmentally friendly management of LMF • Total of 20 farmers trained in Cañete valley in Peru on IPM of major pests of potato	
		Awareness among at least 500 French bean, faba bean, rosecoco bean, snow peas, sugar snap peas, tomato and chrysanthemum farmers by 2014		

7. Field demonstration of leafminer management strategies conducted 8. IPM technology adapted and validated with farmers 9. *Ex-ante* and *ex-post* impact assessment of the introduced technologies undertaken		• No. of training reports	• Three training reports were produced on: (a) farmer training in augmentative and conservation biological control in Kenya; (b) farmer training in environmentally friendly management of LMF in Kenya and (c) farmer training on potato IPM	
		• Popular articles, mass media reports	• Posters were developed on augmentative and conservation biological control of LMF in Kiswahili (2000 copies) and English (1000 copies) in 2013. 50% of these were distributed to farmers and extension officers in Tanzania and Kenya • The posters developed in English and Kiswahili in previous years on LMF and their parasitoids' identification were distributed in Kenya and Tanzania to farmers and extension officers. A total of 500 English and 1,000 Kiswahili copies were distributed	
		• No. of publications and theses	• A total of 3 PhD, 5 MSc and 14 undergraduate students were involved in the project activities • 1 thesis was finalised (Akutse, 2013: PhD Thesis, North-West University, South Africa) • 6 proceedings contributions: Akutse *et al.* 2013: AAIS 2013, Cameroon; Akutse *et al.* 2013: SIP 2013, USA; Akutse *et al*. 2013: ESSA 2013, South Africa; Foba *et al*. 2013: AAIS 2013, Cameroon; Foba *et al*. 2013: ESSA 2013, South Africa; Mujica *et al*. 2013: ISBCA 2013, Chile • 4 progress reports: Foba & Fiaboe 2013: KEPHIS progress report on *P. scabriventris;* Muchemi & Fiaboe 2013: KEPHIS progress report on *H. arduine;* Muchemi & Fiaboe 2013: KEPHIS progress report on *C. flacilla;* Fiaboe 2013: GIZ annual report	
		• At least 15% yield increase in French bean, faba bean, rosecoco bean, peas, sugar snap peas and tomato by 2014 • At least 10% reduction in rejection of French bean, faba bean, snow peas, sugar snap peas and chrysanthemum by 2014	• *Ex-ante* studies conducted in Uganda revealed that farmers' knowledge on leafminer is very limited in Kabale, Kabarole and Kasese districts and farmers confuse the effects of leafminer infestation with drought effects. Major control approach is by use of pesticides • *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.				
1. 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 the growers in the project benchmark sites are currently acquainted and practice fruit fly and MSW IPM technology. Fruit fly and MSW infestations in the participating growers' orchards reduced by 80% and mango yield increased by 30%. By implementing this technology growers reduced the use of synthetic pesticides by 50%. At the regional market, rejection of mango reduced by 50%	• Working closely with NARS and farmers' groups to ensure the successful implementation of the fruit flies IPM
2. 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	• So far *F. arisanus* and *D. longicaudata* released in 17 major mango production localities with as much as 43% parasitism and recovery reported. As a result of sensitisation prior to parasitoid releases, growers in all the project benchmark sites are aware and familiar with the parasitoids releases and impact, and the need for their conservation and thus reduction on cover spray of synthetic pesticides	• Community sensitisation is crucial for success of parasitoid releases and establishment
3. 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	• Approximately 60% of growers became knowledgeable on weaver ant conservation. However, the reluctance of majority of the growers to take up the ant technology coupled with negative impact of the ant on the parasitoid suggest that this technology should be temporarily put on hold pending further investigation	• Growers are reluctant to use this technology due to the aggressiveness of the ant to humans

4. 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	• This experiment has been suspended due to the ongoing synonymization of *B. invadens* with *B. dorsalis* for which hot water treatment parameters are well-documented and in the public domain	
5. 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	• *Ex-ante* studies showed that synthetic pesticides are the main method of pest management on mango by 95% of the growers. Of the respondents, 82% indicated a willingness to try alternative methods of pest management if these were provided. Data for *ex-post* impact assessment are being collected	• NARS involvement in mobilisation of the growers is crucial to success
6. 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's trained on fruit fly and MSW management and post-harvest treatments by 2013	• Over 100 NARS personnel trained on fruit fly and MSW management. Six IPM technology learning sites/FFS have been established for grower training at which over 10,000 growers have been trained on fruit flies and MSW management. Moreover, 5000 English leaflets and 5000 Kiswahili version of the same have been produced and distributed to the growers. Fruit flies field guide manuals have been produced and printed in English, Portuguese and French and distributed to NARs during the Training of Trainers (ToTs) trainings. 3 PhD and 5 MSc students are being trained on fruit fly and MSW management and post-harvest treatments and are expected to complete their studies by the end of 2014	• Work with functional farmers group; overwhelming request for expansion from growers in need of technology; continuous resource mobilisation for expansion
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. Landscape and habitat management effects on diversity, abundance and population dynamics of key cashew insect pests and beneficial insects studied		• Study on bio-ecology of major key insect pests and diseases completed by 2013 • Natural enemies and major pollinators identified by 2013 • At least one semiochemical compound identified by 2013	• Surveys conducted in the major cashew nut producing areas of Tanzania and Benin indicated that *Helopeltis* sp., *Pseudotheraptus wayi*, and the powdery mildew remained the major constraints to cashew nut production in both countries • The study revealed that members of *Ceratina, Braunsapis* and *Apis* genera were the potential or efficient bee pollinators following their high visitation rate, behaviour on flowers and ability to deposit pollen on the stigma	• The rearing of *H. schoutedeni* and *P. wayi* coreid has been a big challenge

2. Control agents based on entomopathogenic fungi, botanicals and *soft* insecticides for the control of mirid and coreid bugs identified 3. Semiochemicals of key insect pests identified 4. Efficacy of weaver ant *Oecophylla longinoda* in the management of mirid and coreid pests evaluated, fine-tuned and disseminated		• At least 1 biopesticide and 1 botanical evaluated by 2012 • No. of peer reviewed publications • PhD student	• 10 MSc and one PhD trained • One peer reviewed publication: Agboton *et al.* (2013) *Journal of Applied Entomology* 137, 782–789.Presence of sex pheromone demonstrated in *H. schoutedeni* and *P. wayi* females • Screening of isolates of *Beauveria bassiana* and of *Metarhizium anisopliae* resulted in the selection of *M. anisopliae* isolate ICIPE 69 that was virulent to both *Helopeltis* sp. and *P. wayi*. This isolate is already commercialised as Campaign® for the control of thrips and mealybug. Neem oil was also found to be toxic to *Helopeltis* sp. • One PhD completed • Two peer reviewed publications: Egonyu (2013) *African Entomology,* 21, 103–107; Egonyu et al. (2014) *Journal of Insect Science* 14, 44 • The impact of density and abundance of *O. longinoda* on damage by *P. wayi* and *Helopeltis* sp. demonstrated in the field • Fungicides used for powdery mildew (PMD) management did not have effect on *O. longinoda*. • Results showed that fish intestines could be used for conservation of *O. longinoda* in cashew farmingOne PhD scholar graduated • Two peer reviewed publications: Olotu et al. (2013) *Pest Management Science* 69, 911–918; Olotu et al. (2013) *International Journal of Tropical Insect Science* 33, 283–290	
5. Alternatives to management strategies for powdery mildew, leaf and nut blight formulated 6. 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 • Resistant varieties identified • No. of peer reviewed publications	• 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 insects such as weaver ants • Two cashew clones (AZA17 and AZ2) found tolerant to the plant pathogen *Cryptosporiopsis* • A diagrammatic scale for estimation of leaf nut blight (LNB) developed and validated • One PhD thesis completed • Publications in preparation	
7. Training of trainer's programme organised for cashew farmers 8. *Ex-ante* impact assessment of potential cashew IPM strategies conducted	• 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	• Information sources and dissemination pathways of cashew production and marketing were assessed; partial budget analysis of cashew production system was analysed; compatibility of proposed technology with the existing system analysed; *ex ante* impact assessment; efforts to integrate IPM technology with existing farmer training and information dissemination channels	

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 (RSM) and its predator elucidated in the laboratory	• Understanding on the behaviour of key pests and their natural enemies of horticultural and staple food crops used by scientific community to refine the use of treated and non-treated nets for pest management by 2014	• No. of publications • No. of theses • At least 1 PhD and 1 MSc student trained by 2014	• 2 PhD studies and 1 MSc study ongoing • Three peer reviewed publications accepted for publication/ published: Azandémè-Hounmalon et al. (2014), *PLos ONE*,; Martin et al. (2013), *Journal of Economic Entomology* 106, 1699–1706; Gogo et al. (2014), *Agronomy* Repellency of 24 plant extracts against legume flower thrips evaluated and 5 essential oils found to be highly repellent to thrips. The active ingredients in these essential oils have been characterized with GC-MS • 6 Publications under preparation	
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 trained on behavioural research to understand interaction between RSM and predators				
4. Small farmer practices in Benin to control the invasive RSM identified				
5. Repellent compounds against whiteflies and thrips from plant extracts that could be used in association with nets identified				

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 0.75 million people in East Africa by 2014	• 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 utilising fodder from Push–pull in their dairy production • Number of dissemination channels optimised and employed • Cereal and fodder yields and milk production levels among target farmers • Number of partnerships formed • Number of stakeholders trained	• Push–pull technology has been adopted by 75,297 smallholder farmers in Ethiopia, Kenya, Tanzania and Uganda, enabling them to achieve significant increases in cereal crop yields, fodder, milk, soil fertility and incomes, thus ensuring food and nutritional security for 750,000 people. The technology had been planted on 22,600 ha, gaining higher maize yields ranging from 2.85t/ha in lowest potential agro-ecologies, 3.45t/ha in medium potential, through 6.47 t/ha in high potential agro-ecologies. Sorghum yields were 2.52t/ha. Each farmer planted about 0.3 ha of Push–pull, with a mean yield of 4.25t/ha, gaining 1.28 tons at an average maize market price of $487.8 per ton. Each household's income from maize alone increased by Ksh. 52,244 (US$622). Sorghum farmers each earned Ksh. 54,210 (US$645.37) • Some 15,059 dairy cow farmers utilised fodder from Push–pull, and each produced 5 litres per day for an average of 250 milking days (18,824,250 litres pa) valued at Ksh. 677,673,000 (Market price of Ksh. 60 per litre). Each earned about Ksh.75,000. Some 6024 dairy goat farmers produced 3 litres a day, each earning about Ksh. 72,000 p.a. at a market price of Ksh. 120 per litre • Push–pull was disseminated using filed days, farmer teacher, direct extension, printed material and videos, through more partnerships with 9 NGOS (e.g Heifer International, Institute for Sustainable Development), Church-based organisations (Catholic Relief Services) and NARES. Through these some 260 farmer groups and stakeholders were trained in four African countries	• Building strong partnerships with the farming communities, national extension networks, NGOs, and the private sector players is key in sustaining the impacts of the project. This is enhanced by clear communication and regular sharing of information by partners within and outside project networks • Working closely with grassroots institutional collaborators such as local chiefs, churches, private sector and Community Based Organisations (CBOs) increases the level of ownership of Push–pull technology • Use of farmer-based communication models is sustainable in the long term • Inclusion of seed companies and contracted farmers in push–pull technology training increases the amount of seeds produced and supplied, for adoption

2. Push–pull IPM approach developed for the management of cotton insect pests in western Kenya and North East Brazil	• Improved cotton productivity and incomes of at least 2000 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	• Some 2100 cotton farmers were trained to identify key pests of cotton and use a Push–pull IPM approach in managing them • 8 stakeholder networks were created under partnerships with EMBRAPA (Brazil) KARI, KEPHIS and the Cotton Development Authority (Kenya) • One peer reviewed publication on farmers' perceptions of cotton pests and their management in western Kenya published Midega *et al.* (2012) *Crop Protection* 42, 193–201	• The farmers' cotton crop is mostly affected by cotton stainers, bollworms, white bugs and cut worms • Farmers mainly use chemical spraying (e.g. Bulldock®) insecticide, which is not affordable • Farmers lose up to 80% of their cotton yield to pests. Farmers demand capacity development in cotton agronomy and an IPM for cotton pests
3. An integrated management approach for Napier stunt disease	• Improved incomes and livelihoods of at least 2000 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	• Out of the 122 Napier grass cultivars screened as above four (Ouma2, South Africa, Kitale1 and Kitale2) remained negative by nested polymerase chain reaction (nPCR), and loop-mediated isothermal amplification (LAMP) methods with no disease symptom expression after second screening • Two of the resistant cultivars (Ouma2 and South Africa) were rescreened and resistance status confirmed; they have been multiplied and distributed to 15 farmers in western Kenya for testing and seed multiplication. As a result 2500 farmers have clean Napier grass material, each gaining an additional 3 litres of milk per day • Community-based resistant Napier multiplication and distribution systems have been established through 6 principal stakeholders (KARI, NARO, Heifer, Send-a-Cow and Ministries of Livestock in Kenya and Uganda) and 15 farmer groups • Phytoplasma infection increases rates of emission of the following compounds benzaldehyde; α-pinene; 6-methyl-5-hepten-2-one; 7-ethyl-1, 3,5-cycloheptatriene; eugenol; phytol dihydroactinidiolide; hexahydrofarnesylacetone, while it suppresses emission of the following compounds (N-methoxy)iminocyclo-pentane; anisole; (*E*)-4,8-dimethyl-1,3,7-nonatriene (PA); (*E*)-β-farnesene (PA) • Phytoplasma infection improves attractiveness of Napier grass to *Maiestas banda* (a leafhopper vector of phytoplasma) and improves population build-up and reduces attractiveness of Napier grass to stemborers but improves survival of stemborer larvae • *Maiestas banda* can transmit stunt phytoplasma from wild inoculum sources into Napier grass • 1 peer-reviewed paper published (early view) Khan *et al.* (2014), *Plant Pathology* doi: 10.1111/ppa.12215	• There are various strains of stunt phytoplasma (SP) in western Kenya, with a wide host range in the Graminae family, causing similar symptoms as Napier stunt disease (NSD) • NSD resistant cultivars exist and their use by smallholder farmers in combination with other disease management can effectively manage the disease • Alternative fodder grasses are available in western Kenya. However, as most of them seem susceptible to the SP they should be carefully evaluated before being recommended • Napier stunt research needs an expanded partnership, with partners of varied competencies if an effective management approach is to be efficiently implemented

4. Stemborer management approach developed by exploiting early herbivory traits and plant signalling	• Staple food sufficiency achieved by at least 3000 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	• Semiochemicals and DNA samples successfully collected from diverse maize/sorghum landraces and improved lines from CIMMYT and ICRISAT (684 samples in total) • Bioassays are on track and behavioural responses to certain maize lines with the trait have been confirmed and a trait identified in an improved maize line (CKIR12001) • Chemical analysis carried out on the collected volatile samples, a key compound, (*E*)-4,8-dimethyl-1,3,7 nonatriene (DMNT), strongly induced by egg laying on maize line and known to attract stemborer parasitoids has been discovered on improved maize line. The collected DNA samples were sent to the Cornell University (New York) sequencing facility. • The project works collaboratively with Rothamsted Research, CIMMYT and ICRISAT, and is building capacities of national research institutes, KARI and NARO • 2 peer-reviewed papers published: Amanuel *et al.* (2012), *Journal of Chemical Ecology* 38, 231–234; and Amanuel *et al.* (2011), *Ecology Letters* 14, 1075–1083	• The egg-induced response identified in certain maize lines is quite rare in improved maize germplasm. Hence, combining volatile analysis with bioassay study will shorten time required in identifying maize/sorghum lines with desired traits among the large number of germplasm samples currently studied
5. Effectiveness of participatory video in disseminating push–pull technology established by 2013	• Food sufficiency and household incomes of 5000 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	• Participatory video was piloted in four districts in western Kenya: Bungoma, Vihiga, Kisumu and Suba, where 24 farmer groups (720 farmers) generated 120 videos and used them to test the dissemination method. Over 5300 farmers in Kenya have learned Push–pull technology using participatory video developed by farmers themselves • More than 24 partnerships were created with farmer groups through KARI, the umbrella farmer field school organisation, Heifer Kenya, and the Ministry of Agriculture	• Deployment of information and communication technology has potential to transfer technical knowledge, even to farmers with low literacy levels • Participatory video, by mutual participation by members of farmer groups has good quality as professional documentary videos, better than printed matter • Community action and social group cohesion were strengthened by PV, important for further knowledge sharing and technology diffusion

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	• 18,200 farmers in 16 districts in western Kenya are now practicing integrated striga control methods, incorporating intercrops of desmodium + IR-maize open pollinated variety (OPV); desmodium +striga-resistant hybrids, groundnuts +striga-resistant hybrid combinations • Farmers have implemented the integrated striga control methods on 9000 ha of cropland, increasing their yields to > 3.6t/ha. • The integrated striga control method has involved over 25 stakeholders, including *icipe*, CIMMYT, AATF, Maseno University, BASF, CIAT-TSBF, Real IPM, Ministry of Agriculture, and farmer groups in 16 districts • Through these partnerships over 45 field days have been conducted, reaching an additional 12,057 farmers • 1 manuscript has been prepared for publication on the relative performance of the different technology combinations	• Desmodium intercrop with any seed variety consistently produced higher yields, and was most preferred by farmers, because of consistent results, and being economical • Involvement of farmer trainers of trainees increases the number of information recipients and adopters of the Push–pull technology.
				• Building strong partnerships, clear communication and regular sharing of information with the farming communities, national extension networks, NGOs, and the private sector players is key to sustaining impacts of the project. Inclusion of seed companies and contracted farmers increased the amount of seeds produced and supplied for adoption

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 and Malawi by June 2013 and Zambia and Rwanda conducted by June 2015 2. Effective and functional rearing facilities and systems for biological control agents of diamondback moth (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 • 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	• Country agreements completed and signed and 1st fund disbursement done by 28th March 2013 • Baseline surveys completed in Mozambique by August 2013 and progress report submitted; surveys in Malawi started in June 2013	• Efficient linkages to other in-country ongoing IFAD-funded projects at national level brings in synergies during the implementation phase as in Mozambique • Forging strong and early public/ private partnerships and establishing a committed national project coordination and steering committee is key for efficient implementation. Bringing pesticide dealers on-board early facilitated access to IPM friendly products and reduced dependency on pesticides in Mozambique
3. Extension agents and farmers trained in locally adapted bio-control IPM approaches for crucifer pests	• 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 Mozambique and Malawi by June 2013 • At least 2000 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	• In Mozambique DBM and aphids confirmed as key pests of cabbage and kale; *Cotesia plutellae* an indigenous natural enemy of DBM was recorded in some fields reaching up to 19.7% parasitism; routine spraying with broad spectrum insecticides common • In Malawi, clubroot, DBM and aphids were reported as the key pests of crucifer vegetables; routine insecticide spraying common • Mozambique established 9 farmer groups for FFS training and conducted one master trainer's course (30 participants) by December 2013 • In Mozambique posters and fliers were developed in Portuguese and distributed to farmers, extension workers and policy makers beginning from April 2013. The brassica IPM manual was reviewed and translated into Portuguese by December 2013 and sent for printing	• In Mozambique, adopting a cropping-system-based/pest complex IPM is more likely to be accepted at farmer level

4. Policy makers and general public sensitised on vegetable IPM methodologies		• Biological control and locally adapted IPM methodologies that reduce insecticide use and improve food safety promoted by July 2015	• Mozambique developed and formulated strategies to raise IPM awareness to farmers, policy makers and pesticide dealers and as a result, the country imported a Bt formulation for distribution to selected pilot sites	• Partnership and awareness of policy makers and pesticide dealers pave way for the introduction of IPM as in Mozambique
5. Impact of *Cotesia plutellae* in semi-arid Eastern province of Kenya assessed and disseminated to other countries	• Knowledge enhancement for further scaling up of DBM biological control in new areas of project countries compiled by 2015	• Impact assessment data collected and analysed by end of 2013 • Information shared in stakeholder and annual planning meetings • Awareness material produced and distributed	• Due to weather conditions the impact assessment data collection was completed in December 2013	
6. Knowledge products developed from field experience in Mozambique and Malawi by end of 2014		• Updated FFS curriculum • Documented lessons learned from field surveys		
7. 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		• 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		

Specific objective 1.9: Responses of tropical insects to global change.				
1. Baseline information on lepidopteran stemborers and parasitoids diversity in sub-Saharan Africa on Poaceae, Thyphaceae and Cyperaceae, community structure of lepidopteran stemborers and parasitoids in wild and cultivated habitats, host plant selection mechanisms by lepidopteran stemborers (Noctuidae), host selection mechanisms by parasitoids (Braconidae). 2. Study of the genetical basis of *Busseola fusca* resistance to *Bt* maize	• At least four study outcomes utilised by scientists and students by 2015	• Phylogeny of the noctuid stemborer • Descriptions of new Lepidoptera stemborer species and genera • Descriptions of new parasitoid species • Identification and preparation of new pheromone blends of new Lepidoptera stemborer 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* • Prediction of the spreading of *Busseola fusca* resistance to *Bt* maize	• 1 *ex ante* post doc study completed (name of the post doc: Pascal Campagne) • 1 *ex ante* PhD studies completed (name of the PhD student: Nicolas Glaser) • 3 PhD studies on course to be completed by 2015: PhD of Gladys Bichanga: (i) on process to isolate the kairomone(s) for further identification; (ii) participation in the genome sequencing of *B. fusca*. • PhD of Christophe Petit: (i) evaluation of genome size according to the feeding status of the stemborer species initiated; (ii) experiments to test the host fidelity of stemborer species on coursePhD of Eric Ntiri: (i) field and laboratory experiments on stemborer species competition achieved; (ii) identification of volatiles emitted by infested plants by different stemborer species almost achieved • 7 peer reviewed publications published: Félix *et al.* (2013). *Ann. Soc. Entomol. Fr.*; 49, 345–354; Ong'amo et al. (2013). *Arthopod–Plant Interactions* 7, 267–275; Jancek *et al.* (2013), *PLoS ONE*, 8(5), e64432; Campagne *et al.* (2013). *PLoS ONE* 8(7), e69675; Glaser *et al.* (2013), *International Journal of Biological Sciences* 9, 481–495; Juma et al. (2013), *Bulletin of Entomological Research* 103, 20–28; Moolman et al. (2013), *Phytoparasitica* 41, 89–104 • 1 PhD thesis • 1 book (749 pages) written on "Insect–Plant Interactions" in French for students and teachers	• Training and education are key ingredients for success. • A close relationship of senior scientists with biological material is a key ingredient for success

Objective 1.10: Better control of infection of Napier grass with *Phytoplasma* through the identification of *Phytoplasma*-specific target molecules for the development of point-of-care diagnostic tests.

Progress toward achieving objective observed: Good progress has been made in learning bacterial DNA extraction techniques. These have been applied and sequencing of the phytoplasma has been done. One highly expressed protein has been expressed and will be used for integration in both antibody and PCR based diagnostic tests.

Outputs Produced (Activities run)	*Expected Outcomes as per plan*	*Performance Indicator of Outcome*	*2013 Progress Observed in Obtaining Outcomes*	*2013 Lessons Learned*
1. Training post-doctoral fellow in phytoplasma DNA extraction techniques in Germany. Manual developed for further training of personnel in PFGE and CsCl DNA extraction techniques 2. Extraction of phytoplasma DNA from infected Napier grass and full genome sequencing 3. PCR amplification, sequencing of the *imp* gene as well as expression of the corresponding protein	• One prototype test validated using field samples in Mbita Point. Test produced and presented to farmers including a user manual in two languages (last quarter of 2015)	• Sequences of genome and transcriptome analysis submitted to public databasesProtocols for DNA and RNA enrichments developed/adapted A) List of potential targets provided and other results written up B) One phytoplasma protein expressed and purified, antibody produced • One publication submitted	• Funding obtained to take on Dr Lillian Wambua as a postdoctoral fellow on the project • Bacterial DNA extraction techniques have been learned and used to achieve full genome sequencing • One protein has been successfully expressed and will be used for generating antibodies. This will be the first candidate protein for a diagnostic test	• Even though the DNA extraction techniques enrich for bacterial DNA, the results of the genome sequencing show that a lot of sequences still belong to the host. We might therefore need to repeat the extraction and add some sequencing • To identify more highly expressed genes and be able to include these in a diagnostic test, we would like to do transcriptome analysis, and look at which bacterial genes are highly expressed in the plant. Since no Napier grass genome is available, we have tried to get an alternative host infected (periwinkle) with the Napier grass phytoplasma. These infection trials have so far been unsuccessful, maybe due to the high host-specificity of the insect vector, the leafhopper

Objective 1.11: Development and Implementation of a sustainable IPM and surveillance programme for the invasive tomato leafminer, *Tuta absoluta* (Meyrick), in North and sub-Saharan Africa by 2017				
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***2013 Progress Observed in Obtaining Outcomes***	***2013 Lessons Learned***
1. Distribution, abundance, dynamics and host plants of *T. absoluta* and their associated natural enemies established	• The abundance, distribution and pest status established in the major tomato growing regions of the two target countries (Sudan and Tunisia) by end of 2014 • Wild and cultivated host plants of *T. absoluta* catalogued and distribution maps developed by end 2016 • The origin and invasion pathways of *T. absoluta* established by 2016 • Colony of *T. absoluta* and at least one indigenous natural enemy species established in target countries by end of 2014	• Abundance, distribution, pest status, and inventory of the host plants of *T. absoluta* documented in target countries by end of 2014 • Modelling and distribution maps of the pest at country and regional levels made available by end of 2015Specific markers developed, origin and invasion pathways known by 2016 • Vibrant colony of *T. absoluta* and one indigenous natural enemy species exist in target countries by end of 2014. • Publications produced	• 80 and 50% of the tomato growing regions in Tunisia and Sudan, respectively, have been surveyed and pest status and seasonal abundance established in the surveyed areas • Data have been gathered and statistical analysis and modelling of the pest distribution maps is underway • Samples are being collected for molecular analysis • Pest colony has been initiated and maintained in one of the project target countries (Tunisia)	• This pest is very aggressive having high dispersal ability and with the political unrest in the Republic of South Sudan and porous borders of the neighboring countries, it can make its way into sub-Saharan Africa
2. Natural enemies of *T. absoluta* identified and tested through explorations in Peru, and if feasible introduced into Africa	• Co-evolved parasitoid(s) identified, tested and if feasible introduced to Africa by mid 2015 • Colonies of at least two species of the most promising natural enemies established by end of 2014 • One parasitoid species introduced into at least one of the target countries by end of 2015	• One co-evolved parasitoid introduced to Africa by mid 2015No. of natural enemies established by end of 2014 • No. of parasitoids introduced to Africa by end of 2015Publications produced	• Different indigenous predators and parasitoids have been identified in both Tunisia and Sudan and colonies of the same initiated in Tunisia • A co-evolved parasitoid species of *T. absoluta* has been identified and a colony established in CIP, Peru but unfortunately the colony was lost due to a fire incident which occurred at the CIP Entomology Laboratory	• From the fire incident at CIP, it is clear that keeping a stock colony in different localities could safeguard against natural disasters

3. New technologies and already existing management tools suitable for use by small and medium scale tomato growers for controlling *T. absoluta* identified, tested and implemented	• At least one new technology for *T. absoluta* suppression identified and integrated with the already existing technologies for management of the pest in one location of each target country by end 2015 • One attract-and-kill strategy developed and tested in Peru by end of 2014	• One new technology for *T. absoluta* management added to existing technologies and implemented in one location of the target countries by end 2015 • One attract-and-kill strategy developed and tested in Peru by end of 2014 • One companion crop suitable for management of *Tuta absoluta* identified and tested widely by end of 2015 • One virulent isolate/strain of an entomopathogen (fungi or virus) identified and field tested by end of 2015	• Components for attract–kill strategy for *T. absoluta* have been identified and preliminary field trials conducted • Promising botanicals have been identified and are planned to be included in laboratory and field trials	• Traditional farmers' practice of intercropping is of great importance and needs to be taken into consideration when designing field trials
4. Country-wide surveillance for *T. absoluta* in the high risk countries of Kenya, Republic of South Sudan and Uganda initiated and sustained	• One companion crop to be used within the framework of habitat management for *Tuta absoluta* suppression identified and tested widely by end of 2015 • At least one virulent isolate/strain of an entomopathogen (fungi or virus) identified, field-tested by end of 2015 and discussion initiated with private partner(s) for its commercialisation by same date • Informed knowledge of occurrence of *T. absoluta* in high risk countries of Kenya, Republic of South Sudan and Uganda established by end of 2014	• No. of meetings held with entrepreneurs • Discussion initiated with one private company for commercialisation by end of 2015No. of trained tomato growers • Publications produced • Assessment reports • Surveillance maps • No. of Technical Advisories Notes (TANs) produced	• Surveillance in the high risk countries has been initiated and is ongoing	• Being an invasive pest, collaboration with the regulatory bodies of the high risk countries is of paramount importance due to the consequence of the pest to the countries' trade

5. Technology transfer and training programmes initiated and implemented with stakeholders	• 10 NARS in each of the target countries get acquainted with *T. absoluta* monitoring and management by mid 2015 • 100 growers become knowledgeable on *T. absoluta* IPM by mid 20153 PhD and 3 MSc students trained on *T. absoluta* IPM by 2015	• One training of trainers (ToT) workshop, and one farmer field day, conducted in each of the target countries by end of 2014 • No. of 10 NARS trained on *T. absoluta* IPM by mid 2015 • No. of growers exposed to *T. absoluta* IPM by mid 2015 • 1500 training materials on *T. absoluta* monitoring and management developed and distributed in the target countries by 2015 • PhD and 3 MSc theses • Independent evaluation by NARS in respective countries • No. of training courses • No. of countries requesting for *T. absoluta* control strategies	• 2 PhD students have been recruited. Additional PhD student and two MSC students will be recruited during the course of the year	
Objective 2: Minimise the vulnerabilities of horticulture and staple crops to climate change-induced pest problems by at least 10% by 2020.				
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				
1. Baseline information on ecosystem services (pollination and pest management, biodiversity, habitats and water resources) established	• Study outcomes utilised by scientists, policy makers, extension workers and other stakeholders by 2015	• Effects of climate change on biodiversity and habitats explored through modelling by 2015	• The study on diversity and abundance of avocado flower visitors along the elevation gradient of Taita Hills completed1 MSc thesis submitted2 manuscripts under preparation (90% completed) for publication • 15 field surveys completed in the target areas. Data on infestation and damage by crucifer pests for 12 months, and of maize pests and their parasitoids for 20 months are available. Seasonal dynamic of coffee diseases assessed in Jimma transect. For the coffee pests' population dynamics, evaluation of parasitism rate undertaken in Kilimanjaro. A draft manuscript is 60% completed. 18-month data on insect pests and their associated natural enemies species composition and abundance along the Taita Hills and Kilimanjaro transects collected, and processed for statistical analysis and modelling. Draft manuscript 50% completed	• Collected data can be used to educate the local communities on pollinator conservation as well as guide the policy makers in better resource planning • Data generated from avocado pollinators' catalogue will help yield increment of many cross pollinators crops

2. 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 utilised by stakeholders by 2015.	• GIS platform established for sharing geospatial datasets among at least 25 East African stakeholder organisations by 2015Geospatial datasets developed for target areas on 8 different themes by 2015MSc and PhD training on GIS organised for at least 25 staff	• CHIESA GeoNetwork available for data and metadata sharing among project scholars and partners. Continuous maintenance of the Database and uploading new datasets once they become available. Instructing GeoNetwork users and problem solving • 1 SPOT image from Taita Hills processed, 2 Landsat images from Kilimanjaro processed and corrected for radiometric and topographic effects • Process AISA hyperspectral remote sensing data acquired from Taita Hills in January 2013, covering 2/3 of the study transect, a total area of 107.5 km^2	• The detailed LU/LC map of Kilimanjaro transect is one of the most crucial baseline datasets required for different ecological applications and modelling, species distribution modelling, integrated water basin management, LU/LC
		members of the stakeholder organisations	• One set of large-scale LU/LC map 100% ready for Kilimanjaro Transect, available for download through CHIESA GeoNetwork. The Taita Hills LU/LC map 60% completed, expected to be ready by July 2014	change detection, etc. The new LU/LC map will facilitate new findings in CHIESA project and beyond • This information can be used by policy makers, for better land management and environmental protection
3. 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	1 set of InVEST tools identified; installation of software and training of scientists to use the software ongoing 2 Participatory Stakeholder Analysis and Mapping campaigns organised and successfully implemented in in the Taita Hills and Mount Kilimanjaro; 240 participants in total, out of which half were women. 1 report on PSAM and gender-disaggregated analysis available for project partners (about 60% complete). 1 paper and policy brief produced	Data sets available enable analysis of stakeholders' perception and understanding of climate change and ecosystem services (ES). This will help in the development of future scenarios for target areas
4. 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 areasRegionally 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	• 3 data sets for regional climate change projections processed, finalised and visualised • A range of high resolution climate change predictions completed for all study areas • Data analysis from vegetation plots underway. Framework abstracted from the range of high resolution climate change predictions for all study areas	• Improved and high resolution regional climate models can be used used by decision-makers in the development of adaptation strategies and for research on impacts on hydrology, pollination, biological control and food security

5. 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 2015Species composition and abundance on target crops available 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 and 1 MSc student to undertake research on climate change impacts on pest management and pollination selected	• Historical data compiled and digitised for the Taita Hills and Kilimanjaro • 5 PhD and 3 MSc (working on pests of maize, crucifers, avocado, diseases of coffee and soil carbon evaluations). The students have completed 50 – 80% of the data collection; the draft text of their dissertations is at 20% completion. PhD degree and at least 4 manuscripts published in peer review journals focusing on entomology. So far crucifer pests and natural enemies data for, 20, 25, 30 and 35 degree C are completed; The 10 and 15 degree C still ongoing. Collection of life history parameters (development time, mortality, fecundity, sex ratio, longevity) and phenology models has been completed for all pest and natural enemy	• Understanding past environmental conditions and land use/land cover patterns will help in understanding the larger picture of environmental and climate change / climate sustainability in the research areas
	• Predictive models generated by 2015Number of MSc and PhD level staff trained, especially females by 2015	• 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	species of maize. Data analysis and drafting under process. Scientific publication on impact of temperature on antestia bug (pest of coffee) demography by the end of the project. Two manuscripts on maize pests submitted for review. 11 AWS installed and collecting meteorological data in Jimma, Mt. Kilimanjaro and the Taita Hills	
6. 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	• SWAT and WEAP models operated with available biophysical and socio-economic data for predictions on water availability. 1 report ready. Validated WEAP model provides understanding that climate change together with future demand expansion will result to an annual unmet demand of 1,673.80Mm^3 and mostly affecting the irrigation sector (72.09% of total unmet demand)	• Updated maps indicate that water catchments have experienced some changes in land use and land cover over the past two decades. The analysis generally shows transformation of Forest and Grassland cover to Urban and Cultivated land in the transects

7. Adaptation strategies to changes in ecosystem services elaborated and Adaptive Management Framework (AMF) tools developed	• A set of AMF tools available by 2015 • Tools for vulnerability assessment prioritised, 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 stakeholders developedCommunity sensitisation on climate change effects and need for research undertaken	• 6 MSc students (2 from each country) carry out household vulnerability assessment for 1400 households and their research projects • PVCA (participatory vulnerability and capacity analysis) tool prioritised and training carried out for the students • Climate Change Adaptation Action Plan Development meetings started in Mt. Kilimanjaro	• Both climate-driven and non-climate-driven components have to be included and clearly identified by the involved stakeholders to develop a sustainable adaptation action plan for a specific area • Normative response to the identified problems should consider, e.g. the availability of technical capacity, physical resources, financial resources, and political considerations to address their causes
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				
1. 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 5000 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	• Out of 75,297 Push–pull adopters, 18,940 households have adopted the climate-smart push–pull technology in drier agro-ecologies of Ethiopia, Kenya, Tanzania, and Uganda, translating into about 180,000 direct beneficiaries), covering an additional 4735 ha. Of these 15,152 farmers planted maize, and 3788 planted sorghum, mostly open-pollinated varieties • The maize farmers got an average yield of 3.7t/ha, maize farmers harvested about 18,688 tons of maize, with a combined market value of 9.1 million at current market prices of $487.8 per ton. Sorghum farmers harvested about 9.5 tons from an average yield of 2.51 t/ha, having a combined market value of about $2.7 million at current market price of $854 per ton • 3788 kept dairy cows under zero grazing units and fed them on *Brachiaria* and *Desmodium* yielding 5 litres per day. Similarly 2841 farmers kept dairy goats yielding 3.5 litres per day	• Climate-adaptation of Push–pull has expanded the ecological range of its application, enabling farmers to obtain cereal and milk yields in places where they would not produce a crop • Increased fodder due to good leaf establishment properties exhibited by both *Brachiaria* cv Mulato and greenleaf desmodium has resulted in increased feed availability, enhancing dairy farming by push-pull female and male farmers in the target areas

2. 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 partnerships formed • Number of publications on farmer perception of the adapted Push–pull technology	• Three *Desmodium* spp. of African origin were evaluated alongside *D. intortum* and *D. uncinatum* and incorporated as potential repellent plants in the climate-smart Push–pull technology. The repellent plants were *D. repandum*, *D. incanum* and *D. ramossisimum*, while *Brachiaria* cv Mulato was screened and adopted as the attractant plant • Project partners, including Heifer Kenya, Heifer Tanzania, ISD, KARI, EIAR and LZARDI participated in technology development and dissemination to over 25,000 farmers. Each organisation worked with many NGOs and CBOs • A manuscript is being prepared on farmers' perception of the adapted Push–pull technology	• Substantial amounts of the stemborer repellent compound (*E*)-4,8-dimethyl-1,3,7-nonatriene (DMNT) were produced by unstressed *Brachiaria* cv Mulato plants as well as *Desmodium intortum* volatiles, that is, 3-methyl-1-butanol acetate and (*Z*)-3-hexenyl acetate • Drought stressed plants produced less DMNT and methyl salicylate, which are attractive to parasitic wasps of stemborers. This, with reduction of stemborers encouraged continued assessment of the possibility that the border crop may also repel the herbivore, and thus enhancing the 'push' effect of the companion crop Well-watered *D. intortum* did not produce large amounts of repellent volatiles documented to repel stemborers as compared to drought-stressed *D. intortum* • All the highly drought tolerant desmodium species were found to possess the same biochemical potential for striga control but with different allelochemic modes of action

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				
1. Land productivity datasets derived for eastern Africa	• Linked to land cover transformation, this can guide interventions and integrative assessments in the CHIESA project	• Satellite-derived datasets developed and used by stakeholders in 2015 • MSc and PhD training on GIS organised for at least 25 staff members of the stakeholder organisations	• Two satellite datasets were processed for eastern Africa and the last 12 years on vegetation productivity and land surface temperature • Four MSc-level and postgraduate training courses were given on the utility of the satellite datasets	• Land productivity data needs to be linked to forest loss and land cover transformation to be meaningful
2. Local scale land cover and land use mapping for Taita Hills, Kilimanjaro and Jimma	• Geospatial datasets developed for the three target areas (Taita Hills in Kenya, Kilimanjaro in Tanzania and Jimma in Ethiopia) are widely utilised 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	• Vegetation chlorophyll activity and LST datasets for 2000 to 2012 pre-processed and sent to University of Helsinki data portal • Local scale mapping ongoing; explicit land use data available for the Jimma site	
3. Model trails and training was done to explore the relationship between land cover and species diversity	• 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	• Species envelop for species distribution of thrips in French bean and maize developed for Kenya • Two training workshops organised on species diversity modelling (SDM) using remote sensing variables • Systematic framework for SDM for an array of pests and biodiversity triggers in crops still being developed	• SDM modelling framework is an important outcome that needs more thought and development

4. Baseline information on pests' life table according to the temperatures, on maize stemborer communities densities along altitudinal gradients, on soil and plant silicon levels influencing the stemborer density and communities, stemborer competitions, soil characteristics along altitudinal gradients, farmer practices and their impacts on the agroecosystem	• At least three study outcomes utilised by scientists and students by 2015	• Development of predicting models combining different parameters evaluated by the group by 2015	• 2 PhD studies on course to be completed by 2015: A) PhD of Nancy Khadioli: i) Life table studies completed for *C. partellus, B. fusca, S. calamistis, Cotesia flavipes* and 2 *C. sesamiae* strains. ii) Prediction of the potential change in distribution of stemborer pests and their main larval parasitoids according to different expected climate change scenarios in East and sub-Saharan Africa. B) PhD of Sizah Mwalusepo: i) Stability analysis of computing insect species for a single resource. ii) Analysis of farmers' perception about changes in climatic variables and adaptation strategies in East Africa: The case of Kilimanjaro in Tanzania, Taita Hills and Machakos Hills in Kenya. iii) Prediction of the potential change in distribution of stem borer pests and their main larval parasitoids according to different expected climate change scenarios along Taita Hills and Kilimanjaro transects • 2 MSc studies in course to be completed by 2014: A) MSc of Elijah Njuguna: All field experiments achieved including maize leaf and soil analyses on the variations of Si levels in soil and maize leaves along altitudinal gradients. The laboratory experiments to test the sensitivity of different stemborer species found in the fields to increasing concentration of Si will be done in 2014 B) MSc of Kevin K. Sambai: All the laboratory experiments on the life table parameters of parasitoids development linked to fluctuating temperatures were evaluated to find out the effects of climate change on the stemborers and parasitoids interactions. The analyses of the life table data and the description of these interactions will be done in 2014	• Training and education are key ingredients for successA 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				
Specific objective 3.1: Provide evidence on postharvest losses of various commodities in sub-Saharan Africa and to help decision-makers in governments to optimise their post-production policies and strategies in order to prevent food losses at different levels of the supply chain				
1. Postharvest losses (PHLs) review conducted in six countries—Benin, Ghana, Kenya, Malawi, Mozambique and Tanzania)	• Evidence on PHLs provided and known by policy makers in Benin, Ghana, Kenya, Malawi, Mozambique and Tanzania • At least one journal article completed and shared with partners • At least one policy brief completed and disseminated to the policy makers in Benin, Ghana, Kenya, Malawi, Mozambique and Tanzania • At least one working paper on methodology of PHL completed	• One technical report of the review completed for each country	• Six (6) technical reports produced • Postharvest research and innovation focused more strongly on cereals under smallholder settings. Fruits and vegetables received less research attention, while milk and meat are least represented • On-farm storage is the most researched value chain stage • Losses are often economic rather than physical product losses. Technologies for loss mitigation fail to address dynamics of supply chains	• Postharvest innovations need to incorporate strategies for improving efficiency at different market levels. Food that is regarded unfit at one market level may enter lower-end markets or might be diverted to alternative processing and other value addition processes • Assessment of losses and postharvest innovations from the perspective of entire value chains is limited
		• Journal article submitted	• One (1) journal article under review at *World Development*	
		• Policy brief	• Six (6) Policy briefs produced	
		• Working paper	• One (1) working paper produced	
Specific objective 3.2: Provide evidence for alternative uses of Purdue Improved Cowpea Storage (PICS) bags				
1. 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 2 journal articles completed and shared with partners	• Research reports • Manuscripts submitted to journals	• Without extreme loss of grain viability, a huge decrease in insect infestation, grain damage and weight loss are achieved by storing maize in PICS bag even under *P. truncatus* endemic conditions • Efficacy of hermetic triple-layer bag (PICS™ bag) for storage of mung bean and pigeonpea grains investigated • PICS bag stops losses due to cowpea bruchids and preserves quality of mung beans and pigeonpeas • PICS bags are superior to Actellic treatment, the insecticide commonly used by householders and small traders as a storage protectant • One (01) Master of Science (MSc) thesis completed • Two (02) journal articles in press with the *Journal of Stored Products Research*	• The technology is a practical and useful way to reduce storage losses. It is also suitable for seed storage by individual farmers or seed producersThe technology is a useful way to store mung beans and pigeonpeas without chemical treatment

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. trypanosomosis 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 2013 RBM Framework Outcomes:

Objective 1: Reduce trypanosomosis 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***	***2013 Progress Observed in Obtaining Outcomes***	***2013 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	• 1 WRB PCT patent application submitted • 1 patent application for dispenser being developed	• Intellectual Property Rights (IPR) issues should be addressed adequately during formulation and implementation of projects
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 >80% • Drug use reduced by >60% • 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 MoUs 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	• 2 brochures produced for wider dissemination • 500 farmers attend dissemination sessions • 8 media articles published worldwide	• Importance of media coverage and public relations understood for wider dissemination and influencing policy
6. Training farmers in use of repellent technology 7. 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	• 494 farmers trained • 2 brochures produced • Assessment report by stakeholders very positive and recommends up-scaling	
8. 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 Agreement signed with Ticona GmbH Company and being pursued • 3 meetings held with private sector	
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***	***2013 Progress Observed in Obtaining Outcomes***	***2013 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	• 4 FAO technical reports produced • Milk yield increased to 2–3x • Units up-scaled to 100 in Kisii • Project activities filmed and available on the FAO website • 1 media article published	• Necessity of full time socio-economist for entire duration of projects • More involvement of veterinary services essential • Consistent involvement of Loan Grant projects a challenge

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 • Case 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 >70% • Mastitis cases reduced by >50% in protected units	
3.Training of farmers and NARES in management of zero grazing units to minimise 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	• 496 farmers trained of which 60% are women • 4 training courses held • Training manual production underway • 1 MSc student from Ethiopia trained	
Objective 3. A novel ticks management strategy that is based on the use of bioacaricide, semiochemicals and or botanical developed and implemented to reduce ticks and tick-borne diseases by 50% in cattle by 2015.				
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***2013 Progress Observed in Obtaining Outcomes***	***Lessons Learned***
1. A joint committee (*icipe* and Real IPM) responsible for project implementation and monitoring of activities established	• At least two meetings held by 2014 to monitor project activities	• No. of meetings held • Terms of reference for the committee documented • List of committee members available	• One meeting already held during which different application strategies for bioacaricide and trial sites were discussed	
2. Novel ticks product (bioacaricide) market survey expanded to Tanzania and completed	• Consultancy contract on acaricide market survey awarded	• Contract document available	• Consultancy reports on market survey for Kenya submitted. The market potential for bioacaricide is enormous	Since data on Kenya were not robust, fresh study had to be carried out before moving to Tanzania

3. A business plan to bring novel ticks control product into market developed	• At least 20 fungal isolates screened for virulence against 2 important tick species by 2014 • Compatibility of selected isolates with semiochemicals, botanicals and synthetic acaricides tested by 2014	• No. of fungal isolates screened • List of the isolates • No. of tests and field trails conducted • Publications produced	• Results of screening of isolates of *Beauveria bassiana* and of *Metarhizium anisopliae* indicate that *M. anisopliae* isolate ICIPE 7 is among the best isolates against different developmental stages of *Rhipicephalus appendiculatus* • *M. anisopliae* isolate ICIPE 7 has been found to be compatible with amitraz, the most used acaricide in Kenya and against which ticks have developed resistance	• In addition to *Amblyomma variegatus* and *R. appendiculatus, R. decoloratus* is also considered as an important tick species in Kenya and should be included in our study

(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 2013 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***	***2013 Progress Observed in Obtaining Outcomes***	***2013 Lessons Learned***
1. 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	• Establishment of partnerships with boundary partners • Preparation and use of outcome journals • Participation in focus group discussions with boundary partners	• Outcome mapping is a convenient means of tracking behavioural change in target communities • Wall calendars are an effective means of disseminating research findings to end users • Small-scale trading and farming plus traditional capture fishery activities aggravate malaria
2. Comprehensive evaluation of *icipe*'s ongoing IVM sub-projects	• Development of proposals to mobilise funding for strengthening IVM research and capacity-building activities at *icipe* • Development of a 5-yr strategic plan (2013–2017) for a new IVM programme	• Comprehensive evaluation report of *icipe* IVM projects in Kenya and Ethiopia published • *icipe* Malaria IVM Strategic Plan 2013–2018 drafted • new IVM proposal document	• One IVM proposal developed and funded by Biovision for IVM operational research in Kenya and Ethiopia from 2013–2015 • One proposal for IVM solicited from *icipe* by WHO-AFRO for demonstration of IVM and strengthening of IVM capacity at national and regional levels. • Draft strategic plan compiled	• Evaluation of IVM project implementation and impact is crucial for developing new proposals and for mobilising fundingA strategic plan needs to be regularly reviewed and updated through exhaustive consultations among researchers

3. Implementation of IVM in Kenya and Ethiopia through project: entitled: "Integrated Vector Management (IVM) for Sustainable Malaria Control in Eastern Africa"	• At least 30% increased awareness among communities on IVM strategies for vector-borne disease control • Adoption of IVM policy for malaria control by the Ministry of Health in Kenya and Ethiopia by 2016 • At least 50% decrease in malaria prevalence and mosquito densities in ▯ target areas	• Number of community members trained • Number of combinations of vector control methods (non-chemical/chemical) being used by national programmes • Availability of an IVM decision-making tool for policy makers and vector control personnel • Number of IVM workshops for policy makers and other key stakeholders • Levels of malaria prevalence and mosquito relative density • Improvement in socio-economic status of households • Number of articles published in peer reviewed journals	• A reduction of more than 60% of *Anopheles* and *Culex* larvae in sites treated with biolarvicides (Bti) in western Kenya • IVM-related income-generating activities (IGAs) ongoing in IVM site in western Kenya including planting of 200 mulberry trees for silkworm rearing and production of 6000 bricks for building • About 2000 schoolchildren in Malindi, Kenya reached with mosquito control messages during mosquito walks and education in school clubs • A total of 3600 community members in Tolay, Ethiopia have received awareness on Malaria IVM activities during meetings • One new effective biopesticide for control of mosquito larvae has been formulated • 675 community members (450 male and 225 female) trained in the Tolay project site • 12,700 seedlings planted in the community nursery at the Tolay project site • One IVM workshop for policy makers held in Ethiopia in November 2013 attended by 15 participants from nine different ministries and organisations • One IVM workshop for policy makers held in Kenya in December 2013 and attended by 22 participants from eight different ministries and organisations • 4350 households interviewed for collection of baseline data on socio-economic sites at IVM sites in Kenya and Ethiopia	• Active participation in an IVM project by researchers with diverse expertise including vector biology and behaviour as well as social science disciplines creates powerful synergy for development of transdisciplinary projects with potential for impact and development of appropriate methods for its assessment
4. Understanding the role plant odours play in mosquito attraction established by 2015	• At least three candidate plant-based lures screened for mosquito attraction in the laboratory and field • Research grants in GMM (genetically modified mosquitoes) • At least one plant-based lure optimised for monitoring populations of *Anopheles* mosquitoes	• Number of peer-reviewed publications • Number of proposals • Graduate theses • Number of candidate plant-based lures developed	• Three candidate plant-based lures available • One peer-reviewed publication • One graduate thesis • One proposal submitted and not funded	• Plant-based lures can compete with human/animal-derived lures • Cost implications of field screening of different lures and trapping technologies • Working with communities enhances scientists' knowledge on community needs and acceptance of technologies

5. At least five scientists based at *icipe* working on aspects of mosquito vector competence and genetic approaches to mosquito control with regard to malaria by 2015	• At least 3 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 and GMM technologies • A baseline infrastructure established for research and capacity building on mosquito transgenic technologies	• Number of proposals submitted and funded • Number of staff trained on GMM technologies, biosafety and arthropod containment • Number of peer-reviewed publications • Number of employees • Graduate theses • Number of field sites identified and characterised as potential targets for confined trials	• Co-developed Arthropod level-2 (ACL2) containment guidelines • Construction of an ACL-2 facility for use with GMMs at *icipe*-TOC initiated • A framework towards application for import and contained use of GMMs established • SOPs for conduct of research with GMMs co-developed • Biosafety capacity in project staff built • 4 isolated islands identified and routine entomological surveys conducted • Project activities aligned with government regulatory framework and adapted them to the needs of stakeholders including communities in target sites	• Working through established government health systems enhances project roll out and adoption of innovations • Knowledge of official regulatory frameworks streamlines operations and promotes government acceptance and support • Assumption of duty of care to project staff is an essential legal requirement • Aligning project work to stakeholders' needs enhances success • Good relationship management is key to gaining loyalty from the external and internal operational environments
6. 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	• Development and roll out of a Health Demographic Surveillance System (HDSS) to monitor epidemiological outcomes • Routine social science surveys • Routine parasitological analyses • Routine entomological surveys • Development of a community advisory board (CAB)	• There is a shift in species composition of malaria vectors • Listening surveys provide a powerful platform for continuous improvement in project performance • A community advisory board is a critical interface between project teams and target communities

7. 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 - *Attractive and repellent oviposition semiochemicals of Anopheles gambiae identified in behavioural assays, through GC-MS analyses and through GC-EAD analyses* - *Attractive and repellent natural infusions identified in behavioural assays and in semi-field systems* - *Several tools developed for the analyses of oviposition behaviour of malaria vectors in semi-field and field assays aim to separate the behaviour in approach and landing and in testing attraction from a distance versus stimulation at contact*	• 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	• 1 peer reviewed publication published: ▯ Dugassa et al. (2013) *PLoS ONE* 8, e68948 • Four manuscripts in their final drafting stage • One PhD thesis (Sisay Dugassa) completed. Thesis title: The development of a trap for the collection of gravid malaria vector *Anopheles gambiae*	• 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

- *Three months field work completed to evaluate the catching efficiency of a newly developed gravid trap in the field* - *Longitudinal study implemented to assess colonisation of 12 similar ponds on Rusinga Island and to compare bacteria communities and other biotic and abiotic factors. Mosquito colonisation significantly associated with water quality parameters but not bacteria communities.*				
8. Innovative application strategies of novel, persistent insecticides for *An. gambiae* developed by 2020 - *Oviposition response of gravid* Anopheles gambiae *towards two novel larvicides,* SumiLarv® *0.5 G and Aquatain AMF, evaluated in cage and semi-field assays*	• 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	One manuscript published: Mbare et al.. (2013) *Malaria Journal* 12: 94 One manuscript in its final drafting stage	Difficulty in exposing gravid malaria vectors to pyriproxyfen under semi-field conditions needs rethinking of the auto-dissemination approach

- *Impact of sub-lethal Aquatain concentrations assessed on fecundity and fertility of malaria vectors* - *Potential of auto-dissemination of pyriproxyfen evaluated under laboratory conditions* - *Effect of pyriproxyfen exposure of adult culicine and anopheline vectors on fecundity and fertility evaluated* - *House exiting behaviour of gravid females studied in semi-field system* - *Development of baiting station for pyriproxyfen exposure of gravid vectors*				

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 on disease surveillance and mitigation approaches by 2020

Progress toward achieving objective observed: The impact of the regional trainings conducted by the project has been felt mainly within Kenya with additional collaborative projects being developed and some approved for funding. The collaboration with regional partners is still being sought. The slow response may have to do with the choice of trainees who were selected for training. This was beyond direct control of the project. The virus discovery progress was hampered by the performance of the technologies adopted by the project, which failed to perform. However, project members made efforts to achieve what they could with available technologies. In future, adoption of new technologies for short-term projects will be done with much caution. One PhD student on this study completed her studies hence enhanced capacity. This project was closed in March 2013 after final report was submitted but a number of manuscripts are still being worked on.

Outputs Produced (Activities run)	*Expected Outcomes as per plan*	*Performance Indicator of Outcome*	*2013 Progress Observed in Obtaining Outcomes*	*2013 Lessons Learned*
1. An arboviral surveillance and response system for early warning and response in East Africa established by 2013	• Improved network of partners engaging with us in arbovirus research	• Joint publications • Additional joint projects	• Director of Veterinary Services and University of Nairobi now collaborating in two additional projects: "Preventing and Controlling Eco-health Approach" funded by IDRC and "Prediction and Preparedness against Outbreaks with Devastating Economic Impact"	
2. Twenty field and lab officers from East African countries trained on lab diagnostics, field sampling and biobanking by 2012	• Enhanced collaboration • Improved virus detection	• Improved regional awareness on infections • Increased surveillance activities	• Regional collaboration being sought for new projects with Somaliland, Tanzania and Sudan	• Investment in new technologies should be considered with much cautionSelection of trainees should be done after a wider consultation for desired impact
3. 20 known (arbo-) viruses and 5 new pathogens or their variants detected, 10,000 samples screened by Multiplex PCR or ELISA	• Over 70 virus isolates identified from mosquitoes and ticks, including viruses of public health significance	• Sequences deposited in genebank • Publications • Improved capacity	• 1 peer reviewed publication published: Lwande et al. (2013) *Vector-Borne & Zoonotic Diseases* 13, 637–642 • One PhD graduate on arbovirus studies • Occurrence and diversity of tick-borne viruses in the pastoral eco-zone of Ijara district, North-eastern province of Kenya	• Investment in new technologies should be considered with much caution

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.				
Progress toward achieving objective observed: Lures that improved trap catches of RVF vectors were developed and this has led to the approval of another project to put this to work in the field for RVF surveillance with community participation. One PhD graduate completed his studies on this project thus capacity was enhanced.				
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***2013 Progress Observed in Obtaining Outcomes***	***2013 Lessons Learned***
1. Odour-bait trapping system for RVF vectors developed	• Utilisation of the trapping system for surveillance and monitoring of RVF vectors by stakeholders in RVF research by 2015	• Lure for trapping RVF vectors available • Progress report • Number of peer-reviewed publications • Theses	• New project approved to try the lures; community-participatory approach for improved vector-based monitoring of Rift Valley fever (RVF) disease in Northeastern Kenya • 1 peer reviewed publication published: Tchouassi et al. PLoS Neglected Tropical Diseases (2013), 7(1): e2007	

C. ADAPTATION TO CLIMATE CHANGE & ECOSYSTEM SERVICES OUTCOMES

Environmental Health Results Based Management (RBM) Framework

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

Specific 2013 RBM Framework Outcomes:

Objective 1: Control of the aquatic plant pest, *Hydrilla verticillata*, in East Africa by wild *Polypedilum* (Chironomidae) species by 2013				
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***2013 Progress Observed in Obtaining Outcomes***	***2013 Lessons Learned***
1. Dissemination of information among weed-control professionals in *Hydrilla*-infested areas by 2013	• *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 • Detailed reports of investigations into the potential use of Chironomidae for *Hydrilla* control were delivered to the US 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	• Completed reports sent to weed-control and water boards in southeastern USA • 5 peer reviewed publications published: Copeland *et al.* (2012), *Annals of the Entomological Society of America* 105, 206–224; Copeland et al. (2012), *Journal of East African Natural History* 101, 29–66; Copeland et al. (2011), *Florida Entomologist* 94, 672–679; Gidudu et al. (2011) *Journal of Aquatic Plant Management* 49. 19–27; Wanda et al. (2011) *Journal of East African Natural History* 100, 113–121	

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***
1. 5000 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	• Number of barcodes generated	• Over 7000 specimens submitted to International Barcode of Life Project (Guelph) for barcodingFirst paper published assigning DNA barcodes with microlepidopteran pests of fruits	• Community members have the ability to learn, appreciate and adopt environmental monitoring technologies.
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	• 11 ARPPIS students successfully complete Insect Taxonomy course	
3. African Insect Taxonomy Toolkit (http://taxonomy.icipe.org)	• Scientists and others make periodic use of taxonomic literature and tools	• 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; Biovision -East Usambara, TZ water quality; Mohamed bin Zayed Species Conservation Fund (*Mormotomyia*); and Base Titanium water quality. Pre-proposal to JRS Biodiversity Foundation not selected for development	
5. By 2013, 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. Checklist with 9 orders and 15 families of aquatic insects produced for East Usamabara region • 49 local community members in Kakamega forest and East Usamabara region trained in sampling aquatic insects and identifying them to family level and on pollinators	
6. At least one taxonomic manuscript published in peer-reviewed journal per year	• Entomologists and taxonomists use the data to further research on Afrotropical insects	• Number of times manuscripts are cited	• 1 peer reviewed publication published: Londt and Copeland (2013) *African Invertebrates* 54, 305–314	

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.				
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.				
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
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 initiated3.1.5. A community-based facility established for processing repellent plants 3.1.6. Production of mosquito repellent products initiated through the 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 one repellent plant—*Ocimum kilimandcharicum* undertaken by 1083 households in Kenya and Tanzania • Two community-based facilities for processing the repellent plant operational in Kenya and Tanzania • 1374 mosquito repellent products produced through private sector for market testing4 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 application3.2.2. Two insecticidal plant-derived products formulated and packaged. 3.2.3. Community-based cultivation of selected insecticidal plants initiated3.2.4. Community-based production and use of plant-derived insecticidal products initiated in at least one project site3.2.5. One PhD and two MSc students trained3.2.6. 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 insecticidal plant-derived products for mosquito larval control (Med-Plant-*icipe*-11, *icipe*-NEEM-OD-001 and Med-Plant 2-*icipe*-21) were shown to be highly effective under semi-field and field conditions • Community-based cultivation of 2 insecticidal plants ongoing • Two PhD students trained • 5 peer reviewed publications published: Samita *et al*. (2013), *Beilstein Journal of Organic Chemistry* 9, 447–452; Mokua *et al*. (2013), *Novus Natural Science Research* 2, 27–34; Mokua *et al*., (2013), J*ournal of Applied Pharmaceutical Science* 3, 091–095; Mokua *et al*. (2013), *Acta Tropica* 12, 199–203; Mokua *et al*. (2013), *Spatula DD—Journal of Complementary Medicine and Drug Discovery* 3, 113–120	Plants have a potential for use in disease vector control particularly with rural community participation.
3.3.1. Two plants with bioactivity against honeybee pests/ diseases identified 3.3.2. One plant-derived product formulated and evaluated for control of a honeybee pest/ disease	• One plant-derived product for honeybee pests/diseases control adopted for production and in use by 2015 • Two papers/utility model/patent on potential honeybee pest control products published by 2014	• Number of products produced and usedNumber of reports and publications	• Evaluation of 5 selected plants for bioactivity against honeybee pests/diseases initiated	

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				

Objective 4: Geographic information systems are fully integrated as a strategic research tool for *icipe* by 2020.				
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.				
Outputs Produced (Activities run)	***Expected Outcomes as per plan***	***Performance Indicator of Outcome***	***Progress Observed in Obtaining Outcomes***	***Lessons Learned***
4.1.1. Chlorophyll activity and Land Surface Temperature time-series data set pre-processed 4.1.2. Numerous new GIS datasets uploaded on geospatial sever 4.1.3. Server maintained and data storage capacity increased	• Vegetation productivity and deforestation dataset for East Africa produced and available to *icipe* staff members • Deforestation maps are being used by Kakamega county for political decision making	• Number of new datasets available • Refinement of moderate resolution datasets with higher resolution data underway • Publication and newsflash will follow in May 2014	• Two new datasets produced and available, corrected NDVI and Land Surface Temperature from 2000 to 2013 • 100% of intended outcome complete • More than 5 people now have access and regularly use geo-spatial data from the GIS server	• More time needs to be allocated for outreach, i.e. dissemination of products

4.2.1. Training in GIS, remote sensing for species diversity modelling, biomass mapping and bee health given to project stakeholders, students, resource managers, technicians, and students	Awareness of trainees in the use of geo-spatial technology within their working agenda raised, regarding specifically pests mapping in maize, REDD+ implementation, and setting up of biophysical field measurements/trials	• Number of people trained at various levels • Publications that now make use of GIS-derived maps	• More than 50 participants from various backgrounds trained in GIS, remote sensing and modelling courses in 2013 • Conference presentation on spatial assessment of stemborers in maize given at AfricaGIS 2013 in Addis Ababa, Ethiopia; the method was taught in a species diversity modelling workshop • All training goals attained to enhance the use of geo-spatial data in *icipe*'s research and working agenda and perform training on various levels, i.e. postgraduate and technician levels	• More thought should be given to the sustainability of training, i.e. the use of open source software should be encouraged
4.3.1. Develop e-learning courses	• Increase awareness of the value of geo-spatial data for insect related science • Create more effective learning possibilities	• e-learning platform is complete and number of users	• e-learning platform still needs to be completed; available as beta version • Possibilities of data access and virtual platform set up ongoing • Final e-learning course is still to be developed for 2014	Clarity on how the course will be accessed, and what the exact curriculum should be is a challenge
4.4.1. Proposals on ecosystem services and spatial epidemiology mapping conceptualised and submitted	• Remote sensing and GIS is an integral part of several existing projects and newly submitted proposals on ESS and integrated land use and disease mapping	• Number of projects and new proposals that make use of GIS mapping for ESS assessments and disease mapping	• Four new project modules on GIS disease mapping submitted within new proposals: EU Tsetse project (Shimba Hills); EU Camel, Thrips Project and EU Milk Value Chain project (latter two already funded) • Project modules on GIS and remote sensing for ESS quantification within several ; one existing project formulated	• There are numerous new potential possibilities for GIS in disease mapping
4.5.1. Efforts undertaken to increase the use of GIS in new and existing projects	• The GIS and remote sensing components in the Rift Valley Fever Project increased • The Earth Observation (EO) Unit able to increase its visibility and impact within *icipe*'s working operations	• Number of newly created positions, and funding attained by existing and through new projects	• The number of staff members rose to 6 from 2 in 2013Funding for the Unit increased from 25K USD to 229 USD from new project participations and contracts • Ten new and existing projects now use GIS as a working tool or the GIS component was expanded (i.e. SIDA RVF, EU Milk Value Chain project, CERNVEC, EU Bee Health, SIDA project on Climate Change and Agriculture, etc.)	• There is need to focus and not divert into every possibility for GIS mapping

Specific 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***
5.1.1. Potential and healthy silk and bee races identified for enterprise development in Africa by 20125.1.2. Healthy silk and bee races are distributed to 3000 trainers for the farmer groups5.1.3. Atleast 15 PhD and 10 MSc. Students trained5.1.4. 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	• 6 potential and healthy wild bees (*Anaphe panda; Gonometa postica; G. negrottoi; Argema mimosa; Epiphora bauhiniae; Samia* spp.) and mulberry silk races (*icipe* I –V) and 7 stingless bees (*Plebeina hildebrandti; Meliponula bocandei; M. ferruginea; M. lendliana; Hypotrigona gribodoi; H. araujoi; H. ruspolii*) and 4 carpenter bee races (*Xylocopa caffra*; *X. nigrita*; *X. flavorufa; X. capensis)* identified for enterprise development in Africa by 2013 • Healthy silk and bee races distributed to 2000 trainers for the farmer groups in 12 African countries • 4 PhD (Kiatoko Nkoba; Addis Kebede Teshome; Boniface Ngoka; Susie Wren) and 2 MSc Students (Nelly Ndungu and Peter Kuria) trained • 4 peer reviewed papers published: Kiatoko *et al.* (2014), *Entomological Science* 17: 106–110.; • • Teshome *et al.* (2014) *Journal of Insect Science* 14, xx. http://www.insectscience.org/14.xx; Teshome *et al.* (2014) *International Journal of Insect Science* 6, 9–14.; • • Cock *et al.* (2013), *CAB Reviews* 8, No. 028, 1–48 • 1 proceedings published	• Trained community accepts the silk and honey enterprise for additional income and pollination services
5.2.1. Training material developed5.2.2. Training sessions held for 2000 trainers	• Knowledge of sericulture and apiculture is applied by at least 750 farmer groups (each 50 to 100)	• Number of farmers trained, number of certificates (exam), number 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	
5.3.1. 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 (Ethiopia, The Sudan, Kenya, Yemen and South Sudan) in Africa • Business responsibility adopted by at least 40 farmers groups	

5.4.1. Establish 16 to 20 marketplaces (honey and silk harvesting, processing and selling units)	• 25% increase in honey and silk quantity by 2013	• DC registry • Production records	• 5 new marketplaces established in 4 African countries (Ethiopia, The Sudan, Kenya and South Sudan) for honey and silk harvesting, processing, and selling units	
5.5.1. Supply modern bee hives to farmers and establish rearing houses (silkmoth)			• 3000 stingless and honeybee hives supplied to farmers in 6 African countries (Ethiopia, The Sudan, Kenya, Yemen, Uganda and South Sudan) 7 rearing houses (silkmoth) established and operational in Kenya, Uganda, The Sudan and Ethiopia	
5.6.1. Internal Control System (ICS) training for 3000 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 honeybee 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***
6.1.1.Key honeybee pests identified, and maps of their occurrence and distribution in Kenya developed	• Documentation of honeybee pests, maps available and utilised by 40% of stakeholders for training beekeepers by 2020	• Number of stakeholders using mapsPeer-reviewed publication	• Project approved and commenced in May 2013 • Surveillance in 5 geographical zones in Kenya completed. The major pests identified were hive beetles and Varroa mites. Surveys in Ethiopia, Cameroon and Liberia ongoing	• Beekeepers/Farmers must learn to monitor pests and diseases in their beehives
6.1.2. 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	• Reference laboratory construction and refurbishment of satellite stations for training of the trainers and Farmers' Federations ongoing (Expected completion - June/July 2014) • Project Inception Workshop and Inaugural Steering Committee meeting held in Sept 2013 with 65 delegates from 15 countries • Signing of MoUs with relevant Ministries in the four project countries and space for marketplaces development allocated in all project countries • Two major trainings covering 15 African countries were held (Uganda, Somaliland, Congo, Tanzania, Ethiopia, Sudan, Cameroon, Ghana, South Sudan, Kenya, Egypt, Burkina Faso, Liberia, Madagascar and Yemen)	• Beekeeping officers and veterinarians ToTs learn the epidemiological reporting methods for infectious honeybee diseases and pests using ARIS 2 for their respective countries • ARIS 2 software helps to collate, analyse and make available in a timely manner, reliable and up-to-date data, information

				and knowledge on bee diseases and pests to support honey production and pollination services, planning and decision making
6.1.3. 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	• Development and optimisation of pesticide residue analysis using gas chromatography-mass spectrometry initiated • GIS and remote sensing: 150 flowering plants identified and tagged in Mwingi using hyper spectral sensor • 1st training workshop of 25 ToTs from participating countries trained in bee health in Nov–Dec 2013 • Collection of wild plans initiated and bioassay being developed	

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 2013 RBM Framework Outcomes:

Objective 1: 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***	***Performance Indicator of Outcome***	***2013 Progress Observed in Obtaining Outcomes***	***2013 Lessons Learned***
1. Two-hundred (200) PhD and MSc postgraduates trained in arthropod-related sciences in research and development and working in NARS, universities and the private sector in Africa	• At least 80% of graduates trained in research and development working in NARS, RECs, SROs, CGIARs, and universities in Africa	• 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	• 14 new PhDs enrolled for research studies and 30 MSc scholars (of these, 13 women) offered short-term internships in 2013 • Training support continued for 28 full-time PhD scholars (ongoing) • 100% of PhD trained and 30% of MSc trainees are effectively employed in NARS, universities and the private sector	• Graduates trained in Africa are mostly retained in the continent to fill capacity gaps in national and sub regional programmes • Graduates trained in agriculture will continue to contribute to reduction of '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 and private organisations/ enterprises in Africa	• 80% of graduates are involved in research leading public and private organizations/enterprises in Africa • As in years before, some scholars suffered delays in completing research experiments due to lack of specific equipment in the universities. In some cases, absence of a clear thesis review and examination system, both at *icipe* and the universities led to some delays in scholars' graduation	• The specificity of *icipe*'s training equips postgraduate scholars with appropriate scientific skills that can be applied to solve specific problems that affect Africa

2. Publication of research results (theses, book chapters, peer-reviewed journal articles, brochures, etc.)	• At least 80% of research results disseminated in relevant formats at scientific community and policy makers levels in Africa by 2013	• 58 publications of research results done in 2012Number of published articles in journals, student theses, book chapters, peer-reviewed journal articles, brochures	• During the reporting period, *icipe* scholars and scientists published a total of ninety-nine (99) peer reviewed publications (13 April 2013 – 31 March 2014 Publication List) (See Annex at end of this Report)	
3. Two-hundred (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 NARES in Africa by 2013	• Number of training courses • Number of trainees • Number of new technologies produced and adopted • Training and information	• 20% progress achieved in 2013 as most of the work has been on baseline and feasibility studiesBaseline work for non-degree training done— Innovation and adoption of relevant insect science in collaboration with regional and national agricultural research and advisory services and the private sector) under Milk Value Chain Project • Statistics training held in Somaliland in Nov. 2013; baseline studies on GIS tracking of camel migration routes; baseline survey to identify indigenous fodder plant species; baseline study on ticks and tick-borne diseases burden; gender analysis of milk value chain in Somaliland; and validation and up-scaling of Push–Pull Project in Somaliland • All this is geared towards eventual group training of practitioners in Somaliland	• Training of mid-level practitioners and extension workers, and internship opportunities offered at *icipe* contribute to solving specific problems that confront research results end users
4. One-hundred and fifty (150) undergraduate interns trained	• At least 80% of trained undergraduate interns progressing to research and development careers by 2013	• Number of interns trained and progressing to research and development careers	• 45 interns trained in 2013 and proceeded with studies at respective universities and technical colleges	• Practical training, through internship opportunities offered at *icipe* contributes to solving specific problems that confront research results end users

5. Ten (10) new networks with national and regional research and higher education institutions established	• At least 5 new projects developed with national and regional partners by 2013 • At least 10 new trainees at postgraduate level and 50 mid-level trainees resulting from these networks • Increased technology uptake and out-scaling in NARES in Africa by 2013	• Number of technologies adopted by research results users • Number of joint research projects funded • Number of innovative field research in insect sciences disseminated with partners • 40% of research results disseminated in relevant formats at scientific community and polytechnic levels in Africa (e.g. fruit fly, thrips, push–pull and related technologies)	• One new project developed with national and regional partners in Somaliland and sub-Saharan Africa • Two *icipe* technologies (Tick & tick-borne surveillance disease, Milk Value Chain and Push-Pull Technology) and out scaling in NARS in Somaliland • Memorandum of Agreement for collaboration and joint research signed with University of Somalia in 2013 and another MoU was signed with Benadir University, Somalia • ARPPIS alumni online platform continued to receive support in 2013 • Training of individuals not done but information leaflets on the tomato leafminer and translation to 5 other languages (Swahili, French, Amharic, Afaan-Oromo, and Somali) done. Brochures have been distributed to partners and NARS where they are most useful	• 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 organisations and universities in Africa and worldwide are contributing to the creation of more opportunities in Africa for early-career African scientists • To ensure sustainability of the programme,, consolidation of the existing alumni network and revival through involvement of members needs to be done in devising future *icipe* development strategies • Respondents felt that main benefits derived from collaboration were use of facilities and equipment at *icipe*, expansion of network of colleagues and exchange of ideas and knowledge

6. Ten (10) career development opportunities for ten professional development programme (short term - visiting scientists and PDFs) implemented by 2013	• At least 70% of graduates contribute to research and development in NARES and higher education institutions in Africa by 2013 • At least 50% of graduates attract competitive research grants by 2015	• Number of postdoctoral fellows and visiting scientists trained • Number of grants received by 2015 • Number of research publications in peer-reviewed journals	• A total of 15 post-doctoral level researchers supported at *icipe* for research activities • 1 visiting scientist supported • 1 postdoctoral fellow co-supported with TWAS in 2013 • 2 PDFs provided 2 year contracts for research work at *icipe* supported by Sida (*both icipe graduates)* • PDFs from Kenya (1); Uganda (1); Zimbabwe (1) and Nigeria (1) provided with co-financing research support from Sida and Administration (stipend, medical insurance and travel) for short-term activities at *icipe* • 1 visiting scientist from Nigeria provided with support for research activities at *icipe* • 6 PDFs provided with 2 year contracts for research with support from DFID *(3 are icipe graduates)*	• Careers developed at *icipe* in insect sciences are bringing considerable rewards to African scientists

ANNEX: LIST OF REFEREED JOURNAL ARTICLES

13 April 2013 – 31 March 2014 Publications List

2013

1. *Agboton B. V.*, *Salifu D.*, Seguni Z., Sijaona M. E., Shomari S., *Ekesi S.* and *Maniania N. K.* (2013) Bioecology of some key cashew insect pests and diseases in diverse habitats and 2landscapes in Tanzania. *Journal of Applied Entomology* 137, 782–789. doi: 10.1111/jen.12069.

2. Ahouangninou C., *Martin T.*, Assogba-Komlan F., Simon S., Djogbénou L., Siddick I., Pennetier C., Corbel V. and Fayomi B. (2013) Using *Aedes aegypti* larvae to assess pesticide contamination of soil, groundwater and vegetables. *British Biotechnology Journal* 3, 143–157.

3. *Akutse K.S.*, *Maniania N.K.*, *Fiaboe K.K.M.*, Van den Berg J. and *Ekesi S.* (2013) Endophytic colonization of *Vicia faba* and *Phaseolus vulgaris* (Fabaceae) by fungal pathogens and their effects on the life-history parameters of *Liriomyza huidobrensis* (Diptera: Agromyzidae). *Fungal Ecology* 6, 293–301. doi.org/10.1016/j.funeco.2013.01.003.

4. *Andargie M.*, *Pasquet R.S.*, Muluvi G.M. and Timko M.P. (2013) Quantative trait loci analysis of flowering time related traits identified in recombinant inbred lines of cowpea (*Vigna unguiculata*). *Genome* 56, 289–294.

5. *Appiah E.F.*, *Ekesi S.*, *Salifu D.*, Afreh-Nuamah K., Obeng-Ofori D., *Khamis F.M.* and *Mohamed S.A.* (2013) Effect of temperature on immature development and longevity of two introduced opiine parasitoids on *Bactrocera invadens*. *Journal of Applied Entomology* 137, 571–579. doi: 10.1111/jen.12036.

6. Beshir K.B., Sutherland C.J., *Sawa P.*, Drakeley C.J., Okell L., *Mweresa C.K.*, Omar S.A., Shekalaghe S.A., Kaur H., Ndaro A., Chilongola J., Schallig H.D.F.H., Sauerwein R.W., Hallett R.L. and Bousema T. (2013) Residual *Plasmodium falciparum* parasitemia in Kenyan children after artemisinin-combination therapy is associated with increased transmission to mosquitoes and parasite recurrence. *The Journal of Infectious Diseases* 208, 2017–2024. doi: 10.1093/infdis/jit431.

7. *Birithia R.*, *Subramanian S.*, Pappu H. R., Muthomi J. and Narla R. D. (2013) Analysis of **Iris yellow spot virus** replication in vector and non-vector thrips species. Plant Pathology, 62: 1407–1414. doi: 10.1111/ppa.12057.

8. Campagne P., Kruger M., *Pasquet R.*, *Le Ru B.* and Van den Berg J. (2013) Dominant inheritance of field-evolved resistance to Bt corn in *Busseola fusca*. *PLoS One* 8(7), e69675. doi:10.1371/journal.pone.0069675.

9. Cerveira A.M. and *Jackson R.R.* (2013) Love is in the air and on the ground: Olfactory and tactile cues elicit visual courtship behavior by *Cyrba* males (Araneae: Salticidae). *Journal of Arachnology* 41, 374–380. doi.org/10.1636/Hi12-42.1.

10. Claude A., *Martin T.*, Assogba-Komlan F., Simon S., Djogbénou L., Siddick I., Pennetier C., Corbel V. and Fayomi B. (2013) Using *Aedes aegypti* larvae to assess pesticide contamination of soil, groundwater and vegetables. *British Biotechnology Journal* 3, 143–157.

11. 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.* (2013) The implications of climate change for the positive contributions

of invertebrates to world agriculture. *CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources* 8, 1–48.

12. Cugala D., *Ekesi S.*, Ambasse D., Adamu R.S. and *Mohamed S.A.* (2013) Assessment of ripening stages of Cavendish dwarf bananas as host or non-host to *Bactrocera invadens*. *Journal of Applied Entomology*, DOI: 10.1111/jen.12045.

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14. Delobel A., Anton K.-W., *Le Ru B.* and Kergoat G.J. (2013) Morphology, biology and phylogeny of African seed beetles belonging to the *Bruchidius ituriensis* species group (Coleoptera: Chrysomelidae: Bruchinae). *Genus—International Journal of Invertebrate Taxonomy* 24, 39–63.

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16. *Dugassa S.*, Lindh J.M., Oyieke F., *Mukabana W. R.*, Lindsay S. W. and *Fillinger U.* (2013) Development of a gravid trap for collecting live malaria vectors *Anopheles gambiae* s.l. *PLoS ONE* 8, (7): e68948. doi:10.1371/journal.pone.0068948.

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of malaria vector control strategies in West Africa. *Acta Tropica* 128, 7–17. doi:10.1016/j.actatropica.2013.06.004.

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analytical performance of PCR and LAMP-based trypanosome detection methods estimated using pooled whole tsetse flies and midguts. *Veterinary Parasitology* 197, 549–556. doi: 10.1016/j.vetpar.2013.05.022.

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the use of eco-friendly nets to ensure sustainable cabbage seedling production in Africa. *Agronomy* 3, 1–12. doi:10.3390/agronomy3010001.

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International Centre of Insect Physiology and Ecology

P. O. Box 30772-00100 Nairobi, Kenya
Phone: +254 (20) 8632000; Fax: +254 (20) 8632001/2
Email: *icipe@icipe*.org Website: www.*icipe*.org