icipe
EXTERNAL REVIEW REPORT (2008–2012)

icipe

African Insect Science for Food and Health

International Centre of Insect Physiology and Ecology

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EXTERNAL REVIEW
2008–2012

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Preamble

Since 1983, the Sponsoring Group of *icipe* together with the Governing Council, have commissioned the *icipe* Periodic External Review (IPER). These reviews are undertaken every 5 or 6 years, the last one covering the period 2002 to 2007. The purpose of the current review is explicitly stated in the Terms of Reference, and this includes the request for a critical review of *icipe*'s new draft Vision and Strategy 2013 – 2020. Global environmental changes such as climate change and increased climate variability, and the already manifest as well as anticipated consequences for global food security and global health, are probably the most important global concerns today. How does *icipe* intend to respond to these challenges? A review of the institution's programmatic and institutional agenda is valuable as a tool for evaluating how *icipe* is positioning itself to meet the new challenges.

The review should gauge how the programme agenda is in tune with *icipe*'s institutional mandate and to what extent it meets the development needs of its African constituency through the creation of knowledge-based solutions, building capacity of individual researchers and institutions, contributing to policy development and ultimately, reducing the impact of pests and vectors of arthropod-borne disorders that have a direct bearing on poverty, health, food security and well-being. The review serves as a benchmarking function, taking stock of what has been achieved during the reporting period (2008 – 2012) while making recommendations to enable any necessary realignment of programme priorities and implementation plans for the next 5 – 7 years.

The review should address the following specific concerns: a) Success in operationalising the preceding Vision and Strategy 2003–2012; b) Critical review of the draft Vision and Strategy 2013–2020; c) Impact of *icipe*'s work in meeting national and regional development priorities of its African constituency since the last external review (period 2002–2007); d) Innovative programme design and strengthened research infrastructure to deliver on the institutional mandate; e) Rising to the challenge of emerging opportunities and threats; f) Sourcing investment for the programmatic agenda; g) Strategic partnering and linkages; h) Assessing the present and future capabilities of the Centre's Management and Administration (including Finance, which has not been reviewed previously) structure and resources and policies in supporting growth in R&D and Capacity Building. (For more details see Terms of Reference, Annex 1).

Our focus during the review has been on *icipe*'s principal research projects, training and capacity building programmes, technology transfer mechanisms and impacts in the field. In addition the team has looked at infrastructure and physical facilities, including Governance and Corporate affairs. The methods used have included a mixture of field visits, interviews of farmer groups (particularly practitioners of *icipe*-generated scientific methods such as push–pull farmer groups, livestock keepers using tsetse repellent collars, etc.), collaborative partners, authorities and relevant officials in the host country, and *icipe* management and staff.

Furthermore, we have conducted a desktop study of the voluminous documentation and presentations supplied to us by *icipe*. Based on our overall observations and analyses we have attempted to arrive at general and specific recommendations for the benefit of the review commissioners (i.e. GC and SGI) and, ultimately, for the benefit of *icipe* management and staff, and current and future students. We are the first to acknowledge that our review cannot be all-encompassing; although extremely intensive, the field programme lasted a total of three weeks and it was impossible in the time available to visit all of the field sites we would have wished to see. Nevertheless, we feel we have had a good insight into what *icipe* is and does, whom they interact with and some of the impacts their work has. We have paid particular attention to the Vision and Strategy document 2013 – 2020, and have attempted to constructively criticise it. We do not expect all our recommendations to be taken on-board by *icipe,* but hope that some may provoke discussion and eventually lead to improvement.

The three members of the review team are from different academic and societal backgrounds and professional careers, and this will be reflected

in some of the recommendations. What we did observe, however, was that this mix was most productive when all three visited a project together, and could contribute to resulting discussions from different backgrounds and viewpoints. We would recommend that this fact be considered when planning the next IPER. We would like to thank *icipe,* particularly the Director General, Prof. Christian Borgemeister and everyone of his colleagues, staff and students who generously gave us their time for interviews and discussions throughout the review period – and beyond! We would also like to especially thank the housekeepers at Kasarani and Mbita for making our stay so comfortable, and the *icipe* chauffeurs who patiently ferried us around countless miles even beyond normal working hours. Perhaps most rewarding for us during the field programme was the possibility to meet and interact with the recipients of *icipe*-generated knowledge, e.g. the push–pull farmer groups, the livestock keepers, the women beekeeper groups, silk marketplace workers and *icipe*'s stakeholders, clients and partners, all of whom were so positive and enthusiastic during our visits.

To all of you, we sincerely hope that this review offers some constructive ideas for the development of *icipe*, enabling *icipe* to further 'improve the well-being and resilience of people and the environment to the challenges of a changing world'.

September 2013

Philip Chiverton (Team Leader), Judi Wakhungu and Jakob Zinsstag

1. Executive Summary

The reviewers highly commend *icipe* for creating a superb portfolio of innovative research and development. **We consider** the research to be of high to highest quality, a fact supported by the large number of peer-reviewed articles published throughout the review period. Furthermore, this 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 SLU[1]. The evaluation was a huge learning process for all of us in the review team and gave us fantastic insights. *icipe* has performed excellently, typified by a strong involvement with national, public and private partners.

We strongly recommend that *icipe* maintain this mix of strategic and applied research but that it should also consider more direct interventions, perhaps with the aid of carefully selected development partners. **We also strongly recommend** that *icipe* focus its activities as far as possible on the whole of Africa. With the Martin Lüscher Emerging Infectious Diseases Laboratory (opened in 2011) and the soon to be constructed African Reference Laboratory (ARL) for research and capacity building on bee health funded by the EU, *icipe* will be well-equipped to serve on a pan-African basis.

Although the engagement of *icipe* with communities and the academic systems through capacity building is excellent, stakeholders have expressed a wish for a stronger engagement with NARS. Most of them would like to contribute to *icipe*'s strategy development. NARS, in particular, expressed a desire to be included in the initial project planning stages. Overall the impact on development is well recognised but remains fairly limited, e.g. in the fields of human and animal health. Emerging evidence of sustainable control of human (malaria) and animal diseases (trypanosomosis) should be rapidly analysed for their cost-effectiveness. *icipe* should strengthen its health economic capacity (see below).

The review team recommends that *icipe* should commission a social scientist or an anthropologist to analyse and document the unique trans-disciplinary experience demonstrated in several projects. Community and farmer perception studies are well-conducted. However, the team feels that a detailed social analysis of stakeholder processes (power and gender relations), e.g. those of the community-based malaria control and/or the stingless bee domestication would facilitate better understanding of the potential of post-project community-based actions. Specific attention should be given to organised community groups and the intersectoral collaboration between different ministries, for instance between the ministries of Health, Agriculture and the Environment.

The review team strongly recommends that *icipe* either builds up socio-economic analytical capacity or, in the interim, commissions suitably qualified consultants to conduct cost/benefit analyses of the majority of its projects /programmes. We note that exactly the same recommendation was made in the last external review 2002–2007. The Intercooperation (Switzerland) impact assessment study of Push–Pull is one example of what should be the norm for each of *icipe*'s programmes. We are aware that one social scientist has begun an economic impact study in the Mwingi Honey Marketplace; however, we feel that this is woefully inadequate, particularly since this project has been ongoing for a number of years. Hive records have been meticulously kept; however, there is a real risk that baseline data, i.e. the state of honey production prior to project implementation, will – at best – be anecdotal. That said, the review team was satisfied to see that the economics of push–pull was to be the subject of an ARPPIS PhD study starting 2013.

Many African universities are poorly planned in that they separate research and teaching. A university teacher not doing her or his own research is out of date within three years. In future, African universities must be research-driven (see e.g. http://r4d.dfid.gov.uk/pdf/outputs/systematicreviews/Capacity_strengthening_2013Posthumus.pdf). Teaching must be linked to research and not separated. International research institutions such as *icipe* could, and should, play an important role in this transition. Originally, international research

1 The 2009 OECD-HERD average is 180,000 USD per paper.

institutions were conceived to bridge this gap. They should first become affiliated to African universities. African university professors should be able to do research at low cost at *icipe* (c.f. ILRI, whose exorbitant bench fee prohibits many such linkages with African scientists) and use their research results in their teaching curricula. In turn *icipe* scientists should be affiliated professors at African universities in order to teach their research, and to be able to let their students defend their PhD theses. In a further step, by the partnership with *icipe*, research groups should be firmly established at African universities to ensure that research and teaching is inextricably linked. **The review team strongly suggests** that this is a recipe for success of African universities and *icipe* can play an important role in this process. **Our recommendation is** that *icipe* identifies one key university in each of the East, South and West African countries and forges greater ties with them, as suggested above. Examples in East Africa include Makerere University in Uganda, Sokoine University of Agriculture in Tanzania and Jomo Kenyatta University of Agriculture and Technology (JKUAT) in Kenya. Moreover, because of ongoing strong ties with the University of Ghana within the ARPPIS programme, this would be a reasonable choice for West Africa.

An excellent example of the above strategy and its impact on the regional spread of the *icipe* research and capacity building is Dr Kiatoko Nkoba from the Republic of Congo, who works very well with the communities in Kakamega, Kenya. He recently finished his PhD, teaches in Kinshasa and wants to transfer the (stingless) beekeeping practices to Congo.

2. General Framework of Programme Research and Capacity Building

2.1 Success in Operationalising the Preceding Vision and Strategy 2007–2012

"The profitability of any enterprise is the key to its success" (Hans Herren)[2]

icipe is unique. It is the only international centre working primarily on arthropods in Africa and for Africa (mostly in eastern and southern Africa, but also with extensive activities in West Africa). The reviewers firmly believe that *icipe*'s 4H paradigm continues to be highly relevant, encompassing as it should, the breadth of *icipe*'s mission. *(But see below in review of Strategy and Vision 2013–2020)*.

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 considers** that *icipe* has indeed gone a long way to fulfilling these aspirations.

2.1.1 Animal and Human Health

icipe develops innovative, site-specific integrated animal health packages for the rural poor (PP. 13-14). The tsetse project in Shimba Hills is certainly a highlight of the outputs of *icipe* in the past project phase. The review team members have not seen smallscale cattle farmers being so enthusiastic about an animal health device like the waterbuck repellent collar. The 'pull' aspect is working in principle, but there is still some room for improvement in its execution, with regards to issues like wind, land ownership, fires and fading of the colour. This could eventually be addressed

2 Raina S.K. (2000). *icipe*, Kenya and IBRA, UK. 86 pp. ISBN 0 86098 236 X..

Prof. Jakob Zinsstag (seated) looking at blood smears for trypanosome infection. Looking on is Dr R.K. Saini, PI of EU funded tsetse repellent project.

by involving communities continuously in the further product development process. However, the scientific community does not currently perceive the tsetse push–pull control method as effective and the few existing results find a rather low effect on the reduction of disease incidence (23% in the Maasai area)[3]. In the Shimba hills study, there seems to be enough data for a comprehensive productivity and benefit–cost analysis of this control system. Attention should be paid to collecting good demographic data on birth, abortions and mortalities *(see below)*. The economic analysis should not only address livestock products but also changes in the herd composition (demography). Provided the current perceptions by the farmers can be confirmed by the productivity and economic analyses, this tsetse control programme should now be scaled up by developing a low cost plastic device with repellent activity lasting 3–6 months and be tested in other African countries and possibly for humans.

The visited farmers in Kisii seem very pleased with the zero-grazing husbandry and livestock protective net fence (LPNF) around their stables and perceive increased productivity and income. This work should be extended to include milk hygiene and possibly genetic improvement. At some point, improved feeding of cows will become an issue as milk production increases. Again, there is no formal analysis of productivity and profitability. This is urgently needed. In due course, the animal welfare dimension of zero-grazing units should be addressed, say by including fly protected areas for free movement of the animals. Similar experiences are reported with pigsties in the New Juaben District in the eastern region of Ghana, reducing piglet mortality and drug expenditure (P. 21). There appears to be an independent uptake by farmers, and *icipe* collaborates closely with the Ministry of Agriculture in Ghana. Similarly, a formal economic analysis of the profitability of LPNF for pig production is urgent and will help to disseminate the technology in Africa.

A reduction of 70% of *Amblyomma variegatum* ticks has been achieved in the field by using the entomopathogenic fungus *Metarhizium anisopliae* and semiochemical-baited traps. This work has high potential and should be pursued, but also analysed for its effect on livestock productivity.

In general, the tested animal health interventions are still too vertical, and mainly oriented to reducing insect vectors. These interventions could be combined, i.e. with improvements in milk hygiene, genetic and feeding improvements and also on human health. There are already similar examples and *icipe* should not wait to publish its own results[4]. Similarly, the study of Rift Valley fever (RVF) inter-epidemic transmission should be pursued, and the monitoring and surveillance should not be restricted to mosquitoes but also to the animal host, i.e. sheep. It is likely that in the event of an RVF outbreak the surveillance sensitivity is higher for sheep abortions than for the presence of the virus in the transmitting mosquitoes.

2.1.2 Plant and Environmental Health

Approximately 30,000 new smallholder farmers in western and central Kenya, as well as ca. 2000 new farmers in Uganda and Tanzania adopted the conventional push–pull technology, which has resulted in an estimated annual increase of ca. 77,000 tons of maize, 11.5 million litres of milk, and 6 tons of *Desmodium* seed. It is further estimated that the latter has improved livelihoods of at least 300,000 beneficiaries in the region. Push–pull technology has been adapted to drier areas (ADOPT; *see page 16*) and climate change effects by selecting drought-tolerant component plants (viz., *Brachiaria* instead of Napier grass, and greenleaf desmodium [*Desmodium intortum*]

3 Bett *et al.* (2010), *Prev. Vet. Med.* 97, 220–227. doi: 10.1016/j.prevetmed.2010.09.001.

4 Maia *et al.* (2012). *PLoS ONE* 7(9): e45794. doi:10.1371/journal.pone.0045794.

instead of silverleaf desmodium [*D. uncinatum*]), and this has subsequently been adopted by 4000 new smallholder farmers. The collaboration with Heifer International is working extremely well and the reviewer met several communities who proudly demonstrated their zero-grazed cows fed on chopped leaves of *Brachiaria*, Napier or *Desmodium*, from their conventional or ADOPT push–pull fields. Local agricultural officials (DLPO etc.) who had been involved, and had supported these community projects from their outset accompanied us on all demonstrations and visits.

Unfortunately, the particularly destructive Napier stunt disease can infect Napier grass. *icipe* scientists have screened different varieties of Napier, and other fodder grasses, for resistance to this disease and have found a number of cultivars showing resistance. These are now being tested on-farm in Kenya.

One particularly exciting development is the commercial production by a private company, Real IPM, of two *icipe* fungal isolates of *Metarhizium anisopliae* (ICIPE 69 and ICIPE 78). These are now marketed as Campaign™ used in IPM programmes against fruit flies, mealybugs and thrips, and Achieve™ for the control of mites, on various crops in East, West and South Africa. Regarding fruit flies, examples of this successful IPM programme were visited at mango growing sites in Tanzania and Kenya. Once again there was enormous enthusiasm among the mango growers and, as with push–pull, there was full involvement and back up from the local agricultural officers and/or other partners.

It is estimated that the fruit fly IPM is now being practised by over 5000 mango and citrus growers in Benin, Cameroon, Kenya, Mozambique and Tanzania ultimately benefitting 30,000 people; and that as a result of the adoption of fruit fly IPM technologies, mango fruit rejection by export markets has been reduced from 37% in 2003 to 4% in 2011 among farmers in eastern Kenya. On the day of the reviewer's visit, one community fruit fly IPM project in Embu, Kenya, had just exported 6 tons of mangoes to Uganda with a clean bill of health.

The African weaver ant has been shown to be an effective predator in the biocontrol of mirid and coreid bugs, which are serious pests of cashew nuts grown in the coastal regions of Tanzania.

Two exciting products resulting from *icipe* research: Fungal isolates of *Metarhizium anisopliae*, (Campaign, right) used in IPM programmes against fruit flies, mealybugs and thrips, and (Achieve, left) used for the control of mites on various crops.

In environmental health, the returns from the community honey and silk enterprises are extremely impressive (see Annex 5), and **the reviewers strongly recommend** robust cost/benefit analysis of these enterprises. For example 24 tons of dry silk cocoons were produced and processed into yarn and cloth by community groups in six African countries with a total value of $ 240,000. Over 1200 tons of honey with a total value of $ 4.5 million were processed and sold by community groups in Kenya, Ethiopia, Sudan, Uganda, South Sudan and Egypt through honey marketplaces developed by *icipe*. At $ 50 per kg the price of the rare Yemeni Sidr honey is astounding, and the potential here is enormous.

The reviewers only had time to visit the community-driven bioprospecting project in Kakamega Forest in Kenya. This community project developed by *icipe* with the full backing of the Kenya Forest Service cultivates insecticidal and medicinal plants and produces products as new alternative livelihood activities. The reviewers were divided as to the economic viability of such activities, and **strongly recommend** a cost/benefit analysis here to strengthen the case.

In conclusion, *icipe*'s outreach in building up East African regional and African research capacity is impressive. Indeed, it appears that almost all entomologists in Africa have, or have had, some involvement with *icipe*. This is particularly recognised by Kenyan universities. In this way, *icipe* plays also an important pan-

African networking role in insect expertise. *icipe* has made tremendous scientific progress in the last five years and consolidated its management and financial situation. However, the reviewers find that *icipe* has only responded partially to the recommendations in the last review to strengthen the socio-economic aspects, i.e. by having an economic analysis for every intervention.

2.1.3 Perceptions of key national and regional stakeholders

Most partners and stakeholders perceive *icipe* as an important partner in advancing the national and regional development agenda. In regard to animal and human health, the Kenya Wildlife Service (KWS) expressed satisfaction with *icipe* and wishes to continue their fruitful collaboration, i.e. on bush meat identification and the training of PhD students in molecular biology for trophy and bush meat identification. KWS would be pleased to see an even stronger engagement in vector-borne zoonoses and human African trypanosomosis (HAT) inside conservation areas like the Tsavo National Park or the Masaai Mara National Reserve. Disease control packages should be integrated with ongoing interventions, say against anthrax or foot-and-mouth disease as outlined in the strategy document. While the latter is certainly an important technical orientation of future work, from a more general institutional development point of view, **we recommend that** *icipe* should rather concentrate on its core strength in vector biology and ecology, rather than to engage strongly in pathogen research *per se*. As a stakeholder cited "*icipe* does not need to do everything".

Discussing field trials at KARI - Kenya, with Professor Chiverton. Partners and stakeholders were particularly happy with their collaboration with *icipe*.

Some national Kenyan partners (e.g. KARI-TRC) wish for a stronger engagement in capacity building and their perception is that *icipe* merely uses them as a junior partner, or using their technicians, without involving their scientists. As most of these organisations have a shortage of scientists and technologists, further training of PhDs in partnership with *icipe* should be strengthened. KARI-TRC wishes for a stronger collaboration in mass rearing of tsetse flies and in the use of the sterile insect technique (SIT). The positive effects of tsetse control in the Shimba Hills need to be substantiated beyond the reported and visible enthusiasm of farmers. Positive effects on cattle productivity should be assessed scientifically and economically to be successfully applied to large-scale use, possibly through PPPs. KARI-TRC wishes better access to *icipe* equipment and technology under affordable conditions.

The Ministry of Health, KEMRI and community representatives recognise the dramatic decrease of malaria along the Kenyan coast in the last 5 years, and *icipe*'s engagement. However, it is not clear to what extent the mass use of insecticide-treated bednets, which is not primarily an *icipe* initiative, or the larvicidal interventions and environmental management, promoted by *icipe*, contributed to this decline. *icipe* should pay a lot of attention in carefully analysing the incremental effects of larvicidal and environmental management techniques on malaria transmission risk. The latter heavily involve community action and local authorities and their sustainability depends on how the effect of their engagement can be substantiated. It is important to recognise the contextual aspect of different malaria interventions. In many cases different techniques have to be adapted to a particular context. For instance, larvicidal treatments may be effective in places with limited breeding places but not in cases with over-abundant breeding places. Ultimately, from a strategic point of view and in view of the increasing resistance to pyrethroids, *icipe* has a strong advantage in developing non-insecticidal intervention techniques, but must demonstrate their effectiveness and profitability. For this purpose, *icipe* should rely on external health economists in the short term, but should also gradually build up its own strong economic unit. For social aspects, **we suggest that** *icipe*

could team up with social science departments at Kenyan universities. KEMRI would appreciate a continuous strengthening of integrated vector management beyond vertical programmes and specifically the training of vector control managers. Other stakeholders would wish to undertake sabbaticals at *icipe*.

AU-IBAR felt that *icipe* could pay more attention to livestock and recommends further strengthening of its collaboration with AU-IBAR and its other institutions such as PATTEC or PANVAC.

On the Plant and Environmental health side, most stakeholders, both national (including the Ministry of Agriculture, and NARS) and regional, expressed their great satisfaction with *icipe*, and considered that the impact of, e.g. push–pull, the honey and silk enterprises, bioprospecting, fruit fly and other IPM programmes, and, potentially, the CHIESA project, have greatly contributed to development priorities in *icipe*'s African constituency. Indeed, the majority of stakeholders ranked *icipe* as 'second to none' in this regard, consistently ranking *icipe* first among the several international organisations (IOs) hosted by Kenya (e.g. the CGIAR Consortium research centres, IITA and CIAT-TSBF). *icipe* was frequently described as 'more approachable' and 'more willing to do business with' compared with other IOs and was definitely not seen as an 'ivory tower with closed doors…'. One notable and somewhat bizarre exception was, however, the view of the Kenya Plant Health Inspectorate Services (KEPHIS). In their opinion *icipe* should 'abandon its focus on resource-poor smallholder farmers and concentrate instead on the development of innovations and products for the benefit of large commercial farmers', most of who grow cash crops for export. In short, *icipe* 'needed to get more in touch with the (Kenyan) commercial world of entrepreneurs, and the (national) economy'. The review team strongly suspects that the majority of donors currently supporting *icipe* would question this view!

Individual stakeholders mentioned a desire to see the revival of former work on locust and the importance of developing a push–pull (anal and ear odours) strategy for ticks.

Overall, the review team notes that Kenyan and neighbouring country chemical synthetic facilities are still not performing well enough to develop *icipe* innovations into marketable products,

Weaving silk at Kabondo Silk Marketplace in western Kenya. The business plan here was excellent.

hence bridging the gap between research and development remains an important issue for the future. At the same time, *icipe* has already significant economic impact through its apiculture and silk production. The economic impact on the livestock economy in tsetse-infested areas could be further massively leveraged by evidence of the profitability of waterbuck repellent device.

2.2 Critical review of the draft Vision and Strategy 2013–2020

The vision and strategy document provides a sound analysis of the current challenges of agriculture and health in Africa and refers to current integrated concepts like 'one health' or 'ecosystem health'. However, the theoretical basis of these concepts should be better reflected to understand the interpretation of *icipe*'s scientists as a basis for integrated vector control approaches in social–ecological systems. We would like to see a reflection on theory of human–environment or social–ecological systems[5]. *icipe* uses the term 4-H and wants to adhere to the 'global one health philosophy' to address the interlinked problems of poverty, low agricultural productivity, poor health and the degradation of the environment. However, the strategy document makes no reference to the vast literature on ecosystem health[6] and an increasing body of knowledge on 'one health'. It would greatly help the reader if the strategy document would refer to the

5 Ostrom E. (2007) *Proc. Nat. Acad. Sci.* 104, 15181–15187.
6 Forget *et al*. (2001) *Int. J. Occup. Environ. Hlth* 7, S3–S36.

Co-operative members of the highly successful Mwingi Honey Marketplace in eastern Kenya. This could act as a hub to dispense other vital technologies developed by *icipe,* e.g. Push–Pull and Fruit Fly IPM.

literature and clarify its interpretation of concept terms. In other words 'one health' should be seen as the added value of closer cooperation of human and animal health. *icipe* is one of the few institutes worldwide that has all the components for demonstrating the added value of holistic approaches, but these elements need to be put together effectively and analysed for their social, ecological and economic dimensions. We see the strongest potential of *icipe* to move from the understanding of system components in human, animal and plant health into progressively integrated approaches for all of them. This aim is well expressed in the new strategy document. However, clear methodological outlines of future research work that would integrate plant, animal and human health and demonstrate the added value and profitability of such integrated approaches are missing. In some instances, the reviewers even felt that some units concentrated on their own research without seeking overly cross-unit activities. As the 4-Hs are organised within three clusters, namely Integrated Vector and Disease Management (IVDM), Integrated Pest Management (IPM) and Adaptation to Climate Change & Ecosystem Services (ACCESS), **the reviewers recommend** that there is room for more inter-cluster activities.

icipe strongly engages with the public and non-academic actors. This is highly appreciated and recognised. But is it done efficiently? We did not find references to theoretical frameworks such as those in the *Handbook of Transdisciplinary Research* by Hirsch Hadorn *et al*.[7] that tie together science and policy, or on social resilience in Obrist *et al*[8]. Most of the community engagement is conducted well by natural scientists although rather intuitively. **We recommend** that a social scientist oversees the public engagement activities of *icipe* to set standards and procedures, and to capitalise on the excellent experiences. **We also recommend** a better way of communication of research results, which should not be in the 'research dialect'.

icipe contributes very well to the building of capacity, i.e. through the ARPPIS programme, and does it much better than many other international institutions. We encourage strengthening these efforts even more, considering the postdoctoral career plans of *icipe* alumni. Young scientists often have great difficulties building up their own research group at African universities. This is recognised by the Wellcome Trust funded THRiVE programme, in which *icipe* should actively seek a phase II involvement. Why should *icipe* not be affiliated to a Kenyan university to become also a degree providing institution? This should not interfere with its international mandate (*see also page 25*).

Specifically, we welcome *icipe*'s intention to strengthen vector control of leishmaniasis and IPM for cotton. Farmer unions would like to have more training in beekeeping. We also welcome *icipe*'s focus on the relatively recent (2011) appearance of maize lethal necrosis disease (MLND). If not tackled successfully, this serious disease could negate a lot of the gains being made, e.g. through the push–pull technology.

Almost all stakeholders expressed their interest to comment or contribute to *icipe*'s vision and strategy 2013–2020, document. Hence **we recommend that** *icipe* circulates the existing, well-written document, among the stakeholders for a further refinement and alignment with national, regional and African priorities, particularly for its pro-poor and bottom-up approach.

Having previously aligned *icipe*'s work to the MDGs, **the reviewers recommend** that it may be a sound tactical move for *icipe* to join the emerging United Nations Sustainable Development Solutions Network (UNSDSN) (http://unsdsn.org/), particularly their Thematic Group 7 on Sustainable Agriculture and Food Systems and & 8, on Forests, Oceans, Biodiversity and Ecosystem Services.

7 Hirsch Hadorn G., *et al.* (Eds) (2008) Springer Science + Business Media B.V. ISBN: 978-1-4020-6698-6 (Print) 978-1-4020-6699-3 (Online).

8 Obrist B., *et al*. (2010) *Prog. Dev. Stud.* 10, 283–293.

2.3 Programme design and research infrastructure

icipe conducts highly innovative research in vector biology, and in understanding molecular, ecological and systemic pathways. In the past years, important investments have been made in virology, genomics and bioinformatics with the building of the Martin Lüscher Emerging Infectious Diseases Laboratory and the collaboration with the BecA hub at ILRI. It can be argued that *icipe* should/cannot establish specialised competence in the field of other pathogens. For instance, although the studies of trypanosome movements in the blood and the antibody clearing studies are interesting, it is debatable if a strong investment should be made in the development of trypanosome control in the animal host (drug development) or diagnostic tests for human trypanosomosis. On the other hand, some room for optimism is important as the successful publication of the phylogeny of *Mycoplasma mycoides* as a spin-off from bioinformatics has shown[9].The SolarMal project on Rusinga Island holds potential far beyond its current conception by introducing low cost solar energy in African households. It has very strong cross-sector aspects involving communities and authorities from the beginning. As the project is combined with a smaller health and demographic surveillance system, baseline data exist for a rather large trial of the effect of mosquito trapping. The trap that is being used works well, but it requires a source of CO_2, which is currently provided by a yeast/malt fermenting system held in a small container with a lid. The maintenance of the container might become a problem and containers with a wider opening might be more appropriate for proper cleaning. But this is a small detail. The potential is much more in other opportunities of the use of solar energy, i.e. feeding into the electric grid or for electric motorbikes, or even electric cooking. The whole island of Rusinga could potentially become energy autonomous. As the project goes on, close interactions with the communities should be nurtured to identify emerging opportunities to which communities adhere.

At ITOC, the work on oviposition, methods for larvicidal assessment and the test of Sumilarv® mosquito larvicide is well conducted and the students are excited. There is a Colombian student who may establish these methods back in his home country. The work on the vampire spider, *Evarcha culicivora,* is extraordinary and driven mostly by a team from New Zealand. The attraction of *E. culicivora* to humans going through the consumption of blood-fed *Anopheles* mosquitoes is an evolutionary miracle. There might be a relationship between the advanced construction of its eye and the need for fresh blood containing vitamin A. **We recommend that** this hypothesis is tested using vitamin A-depleted *E. culicivora* individuals and to measure a potential visual impairment. This team should broaden its funding portfolio, e.g. through a Wellcome Trust fellowship to strengthen its important work on natural *Anopheles* predators. We were unable to find a strong engagement of African capacity building in this promising field of biological control of *Anopheles*.

Using forests in a sustainable way: Members of the review team inspecting a still used to extract aromatic oils from *Ocimum kilimandscharicum* (camphor basil) at the Isecheno Bioprospecting Facility, adjacent to the Kakamega forest, western Kenya that is supported by *icipe* and partners.

The community-based control of malaria using larvicidal substances in habitats or environmental management, thus reducing breeding sites (i.e. introduction of larvivorous fish in swimming pools in Malindi, collection of plastic bags, management of watering troughs for livestock) has a high potential. But health authorities would like to know the incremental profitability and cost-effectiveness of environmental management for malaria control, say versus impregnated bednets. The Kenyan east coast has seen a massive decline of malaria in the last five years. But there is no evidence about the role of environmental management in that. The local stakeholder groups

9 Fischer A., *et al.* (2012) *PLoS ONE* 7(4), e36150. doi:10.1371/journal.pone.0036150.

claim that they have explained the use of bednets to the population. This may certainly have had some effect. The malaria group should now work out the relative contributions of impregnated bednets, larval control and environmental management. This presumably requires the use of mathematical models, which would allow the addressing of the population dynamics of vectors. In the same way, the work on small screens for the control of HAT, which is very promising, should be tested in endemic areas and be analysed comparatively to the current chemotherapy. A formal cost-effectiveness analysis in terms of cost per averted case of HAT, or cost per averted disability adjusted lives years (DALY), of small screens, possibly combined with the use of the waterbuck repellent in a human formulation, should be envisaged now.

Community and farmer perception studies are well conducted. A detailed social analysis of stakeholder processes (power and gender relations) of community based malaria control would help to better understand the potential of post-project community based actions. Specific attention should be given to organised community groups and the inter-sectoral collaboration between different ministries, i.e. between the Ministries of Health, Agriculture and the Environment. Study designs on trans-disciplinary processes, involving stakeholders in the research should refer to the body of trans-disciplinary theory (i.e. *Handbook of Trans-Disciplinary Research*, Springer) and analyse the social dynamics of community-based control efforts. *icipe* should strengthen its capacity in social science and health economics.

Prof. Philip Chiverton's visit to a screenhouse at HORTI-Tengeru, Arusha that was established with assistance from the *icipe* Leafminers project. HORTI-Tengeru staff accompanying him are Dr Silivesta Samali, Ms Massawe and Mr Yousuf Mohamed.

With reference to the push–pull systems for crop production, fruit fly control in horticulture, IPM in vegetable production and the zero-grazing dairy production, *icipe* has the potential to bring these systems together into an integrated health–agriculture–livestock household system which is unprecedented and highly innovative. In the coming years such an integrated system could gradually be built up, component by component. For example, the community run Honey Marketplace at Mwingi is thriving, but they also grow mangoes and plant staple foods such as maize. However, despite nearly a decade of interaction with *icipe* they have no knowledge of fruit fly IPM in mangoes or push–pull technology for maize. In particular push–pull with fodder production and the zero grazing should be combined and knowledge about this disseminated through, e.g. the honey marketplace network. Other opportunities that should not be missed are IPM for cotton, sandfly biology and ecology for leishmaniasis control.

In conclusion, *icipe* research designs are very strong on the systems operating at the molecular and receptor scales. They should be strengthened at the levels of vector and host population dynamics, which will be the backbone of currently missing cost-effectiveness assessments in interventions against *Anopheles* mosquitoes and malaria, and tsetse and trypanosomosis. The presented results on the effects of tsetse control on livestock production are fragmented and lack a coherent approach (P. 13). Research designs are clearly weak and poorly designed for assessment of productivity and demographic effects of interventions in livestock. Larger number of animals should be followed to assess effects of tsetse control on fertility and mortality well. Such designs are a prerequisite for equally urgent analysis of profitability and cost-effectiveness of interventions in human health. *icipe* claims pro-poor interventions (P. 3) but lags behind in providing the economic argument.

2.4 Rising to the challenge of emerging opportunities and threats

icipe and other international institutions were founded because of the lack of local expertise and capacity (PP. 1 and 3). Today, we are in a transition with increasing local capacity and rapidly emerging academic institutions. However, many African universities are conceived as teaching and not as research universities. In natural sciences, an academic teacher not doing his or her own research is outdated within three years. *icipe* should associate more closely with African universities, teaming up to close the research–teaching gap (*see also vii*). Increasingly, projects should be built up together with African universities with the aim of promoting young post-docs building up their own research groups (*see also THRiVE, page 6*).

icipe should focus on its competence in vector research. Involvement in pathogen research should be well reflected beforehand, and emphasise vector–pathogen interactions, say in view of transmission blocking, but significantly less on the pathogenesis in the end host. The development of point-of-care diagnostic tests like paper-based ELISA or LAMP should only be pursued in specific cases, in order not to interfere with the concentration on vector-based control. Livestock ticks are certainly a huge field for a stronger involvement of *icipe* (P. 5). A similar approach as for the waterbuck repellent should be sought. Biological tick control would have a tremendous impact on small-scale and pastoralist livelihoods. Similarly, a stronger engagement in pastoralist livestock production, i.e. in fly control and vector-borne zoonoses would contribute to decreasing the marginalisation of these population groups. Several stakeholders recommended a stronger engagement in work on the insect-related post-harvest losses and the post-harvest handling of crops, vegetables and fruits. Malaria control could also be combined with schistosomiasis control, as both are water-related diseases.

An *icipe* scientist stated: "We tend to work on the upstream end and forget the whole system". Surveillance of vector-borne animal diseases should be seen more as an inherent component to the overall disease surveillance system that is now connected between public and animal

Thomas Ogao, an MSc student at the EID laboratory, prepares automated PCR reaction setup. This device standardises reactions and reduces the risks of cross-contamination.

health by way of the Republic of Kenya Zoonotic Disease Unit (ZDU) (a collaboration between the Ministries of Agriculture, Livestock and Fisheries Development and Health), to which *icipe* contributes actively. A periodic systems analysis (*See also page 13*) of the place of individual projects in the transmission cycle of a particular disease would help the scientists to locate their own work in the whole system. *icipe*'s strategic advantage of its excellent entomological expertise and its track record in plant, animal and human health should now be channelled towards truly integrative interventions, for which *icipe* has still a significant advantage. Geographically, *icipe* should tackle some regional opportunities; to this end the **reviewers strongly recommend** the promotion of apiculture in Tanzania which, to date, is being neglected in this very lucrative enterprise.

icipe's recognition of insects as food and feed is particularly timely. A recent report from researchers at Wageningen University & Research Centre (WUR), in The Netherlands, has been published by FAO (see http://www.fao.org/docrep/018/i3253e/i3253e.pdf)[10]. In the report the authors conclude that "Insect rearing for food and feed remains a sector in its infancy and key future challenges will likely emerge as the field evolves". As an example, with regard to insects as animal feed, a recent Swedish–Swiss–Ugandan collaborative project on peri-urban agriculture in Kampala examined

10 FAO (2013) FAO Forestry Paper No. 171. Food and Agriculture Organization of the United Nations (FAO), Rome. 201 pp.

Geoffrey Jagero, the EID laboratory manager and Martin Koome, a consultant at the EID laboratory preparing high-throughput arbovirus extraction.

a system for simultaneous treatment for human waste and animal feed protein production[11] (see http://www.sciencedirect.com/science/article/pii/S0048969713004555). Black soldier fly larvae, *Hermetia illucens*, make an excellent protein source in animal feed, while the feeding activity of the larvae substantially reduces the dry mass of the treated material. The focus of this particular study was the fate of pathogen and indicator microorganisms in the insect-driven treatment system. The concentration of *Salmonella* spp. was greatly reduced by the action of the larvae, but no effect on *Ascaris suum* ova was established. A post-treatment step was recommended, but this would be greatly simplified by the significant mass reduction. Such systems have enormous potential for improving urban and peri-urban sanitation management whilst, at the same time, replacing expensive fish/soya meal as feed in aquaculture and poultry enterprises. Clearly, the field of insects for food and feed is one in which *icipe* should investigate further. Moreover, in an African context, the potential for the involvement of public–private partnerships (PPPs) is also high in the development of such multi-functional systems. Interestingly, Heifer International, who partner with *icipe* in the push–pull programme, have declared an achievable goal of insects for livestock[12]!

2.5 Sourcing investment for the programmatic agenda

icipe currently has a diversified funding portfolio and is in a rather comfortable financial situation. Its high quality research has maintained continued attention by several European countries and the EU. While nurturing these partners, *icipe* should try to broaden the funding base with other European countries and possibly with the United States and Canada – including the Bill and Melinda Gates Foundation (BMGF). The strong linkages provided by scientists of Indian origin to India could also be further examined, for instance for the involvement of Tata Foundation. Similarly, a stronger partnership with South Africa and possibly China should be examined as the BRICS countries emerge as new development partners. **The reviewers clearly recommend further support by the current donor countries.**

2.6 Synergistic relationship between *icipe* and universities in Africa

icipe plays an important role and performs very well in African institution building. However, many African universities are ill-conceived, by separating research and teaching. A university teacher not doing his or her own research is out of date within three years. Future African universities must be research-driven. Teaching must be linked to research and not separated. International research institutions like *icipe* play an important role in this transition. Originally, international research institutions were conceived to bridge this gap (P. 9). They should first become affiliated to African universities. African university professors should be able to do research at low cost at *icipe* and teach their findings to their students. In turn, *icipe* scientists should be affiliated professors at African universities to teach their research and to support their students in defending their PhD theses. In a further step through the partnership with *icipe*, research groups should be firmly established at African universities to assure that research and teaching is inextricably linked. This is the recipe for success of African universities.

Richard Mukabana is a lecturer at the University of Nairobi (UoN) and is also conducting a good part of his research work at *icipe*. In this way, his students learn directly from his latest research

11 Lalander C., *et al.* (2013) *Sci. Total Environ.* 458–460, 312–318.
12 Schmidt S., http://www.heifer.org/media/world-ark/archives/2011/fall/extra-crunch-with-lunch.

and results. He is able to generate joint *icipe*–UoN grants and has no-cost access to *icipe*. He involves university administrators at an early stage in new projects and sees no barriers to execute his projects from the university side. Kiatoko Nkoba, from the Democratic Republic of Congo (DRC), works very well with the communities at Kakamega. He recently completed his PhD, teaches in Kinshasa and wants to transfer the beekeeping practices to DRC. This is an excellent example of the regional spread of the *icipe* research and capacity building, and also of the urgent linkage between research and teaching. Richard Mukabana and Kiatoko Nkoba are role models, fulfilling **our recommendation**, viz. to link *icipe* research more strongly with university education. An alternative model would be an *icipe* scientist having a teaching assignment at a Kenyan university, e.g. Rosemary Sang, a KEMRI staff member working at *icipe*, is apparently not doing university teaching. Charles Midega, having an excellent research record, doing very innovative work on the push–pull methods in smallholder crop production is not teaching regularly at a Kenyan university. This is a waste of knowledge and information transfer.

2.7 Assessing the present and future capabilities of the Centre's Management

icipe seems to have achieved a rather healthy balance of core and third party funding, the latter increasing steadily. It will be critical to successfully renew the international (Swedish, Swiss, UK) core contributions. This requires an in-depth understanding of the requirements by the different donors. The current directorate seems to be a successful team and should stay in place possibly beyond the next round of securing donor support. The reviewers don't see the need for a separate position of a Director of Research (DoR).

It was clearly not the mandate of this review to state on the succession planning; hence these reflections are limited to the above point.

3. Programme assessment 2008–2012

3.1 Animal and Human Health – (Comments by Prof. Jakob Zinsstag)

icipe has a unique experience and potential to work on insect-related topics in human and animal health. There is vast expertise in biochemical, molecular, biological and ecological aspects, less in epidemiological and economic aspects of insect-related health issues, which is often unique for Africa. As mentioned in *icipe*'s vision and strategy document 2013–2020, *"*icipe*'s operative 4-H paradigm, addressing Human, Animal, Plant and Environmental Health, is of immediate relevance to future strategies for contributing to solutions for food insecurity and malnutrition, disease, poverty and environmental degradation"*. However, the current programme and future plans appear to be fragmented and this reviewer was not able to find strongly convergent ideas between scientists and different programmes (*see also page 6*). This means, in the first place, conceptual thinking of combining and integrating human, animal, plant and environmental health. This reviewer could not identify activities combining say animal and plant health, showing an added value of doing so. For example, push–pull techniques involving fodder production could be combined with zero-grazing dairy production. Of similar importance are integrated approaches combining arthropod and non-arthropod related issues. For instance, surveillance of Rift Valley fever in mosquitoes could be combined with the surveillance of abortions in sheep, which could also include brucellosis, Q fever and other abortion-causing pathogens. **This reviewer recommends *icipe* to assess its potential for combining of human, animal, plant and environmental health activities, possibly with assistance of external experts.** *icipe* would be the only or one of the very few institutes worldwide integrating human, animal, plant and environmental health at the same time. The guiding principle should be searching for any added value (in terms of human, animal, plant or environmental health, financial savings or environmental services) from such a closer cooperation. This will necessarily lead to the development of new methods connecting the different realms. For example, could there be an interaction between the use of anti-insect fences in zero-grazing dairy systems and malaria incidence? Similarly, could tsetse repellents for AAT also be used for HAT? What would be a mixed

farming & human–animal–plant–environment package adapted to a given region?

There is a trade-off between insect vector research and pathogen research. The EID Laboratory will move strongly into virology, genomics and bioinformatics – with its linkage with BecA hub at ILRI. The excellent papers on *Mycoplasma* genomics by Anne Fischer are an example[13]. Similarly, the studies on trypanosome behaviour in host blood are fascinating and technologically advanced. But does *icipe* want to move massively into pathogen research competing with hundreds of parasitological, bacteriological and virological research institutes? There is no prescription here, but *icipe* should be cautioned for its unique potential, which is indeed insect physiology and ecology. Certainly interactions of pathogens and insects remain of critical importance, but should *icipe* concentrate on studies of pathogens in the end host? **This reviewer recommends** that *icipe* should concentrate the bulk of its efforts in insect vector biology and ecology in order to pursue its successful chain of innovation in integrated pest management and vector control. *icipe* is very strong in details of systems understanding but sometimes not sufficiently in the whole system (RVF surveillance). As mentioned above RVF surveillance should be seen from a systemic point of view and not only concentrate on the early detection of the virus in mosquitoes but also of abortions in small ruminants. Ironically, the recent RVF outbreaks in Kenya were detected first in humans, which are the last element and the least sensitive for detection in the chain of transmission. A major concern of this reviewer, as mentioned above, is the weakness in methods to measure effects of animal health interventions on productivity and estimating their socio-economic impact. For instance, in the zero-grazing dairy systems it is not clear which productivity parameters are collected to demonstrate the profitability of the insecticidal fencing. Referring again to the combination of insect and non-insect related aspects, the zero-grazing work should be extended to include milk hygiene, which is likely to be influenced by the insect pressure (*see other aspects below*). **But the main concern of this reviewer is that *icipe* should strengthen its capacity for socio-economic assessments of its landmark discoveries.**

13 Fischer *et al*. (2013) Jan;1(1). pii: e00216-12. doi: 10.1128/genomeA.00216-12 Epub 2013 Feb 21; Fischer *et al. PLoS ONE*. 2012; 7(4):e36150. doi: 10.1371/journal.pone.0036150. Epub 2012 Apr 27.

A cow protected with tsetse repellent collar in Kipambane, Shimba Hills, Kenya Coast.

The tsetse project in Shimba Hills is certainly a highlight of the outputs of *icipe* in the past project phase. **We have not seen small-scale cattle farmers being so enthusiastic about an animal health device like the waterbuck repellent collar, before**. The pull aspect is working in principle but there is room for improvement with regard to issues like wind, land ownership, fires and the fading of the colour. *icipe* has a strong record in community participation and involvement. Especially in product formulation and adaptation to other production systems and contexts, a more formal approach involving stakeholders and end-users will play an important role for successful implementation of novel interventions.

This reviewer suggests that the latter could eventually be addressed by involving communities continuously in the further product development process.

The biggest concern, and this appears clearly as a general trend in the whole research programme, is the weakness of assessing effects on productivity and demographic (actually zoographic)[14] change. Trypanosomosis is likely having effects on cattle fertility, hence influencing the composition of herds, but I have not seen if and how demographic data on cattle herds is collected. Herd structures could be established for all herds involved in the Shimba hills trial to monitor demographic change. There will be an issue on how to measure the effects of repellents against a control group. Effects of within-herd control groups will be minimal because of effect of tsetse repellents on the whole herd.

14 We use the term "demographic" also for the composition of animal populations, because the term is better understood than "zoographic".

Dr R. K. Saini explains how livestock protective net fencing is being used to protect high grade cows in zero-grazing units in Kisii County, western Kenya to Prof. Zinsstag.

The farmers in Kisii seem very happy with the zero-grazing husbandry and impregnated nets around their stables. **The reviewer suggests that** this work should be extended to include milk hygiene and possibly genetic improvement. At some point, improved feeding of cows will become an issue as milk production increases. Agriculture in the Kisii area is very intensive. *icipe* is a critically important partner on the way towards ecologically sound crop and livestock production, by showing ways to minimise pesticide inputs in insect-related pests control. For this purpose, **this reviewer suggests that *icipe* strengthens its perspective on the whole food chain from say milk at the farmgate up to the marketed product**. The reduction of insect-related postharvest losses is even more important for crops (*see above and below*). *Again, there is no formal analysis of productivity and profitability. This is urgently needed*.

There is a lot of good work on the riverine *Glossina* at Mbita using monitor lizard attractant and a reduced size trap. Again, the demonstration of its community effectiveness is pending. Although the work on trypanosomosis in livestock and human hosts has commenced, e.g. on trypanosome movement and adherence, HAT diagnostic tests are very interesting, but are questionable from a strategic point of view as they may spread too thinly within the core expertise of *icipe*. As mentioned above with regards to pathogen-related research, *icipe* is closer to breakthroughs in the work on *Glossina* spp. repellents in humans and even more in cattle. Improving HAT diagnosis is certainly needed, but *icipe* would compete again with many parasitological institutes having a higher critical mass of focused scientists. **The reviewer recommends that it** *may be better to concentrate on the adaptation of the waterbuck repellent to riverine* Glossina *and its human use*.

Demonstrating of community effectiveness of repellent approaches in human trypanosomosis will be difficult and *icipe* will likely require more partners having access to foci in DRC, Uganda and possibly Côte d'Ivoire. The necessary epidemiological capacity is not readily available at *icipe* and strategic partnership with epidemiological institutes may be faster than building up own capacity in the short term.

A strong decrease of malaria cases is not only reported from Malindi and Nyabondo, but also in Tolay (Ethiopia). However, it is not clear what contributes most to control, i.e. what fraction can be attributed to environmental management and larvicidal activities compared to the use of insecticide-treated bednets. It could be argued that the main effect of reducing malaria incidence is because of the use of insecticide-treated bednets and not because of environmental management. This reviewer was not convinced that *icipe* masters this methodologically tricky exercise of disentangling the attributably linked fractions of insecticidal bednets and environmental management. Demonstrating such an effect is important for the advocacy of environmental management, i.e. also to sustain the successful community-based activities we observed in Malindi. As mentioned above, this reviewer recommends stronger strategic partnership with epidemiological research. *Cost-effectiveness assessments of the incremental value of environmental management, larvicidal treatments, repellents etc. are urgently needed to show the effective value of icipe's discoveries*.

There is highly innovative research in vector biology and understanding of molecular and ecological systemic pathways. At Mbita Point, the work on oviposition, methods for larvicidal assessment and the test of Sumilarv is well-conducted and the students are excited. The work on *Evarcha culicivora* is extraordinary and driven mostly by a team from New Zealand. Training of local capacity should not be restricted to laboratory technicians but should be extended to African PhD students. Since the visual capacity of *E. culicivora* is important for the capture of

blood-fed *Anopheles*, its dependence on retinol could be tested using retinol-deficient spiders by feeding them on a retinol depleted diet. But this is only a side activity. The focus of attention should be on the quantitative capacity of *E. culicivora* to reduce *Anopheles* density, and consequently, malaria incidence. This should also be attempted by adapting existing mathematical models of *Anopheles* biology and malaria transmission. *This team should broaden its funding portfolio; say through a Wellcome Trust fellowship, to strengthen its important work on natural* Anopheles *predators*.

The SolarMal project on Rusinga Island holds potential far beyond its current conception of introducing low cost solar energy in African households. The primary purpose of using solar energy for mosquito trapping is highly innovative. As mentioned above, it has very strong cross sector aspects involving communities and authorities from the beginning. As it is combined with a smaller health and demographic surveillance system, baseline data exist for a rather large trial of the effect of mosquito trapping. The use of solar energy in African households has most likely far-reaching consequences beyond the reduction of mosquitoes and malaria incidence. A light source at night may improve the performance of school children because they can work longer on their homework, there will be continuous communication because cell phones can be charged at home, and there might be effects on transport using electrical bikes and so on. There might also be negative effects due to the increased attraction of light sensitive insects. Many more effects may not even be anticipated and it requires continued close cooperation with all stakeholders to identify perceived priorities. **This reviewer recommends *icipe* to strengthen its transdisciplinary methods, involving non-academic partners in the research process of translational research.** *As the project goes on, close interactions with the communities should be nurtured to identify emerging opportunities to which communities adhere. Issues of sanitation and biogas should not be overlooked.*

During review sessions, one of the scientists stated: "We tend to work on the upstream end and forget the whole system". *icipe* research designs are indeed very strong on the systems understanding at the molecular and receptor scale, and the mechanisms at these two levels have critical leverage at the individual host

Dr R. K. Saini (left) discusses with Prof. Zinsstag how *icipe*'s NGU trap works, both for monitoring and control of savannah tsetse species, vectors of nagana.

and population level in animals, plants and humans. **This reviewer perceives that *icipe*'s research capacity is currently weak in assessing cross-scale effects between the molecular and community levels. In the mid- term, *icipe* should strengthen its own capacity in animal and human population based research possibly including mathematical modelling, and sociological and economic capacity. In the short term, strategic partnerhips could be sought to rapidly confirm community effectiveness and profitability of the most important discoveries, i.e. the waterbuck repellent, the monitor lizard repellent, the zero-grazing systems and environmental management of *Anopheles*.** *icipe*'s capacity *should be further strengthened at the levels of vector and host population dynamics, which will be the backbone of currently missing cost-effectiveness assessments in the interventions against Anopheles/malaria and tsetse/trypanosomosis.* **The reviewer also suggests** *that there is a lack of competence on population and transmission dynamics to demonstrate, for example, the cost-effectiveness of the incremental value of environmental management, larvicidal treatments, repellents etc. to show the effective value of its discoveries.*

3.2 Plant and Environmental Health – (Comments by Assoc. Prof. Philip Chiverton)

In 1993, *icipe* in collaboration with the Kenya Agricultural Research Institute (KARI),

Rothamsted Research (UK), and other partners in eastern Africa, started to develop a novel habitat management approach known as 'push–pull'. The strategy involves intercropping cereals with a repellent plant such as *Desmodium*, and planting an attractive trap plant, such as Napier grass, as a border crop around this intercrop. Stemborers are repelled or deterred away from the target food crop (push) while, at the same time; they are attracted to the trap crop (pull), leaving the food crop protected. In addition, *Desmodium* stimulates the germination of *Striga* seeds and inhibits their growth after they germinate. This combination provides an *in situ* reduction of the *Striga* seed bank in the soil through efficient suicidal germination even in the presence of cereal hosts.

In 1997, *icipe* and partners integrated push–pull in maize, and later sorghum-based cropping systems in Kenya and in eastern Uganda. Today, push–pull is widely recognised, and is currently being practised by over 68,000 farmers around Lake Victoria. The success of push–pull is further demonstrated through numerous scientific articles, studies and extension materials produced by *icipe* and partners. In 2009, *icipe* found it necessary to commission an independent organisation, Intercooperation of Switzerland, to conduct a comprehensive impact assessment of PP, to establish its impact on the livelihoods of smallholder farmers in East Africa and their perception towards the technology (http://www.push-pull.net/Impact_assesment.pdf).

A win-win solution: Nearly 70,000 smallholder farmers in East Africa are benefitting from adoption of the Push–Pull technology (long rainy season of 2013) that very effectively manages striga weed and stemborer pests in their maize plots, at the same time fertilising the crop and, ultimately, producing fodder for livestock.

More recently, the push-pull team, led by award-winning scientist, Prof. Zeyaur Khan, looked at ways of adapting the technology to dry areas. The team devised a system called ADOPT utilising the drought-tolerant *Brachiaria* grass (hybrid Mulato) in place of Napier grass (which is prone to the Napier stunt disease), and *Desmodium intortum*. A visit was made to the push–pull ADOPT site in Ukiriguru, Mwanza (and conventional push–pull sites visited later in western Kenya) including a meeting with PP ADOPT farmer group representatives and Dr Mafaru of Heifer International at the Lake Zone Agricultural Research and Development Institute (LZARDI) in Mwanza. The *icipe* + LZARDI + Heifer International model is exemplary.

It is difficult to find a new superlative in praise of the push–pull programme! Long overdue accolades have been awarded Prof. Khan (2011 TWAS prize for Agriculture, 2012 first Thomas Risley Odhiambo Distinguished Research Fellow award, among others) and the demonstration plots and farmers' push–pull fields are visible proof that the method works exceptionally well. To date 68,689 smallholder farmers are using either conventional push–pull or the ADOPT climate-resilient adaptation, and (maize and other cereal) yields have increased from ca. 1 ton/ha to 3.5 tons/ha.

The latest innovative output from the programme has been videos, filmed by farmers, of farmers explaining how to prepare and plant a push–pull field. Studies by team member and social scientist Jimmy Pittchar have shown how effective these methods are at getting push–pull understood—even in a language different to that of the audience (!) compared with pamphlets or lectures or field demonstrations. **The reviewer recommends** *that this innovative instruction method be developed for the majority of icipe's community-driven projects*.

There is, however, one problem that was often voiced by push–pull practitioners in relation to both ADOPT and conventional push–pull, and that is the seed production and distribution of, particularly, both species of *Desmodium*, and propagation (bulking up) of *Brachiaria* (used in ADOPT push–pull) and, to a lesser extent, Napier (used in conventional push–pull). **The reviewer therefore strongly recommends** that *icipe* seeks a long-term solution to seed production in support of a general up-scaling of push–pull throughout

Striga-infested areas in SSA and, indeed, beyond! We are fully aware that production of seed for perennial plants may not be the most attractive business proposition for a seed company, and that overcoming this reluctance may prove expensive. However, the benefits gained by small farmers employing push–pull (as witnessed by this reviewer in both Tanzania and Kenya) should convince any development donor that such an investment is worthwhile. If no seed company can be enticed to produce the *Desmodium* seed (it is after all a temporally limited market, and therefore not a particularly attractive, long term business proposition for a seed company) then **this reviewer suggests** that farmers willing to grow *Desmodium* and sell seeds as a side enterprise, are quickly identified and encouraged (and helped) to start as soon as possible.

Thus, in addition, the reviewer strongly recommends *that a study be made on the overall impact on the economy of push–pull farmers and the added nutritional, health and other benefits (extra income for school fees etc.) derived from using the push–pull systems*. Such a study would, I believe, give information that could potentially attract the development funds required for scaling up. It is, therefore, gratifying to learn that 'The economics of push-pull' will be the subject of an ARPPIS PhD study starting 2013.

Following on from *icipe*'s outstanding success with the biological control of the diamondback moth (DBM) in Kenya, Tanzania and Uganda (where this insect has ceased to be regarded as an important pest, and chemical control applied against it is no longer necessary), *icipe*'s IPM scientists are successfully tackling a new pest, the fruit fly.

The cooperative outgrowers of mango visited in Kibaha, Tanzania (and, later, in Embu, Kenya) are under enormous pressure to deliver quality produce untainted with pesticide residues, most of which resource poor outgrowers can ill afford in the first place. The advent of a new invasive fruit fly, *Bactrocera invadens*, seriously threatened their livelihoods. The mango growers visited in Kibaha demonstrated an extremely effective *icipe* IPM package including baited traps (with their own innovatively designed plastic bottle traps which were much cheaper and equally effective as the standard *icipe* traps), orchard sanitation and the application of entomopathogenic fungi against adult fruit flies and larvae. Introduced fruit

Prof. Philip Chiverton's visit to the *icipe* TRO campus: Prof. Zeyaur Khan (right), *icipe* TRO Distinguished Research Fellow and Leader of the Push-Pull programe convincingly argues that it is knowledge based solutions that are needed to improve African agriculture.

fly parasitoids from Hawaii have been identified and released, and their efficacy is being tested as another weapon in this effective IPM arsenal.

What was most impressive, however, during the visit was the community spirit and enthusiasm for the project, backed up by a very supportive Ministry of Agriculture. **The reviewer strongly recommends** *that this IPM project is scaled up to cover the major mango growing regions in SSA following a cost–benefit analysis; the latter should strengthen the appeal to potential funders*.

Another, general, observation regarding mango production is that, with a few exceptions, most varieties mature at the same time so that, at peak, the market is glutted with mangoes and prices are consequently low. Considering the obvious success of the honey and silk marketplaces visited in Kenya and Ethiopia, this reviewer would suggest that *icipe* examines the potential of establishing (together with relevant development partners and/or PPPs) mango canning or juice-producing enterprises for these communities.

A Cashew IPM project (against mirid and coreid bugs, and cashew leaf and nut blight), also in Kibaha, was briefly visited. This project has great potential and has already produced a high quality paper (and one PhD). It was fascinating to see a method of enhancing predator (ants) distribution among the cashew trees using a method the reviewer had first seen in an old textbook on biological control. The text book described a Chinese method to allow predator distribution among fruit trees by the simple expediency of

providing bamboo cane 'bridges' between trees—biological control in the 1st century! In Kibaha it was wire or string to enable ant dispersal. We look forward to the continuation of this project.

We also visited A to Z Textile Mills, a private company that, in cooperation with Sumitomo Chemicals, Japan, produces AgroNet, a plastic protective net in which the chemical (a pyrethroid) is actually incorporated in the plastic. This greatly reduces the risk of washing off during rain. The nets are mainly designed to exclude (cabbage) pests, but mesh size allows both ingress and egress of natural enemies, e.g. parasitoids. There are also other uses for these nets in protecting zero-grazed livestock. In horticulture, and post-harvest product protection, there have been a number of successful trials testing mesh size, colour, shade conditions, use against both thrips and mites, and recycling of nets etc. **The reviewer would strongly recommend** *a cost–benefit analysis of these nets as it is suspected that, although efficient and long-lasting (ca. 5 years), the initial purchase price at present may put the nets beyond the means of resource poor farmers.*

A short courtesy visit was made to Jacqueline Mkindi, the very dynamic Executive Director of the Tanzania Horticultural Association (TAHA). She was extremely positive in regard to the cooperation with *icipe* and valued the partnership highly, and wished for more collaborative projects. A visit was also made to the Director of Research, Silivesta Samali of the Horticultural Research and Training Institute (HORTI), Tengeru, who praised the long-standing relationship with *icipe*. We discussed ongoing IPM work with leafminers, and training the trainers and extension specialists for pests of, e.g. beans. It must be mentioned here that Dr Subramanian has fostered extremely good relations with all the partners the reviewer met in Arusha, which is a good base for any eventual upscaling of projects in this region.

The review team comprising of Prof. Jakob Zinstag (hat, left), Prof. Judi Wakhungu (middle) and Assoc. Prof. Philip Chiverton (right) looks at a diversity of products on display at Isecheno Bioprospecting facility adjacent to the Kakamega Forest, western Kenya.

One of the most remarkable IPM interviews this reviewer conducted was, however, with a farmer leader in a field of snowpeas near Nyeri in Kenya. We were discussing the IPM of aphids in the crop and I asked how he explained the concept of biological control to uneducated smallholder farmers. This was fairly straightforward I was told. He asked them why it was impossible to farm around Lake Naivasha nowadays without high fencing to keep out the large herds of foraging antelope, when not so long ago the antelopes were not a problem. The answer is that we have killed off the lions and leopards, which used to keep antelope numbers at a reasonable level. So it is with the '*dudu*' [The Swahili word for insect]. The pesticides we used not so many years ago—organochlorines (such as DDT) and organophosphorous preparations, etc.—killed off the predatory insects and parasitoids that kept the greenfly under control = biological control!

Within *icipe*'s Environmental Health, there are three programme areas: a) Biodiversity Conservation Programme (see CHIESA project); b) Commercial Insects Programme (CIP) and c) Applied Bioprospecting Programme, which are supported by two units: Remote Sensing and Geographic Information Systems (GIS) Unit and the Biosystematics Support Unit (BSU).

CIP is primarily concerned with apiculture (including meliponines or stingless bees) and sericulture, as significant contributors to rural livelihoods in Africa and the Near East region (Yemen). In addition to building capacities in traditional (improved) beekeeping and silk moth rearing technologies, *icipe* also researches the potential of domesticating stingless bees and exploiting wild silkmoths for commercial applications. Furthermore, *icipe* assists in the establishment and development of viable and sustainable community-driven enterprises for honey and silk production.

The reviewer visited beekeeping enterprises in Tolay, Ethiopia, including the Tolay Natural Honey

Marketplace. These enterprises are exemplary! There was an equal gender distribution among the beekeeping groups although the male population had initially resisted attempts to include female beekeepers. Project leader and *icipe* scientist Prof. Suresh Raina had to resort to incredible wile approach to ensure gender equality in the beekeeper groups. The main objection was that women were 'unclean' during certain days of the month and thus could not handle important foodstuff such as honey; to which Prof. Raina asked the men: "Do you cook your own meals during such occasions…?" This irony was enforced by providing female beekeepers with free hives whereas male beekeepers had to pay for extra hives. In interview after interview with individual beekeepers (including women), production and sale of honey had given their household extra cash to pay, e.g. school fees. *The latter should be analysed and documented by a social scientist. (See recommendation in executive summary.) What is lacking here, however, is a cost–benefit analysis of the honey enterprises/ marketplace. (See recommendation in executive summary.)*

Commercial insects (honeybees, stingless bees and silkmoths) sites were visited at Mwingi and Kakamega, in eastern and western Kenya, respectively. Additionally, we visited a bioprospecting site at Isecheno and the Kabondo Silk marketplace (both in western Kenya). Similar to push–pull it is difficult to find sufficient superlatives for these enterprises. The business plan for Kabondo was excellent and, once again, it would be extremely useful to follow this up with a cost–benefit analysis. The domestication of six different stingless bee species at Kakamega is fascinating and could potentially produce at least another dozen PhDs, e.g. examining purported medicinal properties of the various varieties of honey, behavioural and ecological studies of each species, etc. These are all excellent examples of community action projects with superb support from local authorities (Kenya Forest Service, and DLPO Mwingi, Kakamega and Kabondo). The beekeeping enterprises in each area created spin-off employment opportunities for local carpenters, all of whom welcomed the extra income generated by orders to produce hundreds of modern beehives.

To contribute to conservation of biodiversity and poverty alleviation, *icipe* and its partners are assisting communities who live adjacent to

Prof. Chiverton's visit to a local apiary in Tolay, Ethiopia: Prof. Suresh Kumar Raina (right), Head of the Commercial Insects Programme, insists on gender equity, and actively encourages women beekeepers.

biodiversity-rich areas to undertake income-generating enterprises that are based on medicinal and insecticidal plants. The purposes of the enterprises are to:

1. Create value-added alternative means of generating income for improving livelihoods of the communities living adjacent to the forests;
2. Conserve the biodiversity-rich forests by relieving some of the economic pressure on the forest resources; and
3. Enhance awareness among the communities about the potential value of the biodiversity-rich forests as source of new commercial products, and hence the need for their conservation.

Currently, the programme and its partners are building the capacity of the following community-based initiatives in Kenya, Tanzania and Uganda:

1. Commercial cultivation and processing of the medicinal and insecticidal plant, *Ocimum kilimandscharicum* by members of the community living adjacent to Kakamega forest in Kenya;
2. Commercial cultivation and processing of the medicinal plant, *Mondia whytei* by members of the community living adjacent to Kakamega forest in Kenya;
3. Commercial cultivation and processing of *O. kilimandscharicum* by members of

the community living adjacent to the East Usambara Mountain forests in Tanzania;

4. Processing of cultivated aloe and neem plant material, and marketing of aloe and neem extracts and products by members of the community living adjacent to Shimba Hills forest in Kenya; and

5. Utilisation of traditional medicines, knowledge and practices, for improvement of health and income for poor, marginalised, natural resource dependent communities in Mpigi District of Uganda.

At Isecheno, Kakamega (1 & 2 above), the bioprospecting and production of natural mosquito repellents, larvicides and herbal medicines was impressive, as was the enthusiasm of the community participants and the strong support of the Kenya Forest Service. However, the review team was divided regarding the long-term viability of the endeavour. The answer, once again, is a cost–benefit analysis of all these enterprises. (We know one cost: benefit analysis has started, albeit belatedly, for the bee enterprise in Mwingi.) Recommendations are summarised in the executive summary.

CHIESA (Climate Change Impacts on Ecosystem Services and Food Security in Eastern Africa) is a four-year (2011–2015) research and development project funded by the Ministry for Foreign Affairs of Finland and coordinated by *icipe*. The key objective of the project is to assess the impacts of climate change and anthropogenic land use and land cover change on ecosystem services and food security in the agroecological zones of three mountain ecosystems in eastern Africa. Available models and predictions on climate change impacts on agriculture and food security have not taken into account how crop diseases, insect pests and pollinators are affected by these impacts. Changes in temperature and humidity may instigate insect pest outbreaks in areas and altitudes where these have not been experienced before. East African mountains thus offer a unique area for analysing climate-driven change on ecosystem services.

Prof. Zinsstag at the Kakamega forest, western Kenya: Maridah Khalawa (left) and John Atsango (middle) displaying Naturub®, mosquito repellent and other products from bioprospecting outside MFCG processing facility adjacent to Kakamega forest.

Of the three 22-km long mountain ecosystem transects (Mt. Kilimanjaro in Tanzania, the Taita Hills in Kenya and Jimma Highlands in Ethiopia) varying from low to relatively high elevations, (1500–2200 masl) constituting the CHIESA project, only that in the Jimma Highlands in Ethiopia was visited due to time constraints. Although in its early stages, this is a promising project that should generate sufficient data in, e.g. land cover and land use change, climate change impacts on functional agrobiodiversity, particularly effects on pest and disease (e.g. coffee berry disease, coffee leaf rust, leafminers and scale insects) development at different altitudes, to enable robust modelling to simulate different climate change scenarios on agricultural production and, ultimately, livelihoods. The reviewer recently received data collected on coffee diseases by Dr Fabrice Pinard (CIRAD-seconded scientist at *icipe*) during the visit. Coffee leaf rust incidence decreased with altitude, which is diametrically opposite to that found with coffee berry disease, which increased with altitude. In the words of Dr Pinard "… it is interesting to observe the opposite behaviour of the two diseases, which will make climate change impact on the (coffee) crop more 'interesting' and complex to assess." He goes on to say: "Our efforts now concentrate on how to explain the epidemics and our plans are to consider macro and micro climate data, and environmental information (land cover, shade tree density)." Remote sensing and GIS in land cover and use are just some of the tools that will be employed to fill knowledge gaps in this important area.

The two PhD students attached to CHIESA were both knowledgeable and enthusiastic; and they had strong support from their supervisors (Dr Pinard, *icipe*) and partner (Dr Fikre Lemessa, President of Jimma University). **The reviewer recommends** that the project seeks ways to forge

links with the nearby Biosphere projects (in Yayu, Siga and Bonge), particularly since these areas harbour natural indigenous coffee growing under montane forest. This would give added value, particularly regarding biodiversity issues.

That *icipe*, through CHIESA and other core research projects like the coffee entomology unit, should concentrate on coffee is quite understandable given that this commodity has a total retail value of $ 90 billion/year. We look forward to ongoing work on the chemical ecology of the coffee berry borer (CBB), and to evaluating both repellents and attractants of this serious coffee pest in the field.

Although (unfortunately) not visited due to time constraints, the review team was made aware of *icipe*'s extensive activities in West Africa, particularly Ghana, Benin and Burkina Faso. As mentioned above there are successful ongoing animal health programmes, including zero grazing and animal protection (Livestock Protection Net Fences) in Ghana (pigs) and Burkina Faso (small ruminants), both of which have already shown large reductions in animal mortality and subsequent increased income for the farmers involved. Furthermore, there is a collaborative project (including scientists from Benin, Ghana, Kenya, Tanzania and Mozambique), conducting an analytical review and synthesis of post-harvest losses in SSA.

The fruit fly IPM programmes in mango, vegetables and cashew are all very active in West Africa (Benin, Ghana) each involving a large number of partners and stakeholders.

What is particularly impressive, however, is the ARPPIS Sub-Regional Masters Programme (*See page 22; Capacity Building*) based at the University of Ghana. Since its inception in 1995 a total of 161 (119 male and 42 female (26%)) students have been through the programme. Many students are supported by DAAD scholarships generously funded by GIZ (formerly GTZ); however, the majority (85) are Ghanaian and are self-supporting as they are ineligible for DAAD scholarships and this must underline the attractiveness of the programme. Other students are from Anglophone Africa: The Gambia, Liberia, Nigeria, Kenya, Tanzania and Sierra Leone; Francophone Africa: Senegal, Cameroon, Rwanda and Togo, and Arabophone Africa: Sudan.

Mango growers at Embu, eastern Kenya: The review team was struck time and again with the enthusiasm displayed by farmers involved in *icipe*'s community action projects.

Summary of statements and recommendations in regard to the 4Hs:

1. *icipe* is the leading entomological institute on the African continent and probably beyond. Its strengths are its: a) scientific mastering of insect physiology and ecology, and b) cross-sector environmental, plant, animal and human health orientation through the 4-H paradigm.

2. *icipe* has a large insufficiently-tapped potential for the integration of the 4-Hs, demonstrating the added value of working across all four realms. For example, there is a strong potential for stronger cooperation between plant–human and animal health. With reference to the push–pull systems for crop production, fruit fly control in horticulture, IPM in vegetable production, and the zero-grazing dairy production, *icipe* has the potential to bring these systems together into an integrated health–agriculture–livestock household system, which is unprecedented and highly innovative. In the coming years, an integrated system could gradually be built up, component by component. In particular the push–pull with fodder production and the zero grazing should be combined.

3. Research should concentrate on vector biology and ecology where further breakthroughs can be expected, rather than on pathogen and pathogen diagnostic work.

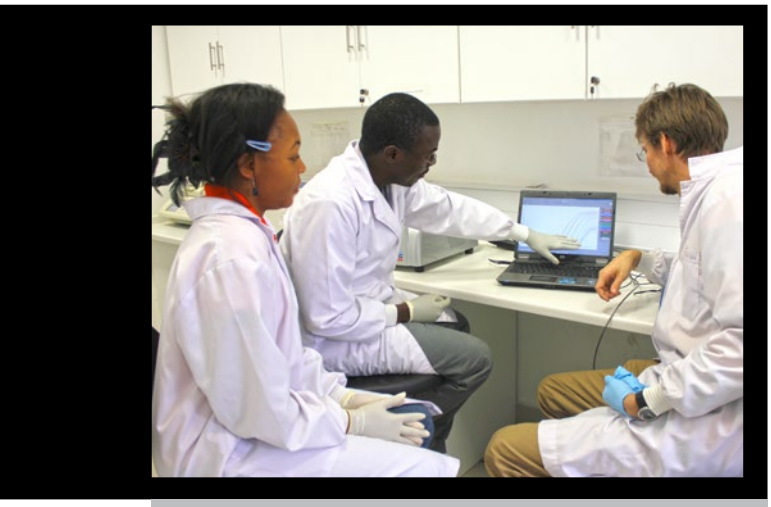
4. In human and animal health, *icipe* is currently weak in translating its vector biological and ecological discoveries to the population and economic levels. *icipe* should strengthen its own capacity in animal and human population based research to fully capitalise on its discoveries.

5. *icipe* has a good record in community-based research and should further strengthen its transdisciplinary research capacity by involving social and cultural scientists.

3.3 Capacity Building and Institutional Development – (Comments by Prof. Judi Wakhungu)

The overall objective of *icipe*'s capacity building initiatives is to build human resource capacity in insect science and related biosciences to enhance the ability of African scientists to respond to arthropod-related development needs. The Centre's capacity building efforts are built into existing research and development programmes spanning basic strategic research, technology development, validation and community-based adaptation.

Previously, *icipe*'s Capacity Building and Institutional Development (CB&ID) programme and the Organisational Capacity Development (OCD) project were conducted under six result-, project-based, areas. Using this approach, *icipe* achieved significant impact in: a) high level postgraduate training for leadership in scientific research and policy analysis; b) dissemination of technologies to national agricultural research and extension systems; and c) institutional development, by strengthening African organisations and institutions. Significantly, *icipe* has managed to strengthen the institutional and organisational capacity of its key collaborators, and to also align itself with agricultural research institutes, research laboratories, regulatory bodies or networks/consortia, for instance KARI, KEMRI, KEPHIS, Association of African Universities (AAU), and Forum for Agricultural Research in Africa (FARA).



Dr Jandouwe Villinger with two doctoral students, David Omondi and Yvonne Obiekwe, in the Martin Lüscher Emerging Infectious Diseases Laboratory discussing results of newly developed real time PCR-high resolution melting analysis based diagnostic tests.

In October 2012, two independent consultants evaluated the CB&ID programme and the OCD project and concluded that not all of the six results were equally important and recommended that, to improve focus, a programme approach, rather than a portfolio of projects should be adopted, and that the activities be re-designed into three result areas: a) Capacity building and professional development of African scientists and professionals; b) Institutional development by nurturing and strengthening of African higher education institutions (including existing *icipe* sub-regional centres) and c) Innovation on insect science promoted in collaboration with regional and national agricultural research and advisory services and the private sector. The consultants also proposed a programme framework for the period 2014–2020.

The programme has already attracted support from DFID, EU, DAAD and SIDA, and hopefully it will also attract funds from other donors and IGAD. *icipe* has also established partnerships with regional and continental higher education networks such as ANAFE, RUFORUM and AAU, so as to be more present and connected in Africa. CB&ID is also partnering with institutions that are responsible for scaling up technologies. For instance, there is now an agreement in place with IGAD to implement the CAADP programme in the Horn of Africa. *icipe* and IGAD agreed to focus on capacity building at postgraduate level in post-conflict countries like South Sudan, northern Uganda and Somalia. A milk value chain programme to be implemented by the two partners in Somaliland has been funded by

the EU. Students from Somalia, Somaliland and Puntland are already being trained. A MoU with the Sheikh Technical Veterinary School (STVS) in Somaliland has been signed and interns from STVS are presently trained at *icipe*. Moreover, *icipe* is now disseminating the push–pull technology in Somaliland, for cereal and feed production, together with FAO. A similar initiative was developed in partnership with AFAAS.

Several GIS and other specialised training courses for postgraduate students have been organised, using a mix of hands-on training together with distance learning techniques, to reduce costs. An E-Learning platform will also be soon available for GIS and other training areas. In partnership with ASARECA, in 2012, a successful proposal-writing workshop was held in *icipe* for participants from six of the 11 ASARECA countries. The objective was to increase the capacity of NARS partners to successfully participate in competitive grant schemes for which, presently, they often lack the necessary skills.

icipe undertakes postgraduate training at doctoral level through the African Regional Postgraduate Programme in Insect Science (ARPPIS) and at masters' level through the Dissertation Research Internship Programme (DRIP). Since 1993, ARPPIS has trained 350 students, 30% of whom are women. The ARPPIS programme has been hailed by NEPAD as an example of South–South partnership, through which participants share existing academic work, publish case studies and ultimately do joint research.

A tracer study of former ARPPIS students was conducted in 2012. One of the recommendations was that the ARPPIS alumni should be revitalised to facilitate the sharing of information and enhance the harnessing and utilisation of African talent in insect science. In response, an open platform for ARPPIS alumni has been developed and is operational. (At the time of the review, the site was barely 10 days old and already had 48 members.) 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 ASARECA, TWAS, FARA and RUFORUM.

David Tchouassi, a doctoral student, pictured in a homestead in Naivasha in the Rift Valley of Kenya, one of the areas that are prone to Rift Valley fever outbreaks.

The reviewers interviewed some of the ongoing postgraduate students at *icipe*, among them a Ghanaian student studying the chemical ecology of sex pheromones, attached to the coffee entomology project. She had learned about ARPPIS through the Internet, and then contacted the programme's coordinator in Ghana. A Cameroonian student was working on the chemical ecology of plants, having learned about ARPPIS through his lecturer in Ghana, himself a former ARPPIS student. Also interviewed was a German student undertaking a joint PhD study between *icipe* and the University of Bremen, Germany. With a background in biology, she is now working on the control of mango fruit pests.

The interviewed students commended the quality of research at *icipe* and described the standard of work as first rate. They also hailed the relationships with supervisors as excellent, and remarked on the very supportive environment at the Centre, noting the laboratory atmosphere as family-like, and citing the open-door policies of supervisors as well as the exposure to a myriad of topics beyond one's area of study.

However, the students also highlighted some challenges, one of them being the perceived weak link between *icipe* and African universities. As a result, students often have to navigate admission issues on their own, right from choosing universities to finding supervisors interested in their work. **This reviewer recommends** that *icipe* continues to strengthen links with public universities. (*See also the section on strategic partnering and linkages above.*) **This reviewer**

further recommends that for quality assurance and consistency, *icipe* maintain a database of supervisors from which scholars can select, rather than (as is currently the case), leaving the scholars to navigate the process on a trial-and-error basis.

Health insurance, which currently only covers the scholars, was considered another key challenge. **This reviewer recommends** that the cover be extended to the families of the scholars. In addition, the age limit for admission into postgraduate programmes should be made more flexible for women applicants.

Housing was also cited as a major hitch for students. The procedure is that joining students are hosted for two weeks at an *icipe* guesthouse. After that, they have to find their own accommodation, often with the help of the students' association. However, the students feel that the current housing rates are rather high and wondered if *icipe* could organise accommodation at lower rates. At *icipe*'s Mbita Point campus the student housing situation is worse. One student suggested that a settling-down package should be awarded at the commencement of studies. **This reviewer recommends** that *icipe* examines options for providing better housing at a lower rate.

The ARPPIS student stipend is currently $ 900 monthly, which is approximately three times the monthly salary of a school-teacher in Kenya. However, the Kenya Revenue Authority has recently stipulated that Kenyan ARPPIS students have to pay income tax on their stipend. The students feel that this significantly reduces the amount, and it might affect performance, as students might need to supplement their income with work outside their studies.

The issue of job opportunities upon completion of studies was also highlighted. Some of the students have jobs to return to, but others do not and have to search for opportunities internationally. The students suggested that *icipe* should become more aggressive about 'selling' their scholars and possibly consider offering more postdoctoral opportunities.

4. Governance and Corporate Affairs

Founded in 1970, *icipe* has evolved into a pan-African research and development centre with operations in 30 countries in sub-Saharan Africa. *icipe* focuses on arthropods and green and sustainable pest control strategies, with a particular emphasis on biological and integrated control. The Centre's R&D philosophy, encapsulated in its *4-H paradigm*, remains the driving vision of its Board, management and scientists, and within its mission and mandate (as per its 1986 Charter):

Mission

"to help alleviate poverty, ensure food security and improve the overall health status of peoples of the tropics by developing and extending management tools and strategies for harmful and useful arthropods, while preserving the natural resource base through research and capacity building."

Mandate

"…research in integrated control methodologies for crop and livestock insect pests and other related arthropods, and insect vectors of tropical diseases, and strengthening of scientific and technological capacities of the developing countries in insect science and its application through training and collaborative work".

4.1 Governance and Management – (Comments by Prof. Judi Wakhungu)

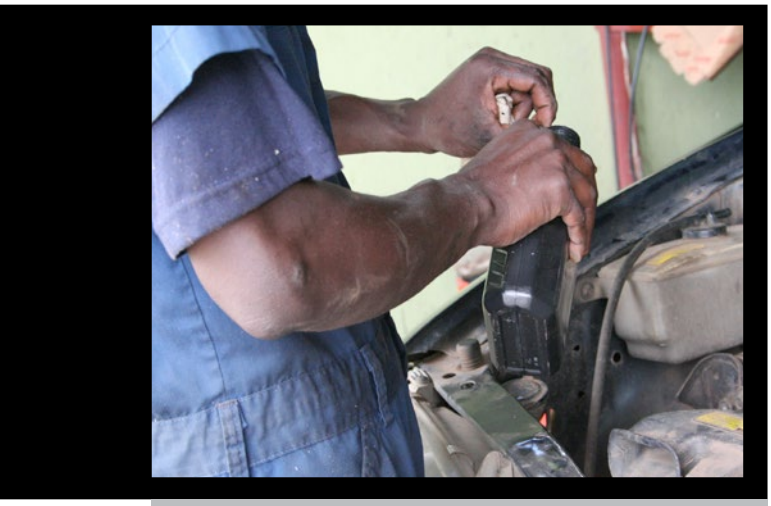
The reviewers were satisfied with the *icipe* governance structure, which they found solid and adequate for the institution's needs. The top management organ of *icipe* is its Governing Council (GC), which consists of 13 international members (including two Kenyans), and is responsible for policy-level governance of the Centre. The GC is very engaged and committed, has a good institutional memory, and very good relations with the Centre's staff and management. An Executive Board assists the Council in determining *icipe* policies. At annual GC meetings scientists are encouraged to present their research and receive feedback from the members.

icipe has a senior Management Team, which effectively steers and guides the Centre's affairs. Various committees monitor operations and ensure compliance with best management practices. They include the Science Management, Research Review, Health and Safety, and Ethics committees. Scientists and corporate meetings are also held regularly, while a dynamic *icipe* Staff Association (ISA) complements these structures.

Functions (Finance, Human Resources, Information & Communications Technology, Information & Publications, Library, Legal, Procurement, Security, Transport, Workshop, and Guest Houses) are diverse and dispersed but highly centralised. All functions eventually report to the Director General (DG) or Director of Finance and Administration (DFA), the former acting as Chief Executive Officer and Director of Research (DoR) while the latter acts as the Chief Financial and Chief Operational Officer.

The senior management team made a very good impression on the review team, and the evolving, but well-established linkages between the Governing Council (GC), Director General (DG), Director Finance & Administration (DFA), Science Management Committee and the Grants Review Committee, were noted.

As the DoR, the DG opens many (donor) doors and fundraises with the research staff, assisting them in getting new and unconventional funding. **The reviewers recommend** that the DG continues to act as the DoR, but that the option of creating a Deputy Director General (DDG) position is considered for purposes of succession which *icipe* will face in 2015; if qualifications support it, an African DG should be envisaged.



Vehicle, machine and instrument maintenance are vital to keep *icipe* rolling, and enable the scientists to do the science.

icipe has recorded significant income growth from USD 10M in 2005 to USD 30M in 2012. Of the *icipe* funding, approximately 65% is restricted and 35% is core. Renewing Swiss and Swedish core funding was considered vital, and there was an ambition to consolidate *icipe*'s position with the EU, with whom the Centre has been successful over the last 2–3 years. Approximately 80% of the budget is allocated to R&D, while approximately 20% is for administration. Some of the core funds have been earmarked for distinct activities, e.g. those from Sweden are earmarked for capacity building. At the time of this review, there were ongoing negotiations with the Swiss for a € 4 million grant to finance the 'greening' of the Centre, i.e. turning *icipe* carbon neutral. The maintenance of all R&D facilities is funded by *icipe*'s own resources. *icipe* aims to achieve its research mandate while maintaining an expenditure ratio of 80:20 (R&D versus Corporate costs). This goal has been consistently achieved over the five years of the external review.

icipe has taken a lead to join forces with organisations like ILRI and ICRAF, and organised the development of several inter-centres joint services (e.g. security, travel, insurance, IT, etc.). These initiatives maximise economies of scale and improve the delivery of quality goods and services while minimising the cost for each Centre. In addition, *icipe* has adopted and continually strives to implement Best-in-Class practices for all its corporate and operational activities such as a Just-In-Time (JIT) purchasing policy.

The last IPER (2002–2007) did not include Finance & Administration and the current management welcomed the opportunity to provide an overview of activities and achievements in this regard. *icipe* complies with the International Financial Reporting Standards (IFRS) and the International Accounting Standards (IAS). Clear and transparent financial management policies guide resource allocation, financial disbursements and reporting. The GC nominates an External Auditor to conduct the annual institutional audit. The present 5-year term of Ernst & Young comes to an end in 2014 and the Council has already initiated the process for the selection of the next auditors. **The reviewer suggests that the** diversity and multiplicity of in-house operations and services may benefit from further streamlining.

icipe has a competent and versatile staff of over 300 employees; 76% at Duduville Campus, 23% at the Thomas Risley Odhiambo Campus, Mbita and 1% at other research sites. Of these, 68% are men and 32% women, holding various nationalities—from Africa, Europe, Asia and the Americas. **The reviewer also recommends** that while staff distribution at the national and geographical levels is sufficiently diverse, the gender gap, particularly for senior staff and scientists, needs to be improved. In addition, **the reviewer also recommends** that the directorate should consider ways to maintain staff diversity, particularly that of senior staff and scientists.

DFA, Roger Finan, noted that just five years ago, the morale at *icipe* was low, mainly due to resource mobilisation challenges. As a consequence, staff turnover was high. However, the situation has improved significantly as the funding base has stabilised. The relationship between finance staff and researchers/scientists has evolved and has become more collegial and complementary (the motto being "Let the researchers do research – we'll worry about the funding!"). Incentives are offered to scientists to communicate, a state of affairs that has led to a better working atmosphere at the Centre. The salary scales have also been revised to meet the international standards, and are now aligned to the Nairobi-based CGIAR Centres (ICRAF and ILRI).

The reviewer noted improvements in performance and operations during the period under review and commends the entire staff. However, while R&D staff appreciate the Management's effort and perceives them as largely fair, they feel that they are somewhat draconian in practice. **The reviewer therefore recommends** continued improvement of dialogue between scientists and Finance.

icipe maintains good relations with its government contacts, particularly with the Government of Kenya. Three *icipe* staff members share the responsibility for maintaining external relations with the Government of Kenya. The host country agreement was regarded as strong, and *icipe* maintains dialogue with like-minded centres (e.g. CGIAR) on these issues. **This reviewer recommends** that in-house operations should be further streamlined, especially when addressing compliance with newly devolved Kenya government policies.

The review team can bear witness to the comfort of the guest accommodations both at Duduville and Mbita.

4.2 Infrastructure and physical facilities – (Comments by Prof. Judi Wakhungu)

icipe's international headquarters are located on the Duduville Campus in Kasarani, Nairobi, which also accommodates its main laboratories. The *icipe*-Thomas Odhiambo Campus (ITOC), Mbita Point, on the shores of Lake Victoria, also houses major research, training and fieldwork. Other field sites in sub-Saharan Africa ensure that the Centre's research and development work spans various types of ecosystems and habitats.

The main campus of *icipe* appears adequate for the near future, with an infrastructure, which in addition to the scientific facilities includes vehicles, workshops and a guesthouse. However, provision should be made to secure adjacent land for future expansion.

In the last four years, *icipe* has embarked on a commendable renovation and upgrade programme to enhance its infrastructure and improve its ability to deliver its mandate. In accordance, *icipe* has made a successful step towards modernising its laboratories with the construction of the Martin Lüscher Emerging Infectious Diseases Laboratory and commencement of the building of the CRL for bee health. **The reviewer recommends** that this ongoing programme must be continued and expanded to assure the future of the institution. The chemical laboratories have up-to-date analytical equipment. However, **the reviewer suggests that** attention should be paid to an equipment fund for special investments.

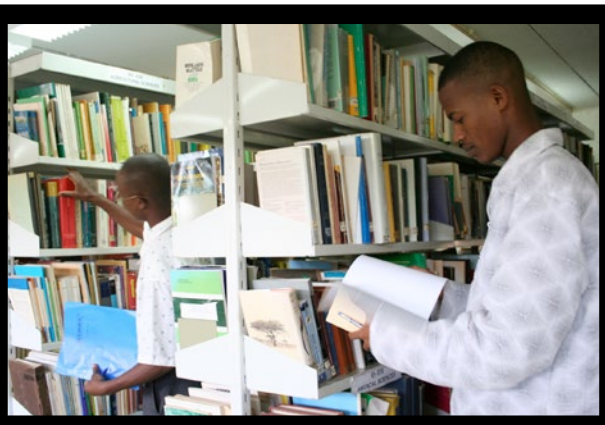
This reviewer considers it regrettable that the *Bacillus thuringiensis israelensis* (Bti) plant at *icipe* is not functional, especially since this is probably the only such facility in East Africa. **The reviewer understands** the difficulties with securing parts from China, but however notes that the window of opportunity to get the fermentation plant working could close soon.

4.2.1 ITOC

The overall operations at ITOC are overseen by the Finance and Administration team in Nairobi, in liaison with managers on the ground. Significant progress has been made towards renovating ITOC. For instance, the generator, water pumps and tanks have been upgraded, and incinerators and screenhouses have been improved. NEMA has expressed its satisfaction with the WHO oxidation pond, which measures up to KEBS standard. **This reviewer notes that** although ITOC has a sufficient water supply, the all-important fuel upon which it is totally dependent is still inadequate. **This reviewer therefore recommends** that *icipe* explores solar power options for ITOC.

There are six resident scientists and 10 visiting scientists stationed at ITOC, who are supported by a variety of field technicians. With more scientists arriving each year, there is growing pressure on the accommodation and working space available for them. **This reviewer recommends** that the staff houses need further renovations.

There is only one Finance Officer stationed at the Campus, who conducts the general administration duties. **This reviewer recommends that** this is an issue that needs to be addressed.



A well-stocked and up-to-date library, with access to both printed and online journals and books, is essential to *icipe* scientists and students.

A guesthouse manager coordinates accommodation, arranges events for *icipe* staff, collaborators and distinguished guests, e.g. the area MPs, ably coping with even a relatively large number of guests, for instance students from the McGill University who visit the Campus annually. There is one security supervisor and 28 contract security officers at the Campus and, as Mbita town is isolated, it is necessary to maintain total surveillance on a 24/7 basis, thus additional two guards and a dog handler should be deployed during the night for effective coverage of the campus. A primary and a nursery school (with 450 pupils) are located on the Campus and are administered by the government.

The medical doctor, Patrick Sawa, has run the clinic at ITOC for the last 10 years. The facility includes a dental unit, and is the only one where local residents in the area can visit a qualified doctor. Dr Sawa would like to conduct research towards providing more quality community care, including clinical trials and capacity building. Donors, for instance, the government of The Netherlands and the Gates Foundation have expressed willingness towards funding the Clinic.

This reviewer notes that ITOC is a significant part of the Mbita community. It provides the best medical services in the area, hosts a world-class research station and the leading school in the County and also an excellent guesthouse. The Campus also provides attachment positions for the area youth, and allows the community to use its Internet connection, in addition to purchasing farm produce from local farmers. ITOC hosts an annual farmer's day, which is a guided tour where community members can get first-hand information on *icipe*'s push–pull technology.

4.2.2 *icipe* Resource Centre (IRC)

The *icipe* IRC serves as a regional resource for information and publications on varied areas of insect science, including agriculture, medical entomology and ecology. Interlibrary loan services are operational with local institutions and through a service offered by the British Lending Library, among others. This service is not only for *icipe* staff but users from research centres, universities, national research and extension systems, and other organisations in the eastern and southern Africa region.

The institutional library under the IRC houses about 12,000 books, and 26 journal titles. Many are specialised publications not found in other libraries in the region. Several databases on CD-ROM (e.g. AGRIS, CABCD) as well as online (e.g. AGORA, OARE and HINARI) make up part of the collection. Journals and reference materials are currently being received in both print and online versions. As well as handling in-house user requests, the library also co-ordinates the ordering of books and other reference materials for staff and interested parties; and maintains an archive of *icipe* publications, student theses, reprints and photographs. The library also helps to produce and provide information.

At present, the library relies on core funding to keep abreast of the various developments. *icipe* is seeking funding through Sida and others to finance monographs, periodicals, CDs and other journals that are currently not available. **This reviewer recommends** that further support be allocated for marketing the library.

There are plans to make the IRC completely 'virtual' in the future. However, currently the staff members lack the necessary capacity and training. The librarian is arranging to visit virtual libraries to learn their operation, and intends to write a proposal to the *icipe* management on the need for capacity building in this area to improve services. She will also be soon receiving her Masters in Open Access.

4.2.3 Information Technology

Established in 1998, the Unit consists of a team of six. The Unit provides hardware and software support to a total of 350 users. The *icipe* management has made investment in IT and the improvement in Internet connectivity in Kenya has had a positive impact on the Unit. Previously, there has been collaboration with ICRAF and ILRI in regard to the purchase of hardware. However, *icipe* now undertakes this procurement on its own.

However, the Unit is affected by high staff turnover, leaving it under great pressure in trying to cope with its mandate. The IT team is considering ways of restructuring the Unit to enable it provide better services. One area that needs specific attention is the management of the *icipe* website, which requires a specialised professional.

5. Partnerships and Stakeholders

(Comments by Prof. Judi Wakhungu)

5.1 National stakeholders

Visits were made to partners and stakeholders including the Ministry of Agriculture, KARI, KEPHIS, JKUAT and Real IPM Company. With one notable exception, the majority of these partners and stakeholders were very satisfied with their relationship with *icipe*, and considered it the most approachable international organisation in Kenya, and was consistently ranked highest in regard to the ease of conducting collaborative work. In particular, KARI and JKUAT praised *icipe*'s success regarding capacity building (1 in 4 PhDs in the Science Faculty at JKUAT were trained in one of *icipe*'s programmes). However, these two organisations felt somewhat of junior partners when it came to collaborative projects and both expressed a wish to be in at the initial project planning stages – a sentiment that obviously has to do with discussions about division of budgets. One partner that was really exciting was Real IPM. They gave the highest royalties to *icipe* (3%) in recognition of their value of *icipe*. They were also extremely eager to develop further collaboration, particularly in production of pathogens against *Varroa*, the parasitic mite infesting bees, and spider mites. Recommendations regarding partners are summarised in the executive summary.

5.2 Relationship with institutions hosted by *icipe*

icipe's main Duduville campus in Nairobi hosts several renowned like-minded organisations that include the International Fertilizer Development Centre (IFDC), the International Institute of Tropical Agriculture (IITA), the International Center for Tropical Agriculture (CIAT) particularly its Tropical Soil Biology and Fertility Institute (TSBF), the Kenya Organic Agriculture Network (KOAN) and the Swiss-based Biovision Foundation particularly its Farmer Communication Programme (FCP) and the Biovision Africa Trust.

5.2.1 Biovision Africa Trust

Biovision Africa Trust (BvAT) was formed in 2009 by the former *icipe* DG, Dr Hans Herren via the Biovision Foundation of Switzerland

and registered with the assistance of *icipe*. The purpose of the Trust is to support dissemination of information in the 4H areas and enhance technology uptake. It has five major activities: the Biovision Farmer Communication Programme (FCP), *The Organic Farmer* (TOF) magazine project, *The Organic Farmer Radio* (TOF) programme, Infonet-Biovision project, and a communication outreach project modelled along TOF in Tanzania (Mkulima Mbunifu project).

icipe hosts the Trust, and provides it with administration and financial support. There is also synergy between *icipe*, Biovision Foundation and Biovision Africa Trust in proposal development towards shared common interests. For instance, Biovision Africa Trust took the lead in developing the Ecological Organic Agriculture (EOA) of African Union concept note and proposal. It was funded by the Swedish Society for Nature Conservation (SSNC) with funds from SIDA and it has now been taken up by the African Union Commission as a recognised platform. Biovision has shaped the continental initiative and hopes to coordinate operations with further funding from SSNC/SIDA. The funds are administered by *icipe* and transferred to partners in the six EOA pilot countries: Kenya, Uganda, Tanzania, Ethiopia, Zambia and Nigeria. The donors are very impressed with the Trust's relationship with *icipe*.

Although the Technology Transfer Unit of *icipe* is akin to the farmer communication programme, the Biovision Africa Trust has taken over the broader task of getting information from various sources, including *icipe*, to end users. In this sense, Biovision helps *icipe* with dissemination of information to a wider audience.

Although the Trust now intends to start developing its own structures, it plans to work in partnership with *icipe*, and would still like to be a hosted institution within *icipe*.

5.2.2 IFDC

The IFDC office in Nairobi, which acts as the regional as well as the national base, has been hosted by *icipe* for four years. Currently, there are 29 staff members, including six international. Geographically, IFDC has its focus most strongly on South Sudan, Tanzania, Rwanda, DRC and Burundi, with activities in agribusiness and natural resource management.

icipe provides IFDC with logistical assistance in many areas, which include payroll (until early 2013), procurement, immigration issues for international staff and registration.

Although IFDC is pursuing a host country agreement with the Government of Kenya (GoK), it plans to remain on the *icipe* campus for the foreseeable future, as it considers the arrangement that it has with the Centre friendly, ideal and convenient.

At the time of this review, IFDC did not have any collaborative projects with *icipe*. However, it has previously worked with *icipe*'s GIS Unit and would particularly like to work with CIP in future.

5.2.3 CIAT

The CIAT office in Nairobi, which is the regional hub for Africa, consists of 30–40 people, among them 10 scientists, plus research assistants, finance and administration personnel. CIAT is financially independent of *icipe* and handles its own human resource issues. Its office space is fully serviced, and the staff members have access to the IRC, common meeting rooms and the guesthouse. They find the location at *icipe* Campus convenient and the parking sufficient. They would, however, like to see the grounds improved and probably gain some more space for meetings.

CIAT is expanding rapidly, especially in view of projects emerging in line with the CGIAR Research Programme (CRP), which means that they will require additional office space at *icipe*. Unfortunately, there is so far not much collaboration going on between CIAT and *icipe*, although both organisations recognise the need for it. There was an attempt in this direction, through a joint proposal developed in response to a call by USAID, which was, however, not funded. There have also been several meetings between CIAT and *icipe* to explore possibilities of developing further joint proposals. What is now needed is proper exploration of areas of synergy, for instance around the pests, diseases and soil fertility interface, and a strategy to realign common goals to facilitate collaboration.

5.2.4 IITA

The IITA office had been hosted by *icipe* for one year at the time of this review. It consists of four scientists, a finance person, station administrator and an accountant and a driver. They are financially independent from *icipe,* but depend on the Centre for procurement and their host country agreement. They have their own boardroom and video conferencing system. They make use of the guesthouse, which is appreciated, but use city hotels for big conferences. IITA also has national and international students who are supervised by the scientists at *icipe*. They do not have their own laboratory, and instead use that of CIAT. Generally, IITA rates the facilities at *icipe* as 8.5 out of 10. One complaint is the phone service, which they find inadequate, for instance for conference calling. They also note the lack of facilities for people with disabilities as one of the issues that ought to be addressed.

Since 2007, IITA has collaborated with *icipe* on several projects, and they would like to have a longstanding partnership. Unfortunately, they feel that there is very little interaction with *icipe* staff to build collegiality. Some of their suggested ways of improving this would be two-way seminar presentations and regular coffee get-togethers.

5.3 Other international organisations

5.3.1 ICRAF

The strongest engagement between *icipe* and ICRAF is in regard to back office management, e.g. joint tendering, security provision, sharing intelligence and joint procurement. The finance teams get on well, and shared services include medical insurance and facilities for CIAT-TSBF.

The ICRAF representative thinks that *icipe* is stretching itself too much, trying to deal with everything. He argues that *icipe* should get more focused and wondered what the Centre's vision was for the next 10 years. He also feels that *icipe* "hunts in CGIAR funding waters, but does not want to join CGIAR". However, he feels that although *icipe* appears opportunistic it "deserves a place in the world". He considers "below-ground biodiversity is the strongest connection with ICRAF", and that they should "explore these mechanisms closer".

5.3.2 CABI

Currently, there is not much work between CABI and *icipe*, except for a small project on tick pathogens (termite pathogens in previous period). There was an unsuccessful attempt towards developing a joint project on biopesticides using individual contacts. However, the two organisations have a shared interest in terms of collaborative efforts with other institutions, e.g. with IITA. CABI is keen to engage with *icipe* on future partnerships.

This reviewer concludes that with the collaborative activities and the range of institutions hosted at its Campus, *icipe* is well positioned to advance its pan-African work and contributions, particularly since the majority of the partners express satisfaction with their relationship with *icipe*.

6. Conclusion: Emerging opportunities and innovations

icipe is well placed to play a key role in future entomological development in Africa. Emerging opportunities appear at the genomics level, specifically genomics and metabolomics, where *icipe* is already heading in the right direction with the Martin Lüscher laboratory and its involvement with the BecA hub. *icipe* risks missing opportunities in capitalising on its innovations by showing their effects at population level, and in economics.

Innovations will be coming from integrating the plant, animal and human health research capacity towards integrated interventions in social-ecological systems. *icipe*'s research capacity should be complemented with the above-mentioned socio-economic and possibly anthropological capacity. Innovations will be needed for more intensified crop and livestock production systems in rural and peri-urban environments towards sustainable food (and feed) security while preserving ecosystem services.

Strategically, *icipe* should concentrate on its entomological core capacity from molecular to ecological levels. It should rather invest in vector biology and control than on transmitted pathogens, except if there are critical interfaces like transmission blocking mechanisms.

icipe's excellent record of collaboration with Kenyan and regional universities carries the potential for leverage in African capacity building and requires a rethinking of the place of *icipe* as international partner in a rapidly changing societal environment.

A recent encouraging development is that *icipe* will create, together with ICRAF and ILRI, a hub for public–private–partnerships (PPPs) to enable science results—very similar to DFID's Research-into-Use (RIU). The hub will be based at *icipe* and is due to start in May/June this year. It will be funded by Germany (BMZ) for a total of € 6 million. Other similar hubs are planned for Asia and Latin America.

ANNEX 1: Background, terms of reference and review team CVs

2013 review of *icipe*'s R&D, Capacity Building and Management Programmes: Background and Terms-of-Reference (ToR)

I. Background to the Review

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. From an institutional standpoint, both the Governing Council (GC) and the Sponsoring Group of *icipe* (SGI – an informal association of donor organisations sympathetic to the Centre's vision and mission) have important roles to play in this vital exercise.

Institutional Reviews

Starting in 1983, the SGI together with the GC of *icipe* instituted the *icipe* Periodic External Review (IPER), as an instrument to undertake the review of the scientific programmes, administrative and financial management of the centre. The GC, in consultation with the SGI, appoints the review members, and provides terms of reference for the review team. The team is usually composed of a multidisciplinary group of individuals knowledgeable not only in their respective disciplines, but also in the global research scene in agriculture, health and the environment and are also conversant with general development bottlenecks, management and resource mobilisation.

The reviews involve study of relevant documentation, visit and review of ongoing work of *icipe*'s programmes, field sites and stations. The review mission also consults with a broad range of partners and collaborators. The review lasts for a period of two to three weeks and results in a detailed report providing key recommendations. The management team has opportunity to comment prior to submission to the GC and to the SGI. The outcome of these reviews consists of policy guidelines such as vision and strategic documents as well as mid-term plans with clear-cut schedules of implementation.

Previous Reviews

The last external review was conducted during the 1st half of 2007 covering the period of 2002–2007. The final report of this review can be found at http://www.icipe.org/images/stories/pdf/about_us/external_review.pdf. Since the 2007 review focused exclusively on the programmatic and strategic issues, in particular the research and capacity building agenda of the Centre, it was agreed between the GC and SGI at the time, that the next review would cover the entire operations of *icipe*, including the management, internal organisation, administration, policies and partnerships of the Centre.

II. Terms-of-Reference for the Institutional Review

a) *Why an Institutional Review?*

The new draft vision and strategy 2013–2020 outlines steps to be taken in order to provide the

much-needed solutions in food security, sustainable livelihoods, good health and sustainable use of natural resources for the peoples of tropical Africa. The strategy is based on the Centre's '4-H' paradigm of Human, Animal, Plant and Environmental Health, and through the use of a number of scientific tools, approaches and disciplines, in collaboration with R&D partners as well as institutions of higher learning.

The draft vision and strategy is conscious of the very dynamic global environment that *icipe* operates in. The strategy recognises the tremendous advances being made in natural sciences, increased access to knowledge and information, and opening of niche markets based on bio- and industrial products from plants and animals, and spread of arthropod-transmitted diseases and various invasive species of arthropods, as some of the issues that an institution such as *icipe* must continually reappraise. Global environmental changes such as climate change and increased climate variability, and the already manifest as well as anticipated consequences for global food security and global health, are probably the most important global concerns of today. How is *icipe* responding to these challenges?

A review of the institution's programmatic and institutional agenda is valuable as a tool for evaluating how *icipe* is positioning itself to meet the new challenges. Most importantly, the review is able to gauge how the programme agenda is in tune with its institutional mandate and to what extent it meets the development needs of its beneficiary constituency through the creation of knowledge-based solutions, building capacity of individual researchers and institutions in Africa, contributing to policy development and ultimately, reducing the impact of arthropod pests and vectors that have a direct bearing on poverty, health, food security and well-being. The timing of the envisaged external review will enable *icipe* to finalise the draft vision and strategy 2013–2020 under the guidance of its GC, stakeholders and also the review team. The review also serves the benchmarking function, taking stock of what has been achieved during the reporting period and enabling a more realistic realignment of programme priorities and implementation plans for the next 5–7 years.

The Programme and Institutional Review will be conducted by an appropriate multidisciplinary team of three members knowledgeable not only in their respective disciplines, but also in the global research scene in agriculture, health, environment and the institutional landscape; they will also be conversant with organisational, management and resource mobilisation issues. Much of the Review will be completed as a desk exercise, with essential team meetings for: the allocation of responsibilities; visits to *icipe* headquarters and selected *icipe* field sites; discussions with *icipe* stakeholders, partners and beneficiaries; and in the writing of the final report.

b) *Strategic and institutional issues to be considered by the review*

Based on material provided by the Centre, the team will review impact of *icipe*'s research and training programmes. Then, following consultation with the Centre's stakeholders, and recognising the fundamental comparative advantage of an international centre in being able to work across country borders, and at the same time acknowledging the constraint of financial resources, the team will examine the trade-offs across strategic dimensions and offer options for the future research planning of its programmes as well as the institutional requirements for doing so. An important consideration in the analysis will be how effective has *icipe*'s historical perspective and unique evolution as an African institution and its institutional commitment in pursuing a development agenda for the benefit of Africa's poor been useful in driving and sustaining its research agenda.

The following are specific key concerns that the review will address:

i. Success in operationalising the preceding Vision and Strategy 2003–2012

ii. Critical review of the draft Vision and Strategy 2013–2020

iii. Impact of *icipe*'s work in meeting national and regional development priorities of its African constituency since the last external review (i.e. the period 2007–2012)

iv. Innovative programme design and strengthened research infrastructure to deliver on the institutional mandate

v. Rising to the challenge of emerging opportunities and threats

vi. Sourcing investment for the programmatic agenda

vii. Strategic partnering and linkages

viii. Assessing the present and future capabilities of the Centre's Management and Administration structure, and resources and policies in supporting growth in R&D and Capacity Building

III. Scheduling of the Review

- May–June, 2012: Internal consultations and sounding of potential review team members
- Early June, 2012: Draft ToR and review team nominees provided to *icipe* Ex-Bo for endorsement
- Mid June, 2012: ToR and review team nominees sent to SGI for endorsement.
- Late June, 2012: ToR shared with approved review team
- Oct–Nov, 2012: Desk study material provided to review team
- Nov, 2012: Review team leader participates in annual GC meeting to discuss the forthcoming review with the GC and *icipe* management and scientists
- Late January – early February, 2013: Review mission (approx. 14 days in Kenya and 1–2 additional countries in Africa with significant programmatic activities of *icipe*
- March–May, 2013: Finalisation of Report, in consultation with *icipe* management
- Early June, 2013: Submission of Report to *icipe* GC

Short CVs of the Review Team

Philip Chiverton (Chair of the team)

UK/Sweden: Philip Chiverton, a British national resident in Sweden since 1979, is a Senior Advisor at SLU Global (Agricultural Sciences for Global Development), in the Division of Strategic Development, Vice Chancellor's Office, at the Swedish University of Agricultural Sciences (SLU), in Uppsala, Sweden.

Background: He gained a BSc (Hons) in Agricultural Zoology from the University of Newcastle upon Tyne, UK. (1976). He earned a Doctor of Agronomy (Entomology) at the Swedish University of Agricultural Sciences, Uppsala, Sweden (1987). He was a Visiting Postdoctoral Research Fellow at The Game Conservancy, Fordingbridge, UK. (1989) He was made Associate Professor (Docent) in Entomology at SLU in September 2000.

Positions include overseas volunteer agriculturist in Tanzania (1977–1979); Research Assistant at Department of Plant and Forest Protection, SLU (1980–1987); Researcher at Department of Entomology, SLU (1988 – 2000), including the 5 year IAEA/FAO/Sida-funded project in 8 African countries examining the effects of organochlorine pesticides on non-target fauna in African agricultural ecosystems; Member of the IOBC/WPRS Working Group on Pesticides and Beneficial Organisms (1986–1991); Senior Advisor, International Office, SLU (2000 – present).

Representative for SIDA at EIARD WG meetings since 2006; Part-time employee (2009)/consulting for Sida on the CGIAR reform process since 2008, and is the Swedish representative on the CGIAR Fund Council from its creation in 2010–present.

Judi Wakhungu

Kenya: Judi Wakhungu is the Executive Director of the African Centre for Technology Studies (ACTS) in Nairobi, Kenya. Prof. Wakhungu's research interests include science, technology and innovation; agriculture and food security; biodiversity and natural resource management; energy and water security; and gender issues in science and technology. She has published widely in these fields.

Background: Prof. Wakhungu serves on several national and international boards, task forces and committees. These include the: the African Conservation Centre (ACC); the United Nations Environment Programme (UNEP)–Global Environmental Outlook (GEO-4); Innovation Africa; the International Assessment of Agricultural Science and Technology for Development (IAASTD); the GoDown Arts Centre; Institute for Security Studies (ISS); the Lemelson Foundation; The Legatum Center for Development and Entrepreneurship at MIT; Scientists Without Borders; the STEPS Centre – University of Sussex; and the World Bioenergy Association (WBA).

Following the Kenyan General Election in spring 2013, Prof. Wakhungu was nominated and endorsed as Cabinet Secretary (Minister) for Environment, Water, and Natural Resources in President Uhuru Kenyatta's new government.

Jakob Zinsstag

Switzerland: Jakob Zinsstag is Deputy Head of the Department of Public Health and Epidemiology at the Swiss Tropical and Public Health Institute in Basel, Switzerland. Prof. Zinsstag's research interest is in the added value of closer cooperation of human and animal health, also called "one health". Specifically his group investigates avenues for better access to health care for mobile pastoralists and the control of zoonoses in developing countries.

Background: Jakob Zinsstag graduated with a doctorate in veterinary medicine at the Veterinary Faculty of the University of Berne in 1986. After his studies he worked in rural practice and as postdoctoral fellow on trypanosomosis research at the Swiss Tropical Institute. From 1990 to end of 1998 he worked in the Gambia and Côte d'Ivoire. Since 1998 he leads a research group at the Swiss Tropical and Public Health Institute (Swiss TPH) on the interface between human and animal health. The group focuses on health of mobile pastoralists and zoonoses control in developing countries. He holds a PhD in Tropical Animal Production from the Prince Leopold Institute of Tropical Medicine in Antwerp, Belgium.

Since 2010 he is Professor of Epidemiology at the University of Basel and since 2011 deputy head of department of Epidemiology and Public Health at the Swiss TPH. He is a member of the transdisciplinarity board of the Swiss Academy of Sciences (www.transdisciplinarity.ch) and president of the International Association of Ecology & Health (www.ecohealth.net).

ANNEX 2: Major scientific collaborations (2008—2012)

IPM Cluster

a) Outside Africa

PUSH–PULL

1. John Pickett, Michael Elliott Distinguished Research Fellow and Scientific Leader of Chemical Ecology, Rothamsted Research, Harpenden, Herts., AL5 2JQ, United Kingdom, Email: John.pickett@bbsrc.ac.uk, Tel.: +44 (0) 1582 763133 x2320, Fax: +44 (0) 1582 762595.
2. Miguel Borges, Brazilian Agricultural Research Corporation (EMBRAPA), Brazil, Email: mborges@cenargen.embrapa.br, Tel.: +55 61 3448-4688.

IRD

1. Andrew Mitchell, Australian Museum, 6 College Street Sydney NSW 2010, Australia.
2. Petri Pellikka and Tino Johansson, University of Helsinki, Department of Geosciences and Geography, P.O. Box 64, 00014 University of Helsinki, Finland, Email: petri.pellikka@helsinki.fi, Tel.: +358-9-19151068.
3. Jean François Silvain (Jean-Francois.Silvain@legs.cnrs-gif.fr), Stéphane Dupas (Stephane.Dupas@legs.cnrs-gif.fr) and Laure Kaiser-Arnauld (Laure.Kaiser-Arnauld@legs.cnrs-gif.fr), CNRS, Gif/Yvette, France.
4. Gaël Kergoat (kergoat@supagro.inra.fr) and Gérard Delvare (gerard.delvare@cirad.fr), INRA CBGP Montpellier, France.
5. Brigitte Frérot (brigitte.frerot@versailles.inra.fr), Emmanuelle Jacquin-Joly (emmanuelle.jacquin@versailles.inra.fr) and Frédéric Marion-Poll (frederic.marion-poll@versailles.inra.fr.), INRA, PISC Unit, Versailles, France.
6. Alex Delobel (delobel@mnhn.fr) and Jérôme Barbut (barbut@mnhn.fr), Museum National d'Histoire Naturelle (MNHN), 45 rue Buffon, 75005 Paris, France.
7. Elisabeth Herniou (elisabeth.herniou@univ-tours.fr) and Jean-Michel Drezen (drezen@univ-tours.fr), Institut de Recherche sur la Biologie de l'Insecte (IRBI), Tours, France.
8. Jurgen Kroschel and Henri Tonnang, International Potato Center (CIP), Avenida La Molina 1895, La Molina Apartado Postal 1558, Lima, Peru.
9. James Cuda (jcuda@ufl.edu), Bill Overholt (billover@ufl.edu) and J.L. Gillet-Kaufman (gillet@ufl.edu), University of Florida, Gainesville, FL 32611 Florida, USA.

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2. H-.M.Poehling and Rainer Meyhoefer, Leibniz Universitat, Hannover, Department of Plant Pathology and Plant Protection, Herrenhäuser Str 2, 30419 Hannover, Tel.: +49 511 762 3096, +49 511 762 3015, Email: Meyhoefer@ipp.uni-hannover.de, Poehling@ipp.uni-hannover.de
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4. Srinivasan Ramasamy, AVRDC – The World Vegetable Center, P.O. Box 42, Shanhua, Tainan 74199, Taiwan, Email: Srini.ramasamy@worldveg.org

5. Jurgen Kroschel, Global Program of Integrated Crop and Systems Research, International Potato Center, Peru, Apartado 1558, Lima 12, Peru , +51 1 349 6017, ext 3070, Email: j.kroschel@cgiar.org
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ANNEX 3: Research information: 2008 – 2012 publication statistics

Table 1. Publications Peer Reviewed (2007– Nov 2012)

Year	Number of peer reviewed publications	Mean number of peer reviewed articles per scientist
2007	87	2.4
2008	108	3.0
2009	84	2.3
2010	76	1.9
2011	79	2.1
2012	60	1.6
TOTAL	494	13

Table 2. Other Publications of Scientific Value (2007– Nov 2012)

Year	Number of other publications of scientific value	Mean number of other publications of scientific value per scientist
2007	18	0.5
2008	3	0.08
2009	4	0.11
2010	3	0.08
2011	2	0.05
2012	1	0.03
TOTAL	**31**	**0.85**

Ratio of other scientific material: peer reviewed = 1:13.

ANNEX 4: Training courses and capacity building data from ARPPIS/ students trained

Summary Output of *icipe's* Capacity Building Programmes (2007 – 2012)

	2007	2008	2009	2010	2011	2012
I. ARPPIS (PhD)	Ongoing 30	New 7	New 7	New 7	New 11	New 8
HH	2	-	1	1	2	-
PH	20	3	5	4	6	4
AH	2	2	1	2	3	2
EH	6	2	-	-	-	2
II. ARPPIS (MSc) Western Africa (Accra)	All 10	13	5	5	5	5
Eastern Africa (Addis)	3	-	-	-	-	-
Southern Africa (Harare)	5	3	-	-	-	-
III. DRIP (PhD)	11	15	13	3	12	15
HH	1	3	2	-	4	4
PH	4	7	8	1	3	6
AH	-	2	1	-	5	3
EH	6	3	2	2	-	2
IV. DRIP (MSc)	22	16	29	13	14	18
HH	4	2	3	-	1	3
PH	13	9	15	9	8	9
AH	1	3	8	2	4	5
EH	4	2	3	2	1	1
V. Training Courses	1		1	2	2	1
HH						
PH					1	
AH				2	1	1
EH	1		1			

*Key: **HH** – Human Health, **PH** – Plant Health, **AH** – Animal Health, **EH** – Environmental Health, **ARPPIS** – African Regional Postgraduate Programme in Insect Science and **DRIP** – Dissertation Research Internship Programme*

ANNEX 5: Technology transfer

Impact (Practical Application of Research Results) and Adoption Rate of *icipe* Technologies and Systems:

I. IPM Cluster:

- During the last 5 years about 27,000 new farmers in western Kenya, 2000 new farmers in Central Kenya, and about 2000 new farmers in both Uganda and Tanzania adopted push–pull technology resulting in an annual increase of 77,000 tons of maize, 11.5 million liters of milk, and 6 tons of *Desmodium* seed. This has directly improved livelihoods of at least 300,000 beneficiaries in the region.
- Push–pull technology has been adapted to drier areas and climate change effects, by identifying and incorporating drought-tolerant companion plants (*Brachiaria* as a trap plant and greenleaf desmodium as an intercrop), and has been adopted by about 4000 new farmers. Similarly, 12 'smart' maize varieties that have advanced inherent system of defence against attack by stemborer pests have also been identified. During the next 5 years at least 50,000 new farmers are expected to join push–pull (conventional and adapted) technology.
- The vector of the devastating Napier stunt disease caused by a phytoplasma has been identified as *Maiestas banda* Kramer. Consequently, three Napier grass cultivars and three alternative fodder grasses showing resistance to the disease have been identified and are currently being tested on-farm in western Kenya.
- Area-wide fruit fly IPM technologies (based on baiting and male annihilation technique, fungal biopesticide and orchard sanitation) are being practised by over 5000 mango and citrus growers in Benin, Cameroon, Kenya, Mozambique and Tanzania, with over 30,000 beneficiaries. Post-harvest treatment parameters that meet probit 9 quarantine security developed for disinfestation of citrus and avocado against *Bactrocera invadens*.
- As a result of the adoption of fruit fly technologies, mango fruit rejection by export markets has been reduced from 37% in 2003 to 4% in 2011 among farmers in eastern Kenya.
- Fruit fly parasitoids targeting invasive fruit fly species released and established in Benin, Cameroon, Kenya and Mozambique.
- Two *icipe* fungal isolates (ICIPE 69 and ICIPE 78) are registered and commercialised as Campaign® for the management of mealybugs, thrips and fruit flies and Achieve® for the control of mites, respectively, on various crops in Ghana, Ethiopia, Kenya and South Africa.
- The African weaver ant, *Oecophylla longinoda*, has been shown to be an effective biocontrol agent of the sap-sucking pests (*Helopeltis anacardii*, *H. schoutedeni* and *Pseudotheraptus wayi*) of cashew in the Coast region of Tanzania.
- Some entomopathogenic fungal isolates can endophytically colonise the seedlings of the faba bean *Vicia faba* and induce negative effects on the leafminer fly *Liriomyza huidobrensis* in terms of mortality, reduction in oviposition, fly emergence and longevity.
- Three exotic leafminer parasitoid species identified, introduced and two of them released and established in farmers' fields in Kenya, with direct increase in total parasitism rate from below 5% to 30–77%.
- Four endophytic fungal isolates were identified for use against leafminer flies.
- An efficient predatory mite was identified, introduced, released and established in pilot sites in Kenya.

II. IVDM (Human and Animal) Cluster:

Animal Health

(a) Tsetse Repellent Technology

- Repellent blend responsible for making waterbuck refractory to tsetse attack identified (patent application).

- Prototype dispensers for dispensing repellents on-host developed (patent application).
- The repellent technology of *icipe* has opened up possibilities of public–private partnerships for mass production of the collars and the repellent compounds.
- Several impacts of the large-scale tsetse repellent validation trials at the outskirts of Shimba Hills Game Reserve in Kwale District Kenya Coast can already be observed since the intervention started and farmers' perceptions of the technology are very positive. The impact of the repellent technology includes:
  - Disease incidence reduced by > 90%,
  - Drug use reduced by >90%,
  - Body weights of the protected animals have increased significantly resulting in higher selling prices and more traction power (of the bulls)
    - Protected bulls are ploughing 2–3x more land daily as reported by >60% of the farmers
    - Animals are now being sold at 2–3x the price,
  - Milk yield has gone up 2x even though lactating cows are native,
  - 95% of participating farmers can graze their animals anywhere including in tsetse-infested areas close to the park fence,
  - 94% of livestock keepers report that they can graze longer in tsetse-infested areas, including early morning and evening when tsetse flies are the most active,
  - In the evenings, farmers have stopped lighting fires to smoke away flies from the animals,
  - 96% of livestock keepers report that the animals are now more settled when grazing or ploughing,
  - Another positive feature is that demand for the collars is very high.

The above impacts have been achieved despite the prototype nature of the technology (only about 70–80% dispensers working during the evaluations due to losses or damage, and leakage and maintenance problems of the dispensers on cattle).

(b) Impacts of Innovative Animal Health Packages for zero-grazing dairy enterprises with Livestock Protective Net Fence (LPNF) as an essential component

- A reduction in biting fly numbers by more than 90% within a year.
- A reduction in mastitis cases by >45% in LPNF-protected units and by 30% in waste-protected units.
- Reduction in mosquito catches by nearly 50% in LPNF-protected units and by >85% in waste-protected units, as a result of which farmers are already reporting reduction in malaria cases in households next to the protected units or waste pits.
- Increase in milk production by 2–3x.
- Cows being more calmer, feeding better and easier to milk in protected units due to reduction in biting fly numbers.
- Very high demand of the new packages – a demand we cannot meet.

(c) Entomopathogens for Vector Control

- A reduction of 70% of *Amblyomma variegatum* ticks was achieved in the field by using environmentally friendly and low cost application strategy based on the entomopathogenic fungus *Metarhizium anisopliae* and semiochemical-baited traps.
- Infection by entomopathogenic fungus does not affect the mating behaviour of tsetse flies. Since autodissemination is achieved mainly through mating, there is possibility of using sterile males to disseminate spores of entomopathogenic fungus and reduce tsetse populations.

Human Health

Impact statements:

- 2005–2007: An integrated vector management (IVM) strategy is investigated, and baseline surveys of malaria vectors and other mosquito population breeding sites and larval control are carried out in parts of Kenya and Ethiopia.

- 2008–2012: Sustainable IVM technology is developed for mosquito control and tested in 3 ecologically different sites in Kenya and one site in Ethiopia through demonstrations on larval source management, environmental management, and best practices for bednet utilisation by the communities.
- 2007–2012: Annual mosquito field days continue demonstrating the benefits felt by communities through practising IVM techniques, attracting the press and decision makers.
- 2009–2012: A user-friendly IVM decision support tool (model) is developed.
- 2010–2011 Two regional workshops with the goal of strengthening in-country capacities to *implement IVM as an alternative to DDT* conducted for 8 African countries in eastern and southern Africa.
- 2011: The International Centre of Insect Physiology and Ecology (*icipe*) is nominated by the Africa region and endorsed by the Stockholm Secretariat in Geneva to serve as a Stockholm Convention Regional Centre for capacity building, the transfer of technology in the area of integrated vector management, informed decision-making within IVM approach and the development of non-chemical approaches to vector control.

IVM impact on mosquitoes and malaria:
Mosquito control interventions: Environmental Management (EM)

- Over 200 larval habitats were drained, filled or completely covered to avoid mosquito breeding in Malindi (Kenya), while, 530 m^2 ditches and habitats in Tolay (Ethiopia) were either filled or eliminated. The communities conducted all these activities.
- 90 Community Resource Persons (CORPs) have been trained to lead the communities in EM activities in Malindi and Nyabondo (Kenya) and Tolay (Ethiopia).
- A total of more than 470 community members were trained in different aspects of mosquito control including best practices on ITN utilisation and EM.
- Every week community members are reached out with information on mosquito and malaria control through the neighbourhood campaigns.
- School children are now actively involved in EM activities as a result of our programme's involvement in School Health and Mosquito Clubs. Children have been trained as 'health messengers' in malaria and mosquito control.

Entomological Impact

- All available habitats during wet and dry seasons have been surveyed and detailed maps developed showing their location and relative productivity.
- A significant reduction in the study sites of the main malaria vector *Anopheles gambiae* larvae in Kenya and *An. arabiensis* in Ethiopia was observed. Overall, anopheline larval densities were reduced by 55.7, 72.9 and 60% in Malindi, Nyabondo and Tolay, respectively. Subsequently, overall reduction in *Anopheles* resting indoors was 60.9% in Malindi and 28% in Nyabondo.
- Other mosquito species larvae and adults were additionally reduced by 68.6% in Malindi, 76.5% in Nyabondo and 70.2% in Tolay.
- Generally, fewer *Anopheles* mosquitoes were observed and none of them was found positive for *Plasmodium falciparum* circumsporozoites, suggesting a drastic reduction in human–vector contact and transmission.
- A high larval mortality of more than 95% was recorded when using crude neem extracts. Larval habitats treated with a single application of crude neem products were free of mosquito larvae after 3–4 weeks.
- A regular *Bacillus thuringiensis israeliensis* or *Bti* (an ecologically and environmentally safe biopesticide) application has been used successfully to control mosquito larvae in Kenya and Ethiopia.
- CORPs have been trained in basic entomological skills and they assist and guide the communities in identifying and seeking solutions to mosquito problems.
- The ITN distribution system and best practises on their utilisation has been synchronised, involving community members, MoH and other stakeholders.

Epidemiological Impact

- We have established malaria morbidity and mortality data sharing system with the MoHs officials in Malindi, Nyabondo and Tolay.
- Epidemiological assessment of malaria cases shows a 62 and 51.5% reduction in Malindi and Nyabondo, respectively.
- A dramatic decrease in malaria cases from 82.5 to 25% was observed in Tolay, Ethiopia from 2009 to 2011.

Impact on policy

- We have established a close working relationship with the National Malaria Control Programmes (NMCP) in Kenya and Ethiopia.
- In Kenya, an IVM policy guideline has been developed and adopted as a strategy in malaria vector control.
- Development and diffusion of simulation tools to support decision-making for malaria strategies and further integrate it with the national T21 Kenya model.

III. ACCES Cluster:

- *icipe* showed conclusively that African Chironomidae are not suitable for use in the biological control of the aquatic weed *Hydrilla verticillata*. This information allowed stakeholders to refocus their funding and research efforts on other control strategies.
- The insect-based community enterprises at Arabuko-Sokoke Forest generated US$ 30–35,000 per year with a total 5 years average of over $150,000 in revenues for forest conservation and local livelihoods.
- An additional 12 community-owned and managed marketplaces for honey and silk processing and marketing established by *icipe* in Kenya, Madagascar, Uganda, Egypt, the Sudan and Ethiopia were operational.
- Twenty-four tons of dry silk cocoons were produced and processed into yarn and cloth by community groups in seven countries (Kenya, Madagascar, Uganda, Egypt, Ghana and Sudan and Ethiopia) with a total value of $240,000.
- Over 1200 tons of honey with a total value of $4.5 million were processed and sold by community groups in Kenya, Ethiopia, Sudan, Uganda, South Sudan and Egypt through marketplaces developed by *icipe*. In addition, Yemen produced 200 tons of Sidr honey worth $1.0 million in five years, with a higher value of $50 per kg compared to the normal honey that is sold at US $3 to $6 per kg.
- A total of 1230 natural resource-dependent rural community households in Kenya, Tanzania and Uganda participated in commercial cultivation of insecticidal and medicinal plants, and production of products as new alternative livelihood activities.
- Over 35,000 pieces of plant-derived community products developed by *icipe* and partners were sold and used by thousands of consumers to improve their health and nutrition.
- Three global awards, BioFach 2010 World Organic Trade Fair award, Equator Prize 2010 and SEED Award 2010 for production of high quality organic honey, biodiversity conservation and poverty reduction, and social and environmental entrepreneurship, respectively, were won by community groups participating in commercial insects and bioprospecting livelihood activities initiated by *icipe* and partners.
- Four case studies on *icipe*'s public–private partnership in bioprospecting and 3 on community-based bioprospecting enterprises initiated by *icipe* and partners were documented by independent intellectual property specialists and international development organisations and used for policy development, capacity building and advocacy.
- As a result of the community-based commercial insects and bioprospecting enterprises that were established by *icipe*, over 5210 community members began to participate in conservation-related activities.

ANNEX 6: Training courses organised by *icipe* (within and between divisions) and/or participation of *icipe* staff in training courses organised by other institutions

IPM Cluster

Title	Duration and location	Sponsor	Number of participants
Stakeholders planning meeting on Adaptation and Dissemination of the Push–Pull Technology (ADOPT)	28–29 January 2011	EU-funded ADOPT Project	26
ADOPT Implementation Training workshop at *icipe* Mbita	1–2 March 2011	EU-funded ADOPT Project	30
Training workshop on McKnight-funded projects' work planning, monitoring and evaluation	24–25 May 2011	McKnight Foundation	21
Push–pull Technology Training for Heifer/ Kenya Technical staff and partners	19–22 July 2011	EU-funded ADOPT Project	20
Stakeholders' training on the Adaptation and Dissemination of the Push–Pull Technology, Melkassa Agricultural Research Center, Ethiopia	6–8 June 2011	EU-funded ADOPT Project	38 scientists, extension and development officers
Training of Heifer Project/ Tanzania Field Managers on the Push–Pull technology	8–10 June 2011	EU-funded ADOPT Project	16
EU Financial Management Training	8 September 2011	European Union via the EU-funded ADOPT project	7 project partners' and associates' accountants
Farmer training on the basics of video camera use, how to prepare a story board as well as a script	19 September–5 October 2011	McKnight Foundation (Participatory Video Project)	124
Training on video recording and editing	23 November–1 December 2011	McKnight Foundation (Participatory Video Project)	102
Training on video recording, video backup and editing	13– 16 December 2011	McKnight Foundation (Participatory Video Project)	90
Second Stakeholders' planning meeting on Adaptation and Dissemination of the Push–Pull Technology	16–18 January 2012	EU-funded ADOPT Project	21
Joint training of the Participatory Video farmer facilitators and Divisional Level Extension Staff	6–7 February 2012	McKnight Foundation	12
Training of Farmer Groups in Bungoma on Desmodium Bulking	4–6 April 2012	BMGF	200

Title	Duration and location	Sponsor	Number of participants
Training of farmer groups' facilitators as well as extension teams on video as a communication tool	5–8 February 2012	McKnight Foundation (Participatory Video Project)	13
Results Based Management Training	16– 17 February 2012	*icipe* DG's office	2 project staff
Peer Farmer TOT Workshop on Push–Pull Technology	29 February–2 March 2012	EU-funded ADOPT Project	
Training of ADOPT enumerators in Tanzania	25 March–13 April 2012	EU-funded ADOPT Project	
Napier Stunt Disease Training on Phytoplasma Genetics and Phylogeny	3–8 June 2012	Molecular Biology Unit, *icipe*	2 project staff
Training of farmers in Suba District on the ADOPT Technology	30 July 2012	EU-funded ADOPT Project	32
Training of farmers in Homa Bay District on the ADOPT Technology	31 July 2012	EU-funded ADOPT Project	30
Training of farmers in Rachuonyo District on the ADOPT Technology	1 August 2012	EU-funded ADOPT Project	32
Training of farmers in Bondo District on the ADOPT Technology	2 August 2012	EU-funded ADOPT Project	29
Training of a Heifer Project farmer group based in Teso District on the ADOPT Technology	30 July 2012	EU-funded ADOPT Project	26
Training of farmers in Bondo District on the ADOPT Technology	8 August 2012	EU-funded ADOPT Project	12
Training of farmers in Siaya District on the ADOPT Technology	8 August 2012	EU-funded ADOPT Project	13
ADOPT Project farmers' field day held in Lambwe	24 August 2012	EU-funded ADOPT Project	79
Training of Habitat Management field officers on the adapted push–pull technology	4–5 September 2012	EU-funded ADOPT Project	23 technicians and field extension staff
Training in Ndhiwa District - Magoba Farmer group on the ADOPT Technology	7 September 2012	EU-funded ADOPT Project	7
Training and demonstration to farmers in Rangwe in Homa Bay District-Ouga Farmer group on the ADOPT Technology and distribution of greenleaf desmodium and *Brachiaria* cv. Mulato seeds	11 September 2012	EU-funded ADOPT Project	7
Training and demonstration to farmers in Rangwe in Homa Bay District-Orero Farmer group on the ADOPT Technology and distribution of greenleaf desmodium and *Brachiaria* cv. Mulato seeds	11 September 2012	EU-funded ADOPT Project	33
Training and demonstration to Yago farmers in Ndhiwa District on the ADOPT Technology and distribution of greenleaf desmodium and *Brachiaria* cv. Mulato seeds	12 September 2012	EU-funded ADOPT Project	24
Training and demonstration to St. Florence farmers in Suba District on the ADOPT Technology and distribution of greenleaf desmodium and *Brachiaria* cv. Mulato seeds	12 September 2012	EU-funded ADOPT Project	16
Training and demonstration to farmers in Homa Bay District on the ADOPT Technology and distribution of greenleaf desmodium and *Brachiaria* cv. Mulato seeds	13 September 2012	EU-funded ADOPT Project	11

Title	Duration and location	Sponsor	Number of participants
Training and demonstration to Nyasanje farmers in Mbita District on the ADOPT Technology and distribution of greenleaf desmodium and *Brachiaria* cv. Mulato seeds	14 September 2012	EU-funded ADOPT Project	9
Training and demonstration to Sokoni Group farmers in Suba District on the ADOPT Technology and distribution of greenleaf desmodium and *Brachiaria* cv. Mulato seeds	16 September 2012	EU-funded ADOPT Project	11
Training and demonstration to WAPA farmers in Mbita District on the ADOPT Technology and distribution of greenleaf desmodium and *Brachiaria* cv. Mulato seeds	17 September 2012	EU-funded ADOPT Project	8
Training and demonstration to Gwikonge Women Group farmers in Kuria District on the ADOPT Technology and distribution of greenleaf desmodium and *Brachiaria* cv. Mulato seeds	17 September 2012	EU-funded ADOPT Project	16
Training and demonstration to Kamide Group farmers in Kuria District on the ADOPT Technology and distribution of greenleaf desmodium and *Brachiaria* cv. Mulato seeds	17 September 2012	EU-funded ADOPT Project	29
Training and demonstration to Gendo Group farmers in Suba District on the ADOPT Technology and distribution of greenleaf desmodium and *Brachiaria* cv. Mulato seeds	19 September 2012	EU-funded ADOPT Project	37
Training and demonstration to C-MATCO Group farmers in Suba District on the ADOPT Technology	19 September 2012	EU-funded ADOPT Project	101
Training and demonstration to Pundo Mandera Group farmers in Suba District on the ADOPT Technology and distribution of greenleaf desmodium and *Brachiaria* cv. Mulato seeds	19 September 2012	EU-funded ADOPT Project	12
Training and demonstration to Magoba Women Group farmers in Mbita District on the ADOPT Technology and distribution of greenleaf desmodium and *Brachiaria* cv. Mulato seeds	24 September 2012	EU-funded ADOPT Project	11
Training and demonstration to WERA Women Group farmers in Homa Bay District on the ADOPT Technology and distribution of greenleaf desmodium and *Brachiaria* cv. Mulato seeds	27 September 2012	EU-funded ADOPT Project	20
Training and demonstration to World Vision associated Group of farmers in Mbita District on the ADOPT Technology	26 October 2012	EU-funded ADOPT Project	71
Training and demonstration to Dunga Women Group farmers in Ndhiwa District on the ADOPT Technology and distribution of greenleaf desmodium and *Brachiaria* cv. Mulato seeds	28 September 2012	EU-Funded Project	7
Training and demonstration to Masanga S.H. Group farmers in Mbita District on the ADOPT Technology	01 October 2012	EU-Funded ADOPT Project	38
Training of TOTs at Homa Bay ATC on the ADOPT Technology organised by Heifer Project - Nyanza	20–21 November 2012	EU-funded ADOPT Project	25

Title	Duration and location	Sponsor	Number of participants
Frontiers of Chemical Ecology Course 2012 (ICE 12) at the Max Planck Institute for Chemical Ecology, Jena, Germany	26 November– 7 December 2012	EU-funded ADOPT Project and Capacity Building and Institutional Development (CB&ID) Programme	2 PhD students within the ADOPT Project Prof. Khan also presented one of the sessions reserved for renowned scientists
Training of a Siaya-based Heifer Project Kenya Farmer group on the ADOPT Technology	26 November 2012	EU-funded ADOPT Project	22
Training of a Migori based Heifer Project Kenya Farmer group on the ADOPT Technology	28 November 2012	EU-funded ADOPT Project	26
Training on digital video-mediated technology communication and meta-data management in collaboraton with Digital Green (India) and McKnight Foundation in Ziway, Ethiopia	9 –18 December 2012	McKnight Foundation (Participatory Video Project)	15
Training of Mcknight Participatory Video Project Farmers in Lambwe, Kisumu, Vihiga and Bungoma **Topics:** 1. How to operate a Video Camera 2. How to Prepare a Story Board 3. How to Shoot a Video using a Story Board	19–20 September 2012 21–22 September 2012 22–24 September 2012 4–5 October 2012	McKnight Foundation	100
Training of Mcknight Participatory Video Project Farmers in Lambwe, Kisumu, Vihiga and Bungoma **Topics:** 1. Recording of Videos 2. Editing	23–24 November 2012 24–25 November 2012 28–29 November 2012 30 November–1 December 2012	McKnight Foundation	102
Training of McKnight Participatory Video Project Farmers in Lambwe, Kisumu, Vihiga and Bungoma **Topics:** 1. Recording of Videos 2. Editing	13–16 December 2012	McKnight Foundation	90
Training of McKnight Participatory Video Project Farmers in Rachuonyo, Nyakach and Bondo **Topics:** 1. How to Handle and Use Pico Projectors for Screening Videos 2. How to Recharge Batteries	1–6 October 2012	McKnight Foundation	127
Training of McKnight Participatory Video Project Farmers in Rachuonyo, Nyakach, and Bondo **Topics:** 1. How to Use Pico Projectors for Screening Videos 2. How to Recharge Batteries	11–13 October 2012	McKnight Foundation	115
Training on rearing of tephritid fruit flies and their associated parasitoids	May 2008	BMZ	3
Group Training Course on Fruit Fly Taxonomy, Detection and Management (English)	July 2009	USDA-APHIS/FAS, RMCA & *icipe*	15

Title	Duration and location	Sponsor	Number of participants
Group Training Course on Fruit Fly Taxonomy, Detection and Management (French)	May, 2010	USDA-APHIS/FAS, RMCA & *icipe*	14
Group Training Course on Fruit Fly Taxonomy, Detection and Management (English and Portuguese)	September 2010	FAO	50
Group Training Course on Fruit Fly Taxonomy, Detection and Management	September 2011	TechnoServe	22
Training of Trainers (ToT) Course on Fruit Fly and Mango Seed Weevil Management, Kilifi, Coast province	October 2011	Biovision/BMZ	16
Training of farmers on fruit flies monitoring and suppression, Malindi, Coast province	December 2011	Biovision/BMZ	300
ToT Course on Fruit Fly and Mango Seed Weevil Management, Embu, Eastern province	October 2011	Biovision/BMZ	18
Training of farmers on fruit flies monitoring and suppression, Embu	December 2011	Biovision/BMZ	480
Training on rearing and taxonomy of tephritid fruit flies and their associated parasitoids	January 2012	BMZ	3
ToT Course on Fruit Fly and Mango Seed Weevil Management	October 2012	BMZ	20
Taxonomy of Thrips and Techniques for their Identification	July 2008	BMZ/GIZ – Thrips IPM programme	14
Laboratory Techniques in Thrips Research	May 2009	BMZ/GIZ – Thrips IPM programme	1
Modelling species distribution using CLIMEX–DYMEX	December 2009	BMZ/GIZ – Thrips IPM programme and Leafminer IPM programme; Centre for International Migration and Development (CIM)	15
ToT course on "Improving *Liriomyza* leafminer and thrips monitoring and management in vegetable cropping systems of East Africa"	November–December 2010	BMZ/GIZ – Thrips IPM programme and Leafminer IPM programme	14
Improving Monitoring and Management of Exotic Invasive Insect Pests in Vegetable Cropping Systems in the eastern Africa Countries	June–July 2011	The Netherlands Ministry of Foreign Affairs – OCD project; BMZ/GIZ – Thrips IPM programme; Leafminer IPM programme and Fruit Fly initiative	13
Improving *Liriomyza* leafminers and thrips monitoring and management in vegetable cropping systems for the Eastern Africa countries	July 2011 (Uganda), September 2011 (Kenya), September 2011 (Tanzania)	BMZ/GIZ – Thrips IPM programme and Leafminer IPM programme	77
Laboratory techniques in thrips identification	September 2012	BMZ/GIZ – Thrips IPM programme	2
Farmer field day	20th September 2012 Kabaru, Nyeri district		111
Farmer field day	11th October 2012 Sagana, Nyeri district		67

Title	Duration and location	Sponsor	Number of participants
Training of farmer group leaders from Nyeri district in LMF and parasitoid rearing ahead of the installation of colony multiplication sites	2 weeks in November 2012 *at icipe*		2
Capacity building for Plant Inspectors from South Sudan, Somaliland and Zanzibar	June 2011		13
Capacity building for horticultural extension workers in Kenya, Uganda and Tanzania on "Improving *Liriomyza* leafminers and thrips monitoring and management in vegetable cropping systems for the Eastern Africa countries"	July–September 2011		27 participants in Uganda, 25 in Kenya, 25 in Tanzania
Training of partners from Tanzania and Uganda in LMF and parasitoid identification, rearing and management	2 weeks, *icipe* Duduville Campus		3
Farmer field day in Naro Moru, Central Kenya region	11th November 2011, Nyeri district		50
Farmer field day in Kabaru, Central Kenya region	9th November 2011, Nyeri district		60
Farmer field day on LMF management in Meru district	12 to 14 September 2011		More than 200 participants
Farmer field day in Namelok, Isinet and Empiron, Oloitokitok district	21 November 2011		84
Farmer field day in Ikisandjani, Oloitokitok district	22nd November 2011		42
Farmer field day in Kyakyai, Kikoo and Mangelete, Kibwezi district	23rd November 2011		57
A five-day hands-on training course of core trainers to strengthen the skills and knowledge of Plant Health Inspectors of Kenya, Tanzania and Uganda in effective monitoring and surveillance of quarantine *Liriomyza* leafminer species	29 November–3 December 2010 at the *icipe* Duduville Campus		13
The regional training of trainers' course on Improving *Liriomyza* leafminer and thrips monitoring and management in vegetable cropping systems for the eastern Africa countries	29 November–3 December 2010	BMZ-funded Leafminer and Thrips projects	Kenya (5), Tanzania (4) and Uganda (4)
IPM training course, requested by Ministry of Agriculture Plant Protection Department, South Sudan	24 January–18 February 2011 at *icipe*		4
ToT course for horticultural extension workers towards improving thrips and *Liriomyza* leafminer monitoring and management in vegetable production systems	Kenya, 5–9 September 2011 Tanzania, 8–12 August 2011 Uganda, 4–8th July 2011	BMZ-funded Leafminer and Thrips projects	Kenya (25) Tanzania (25) and Uganda (26)
Improving monitoring and management of exotic invasive insect pests in vegetable cropping systems in the eastern Africa countries	19 June–2 July 2011 at *icipe* Duduville Campus	OCD, the BMZ funded Thrips and Leafminers projects	Somalia (3), South Sudan (6), Zanzibar Islands (3) and Somaliland (1)
R for beginners	5–8 November 2012 at *icipe* Duduville Campus		10 participants

Title	Duration and location	Sponsor	Number of participants
General coffee entomology laboratory skills, set up of a coffee berry borer laboratory, and colony and climate change field collection data	February 2012		6 students from Sweden, Uganda, Kenya, Tanzania and Ethiopia
International Master in Public Health from Montpellier University and Abomey Calavi University on «Impact of agricultural practices on the selection of insecticide resistant population of malaria vectors in West Africa».	2007–2011	IRD	15 trainees, formal
Master of Applied Entomology (d'Entomologie Appliquée) from Abomey Calavi University on «Insecticide resistance: from mechanism to management»	2008–2010	IRD	30 trainees, formal
Master Hortimet from Montpellier University on «Physical protection of horticultural crops in tropical areas»	2009–2011	Cirad	15 trainees, formal
1st *icipe*/FAO Training Course on "Development of innovative site-specific integrated animal health packages for the rural poor"	24 – 28 September, 2012, Kisii, Kenya	FAO	21
Training seminar on the evaluation of the use of PICS bags	5 December 2011 NARO Kawanda in Kampala	Purdue University, USA	7
Training seminar on the evaluation of the use of PICS bags	20 December 2011 at Bunda College of Agriculture in Lilongwe, Malawi	Purdue University, USA	6
Training seminar on the evaluation of the use of PICS bags	31 February 2012 at Plant Protection Service in Dar es Salam, Tanzania	Purdue University, USA	8
Training seminar on the evaluation of the use of PICS bags	13 March 2012 at Kenya Agricultural Research Institute (KARI)	Purdue University, USA	6
Training seminar on the utilisation of PICS bags	8 December at Panari hotel,Nairobi	Sumitomo Company, Kenya	7

IVDM cluster

Course Title	Duration and Location	Sponsor	No. of Participants
Development of a Dynamic Integrated Malaria Sector for T21 and Its Application in T21-Kenya	22–24 November 2012	Biovision/Millennium Institute	12
Steering Committee Meeting of the Global Alliance for the Development and Deployment of Alternatives to DDT for Disease Vector Control	27–28 August 2012	UNEP-The Chemicals in Products project	12
Training Workshop on Data Collection Information Exchange, and Informed Decision Making within IVM Approach for Disease Vector Control to Reduce Reliance on DDT	29–31 August 2012	UNEP-The Chemicals in Products project	14 Participants from 11 African countries
Malaria Decision Analysis Support Tool (MDAST): Demonstration and Training workshop	23 April 2012	University of Pretoria	17 participants from Kenya

Course Title	Duration and Location	Sponsor	No. of Participants
Solarmal Start-up workshop	7–10 February 2012	Wageningen University	30 participants from Kenya
Regional Training workshop on Integrated Vector Management (IVM) as an alternative approach to use of DDT for Malaria Control	28 March – 7 April 2011	UNEP	16 Participants from African countries
Training programme on "Strengthening Country Capacities to Implement Integrated Vector Management (IVM) towards Reducing the Reliance on DDT in Selected Countries in Africa"	7–11 June 2010	UNEP	13 participants from 7 African countries
Mwea Stakeholders' Partnership Training Workshop	30–31 August 2010	The Global Fund to Fight AIDS, Tuberculosis and Malaria	45
icipe-Helsinki meeting on FP7 Health	18–23 May 2009		12
Transferring the Malaria Epidemic Prediction Models to End Users in East Africa: Policy Makers and Stakeholders' meeting	29 April 2010	IDRC	25 participants from 3 African countries
Transferring the Malaria Epidemic Prediction Model to End Users in East Africa: PIs Meeting	16–17 March 2008	IDRC	17 participants from 3 African countries
Tsetse Genomics, Annotations and Science Writing Workshop; A Short Course for Postgraduate Students and Research Staff	March 2012		
Postgraduate Students and Research Staff		NIH (via a grant to Prof. Serap Aksoy, Yale University of Public Health)	
Regional Training on Integrated Morphology and DNA Barcoding in Species Identification	December 2011	Capacity Building and Institutional Development (CB&ID) Programme	
Glossina Transcriptome on Annotation Workshop	May 2008	WHO-TDR	
AVID sampling and biobanking	November 2010	Google.org and *icipe* Capacity Building and Institutional Development (CB&ID) Programme	16
AVID Scientific Conference	June 2011	Google.org	76
IDRC Ecohealth RVF Project Inception Meeting	March 2012	IDRC	38
Outcome mapping training	May 2012	IDRC	13
AVID diagnostic training	October 2012	Google.org	13
GCLP training	November 2012	*icipe* Training	34
Modelling training	November 2012	SIDA	30
Farmer stakeholders' and training workshop on "Animal Health Package for enhancing milk production in zero-grazing units" (Kisii)	December 2011	*icipe*	158
Farmer stakeholders' and training workshop on "Animal Health Package for controlling biting flies in zero-grazing units" (Bungoma)	December 2011	*icipe*	154
Training of farmer groups in capacity building on deployment of repellent technology	March 2012	*icipe*	196
Farmer stakeholders' training on Tsetse and Trypanosomiasis control (EU Tsetse Project)	April 2012	*icipe*	184

Course Title	Duration and Location	Sponsor	No. of Participants
First *icipe*/FAO training workshop on "Development of innovative site-specific integrated animal health packages for the rural poor"	September 2012	FAO	21

ACCES cluster

Title	Duration and location	Sponsor	Number of Trainees
Training course on bee health and beekeeping techniques for trainees from Botswana	1–23rd Nov 2012: *icipe*	Ministry of Agriculture, Botswana	3
Internal Control Systems (ICS) and organic certification training and queen rearing	18–28 September 2012: Tigray and Tolay, Ethiopia	IFAD grant, Biovision and Ministry of Agriculture	30
Internal Control Systems (ICS) and organic certification training and queen rearing	5–27 August 2012: Tigray and Tolay, Ethiopia	IFAD grant, PASSDIP and Ministry of Agriculture	239
Silk post-harvest training for Bushenyi Silk Farmers' Association (BSFA)	25th June – 6th July 2012: Bushenyi, Uganda	IFAD grant and Bushenyi Silk Farmers Association	14
Training course on silk post-harvest for trainees from Alage, Ethiopia	25 June–6 July 2012 at *icipe*	IFAD/*icipe* and Ministry of Agriculture	4
Internal Control Systems (ICS) and re-certification training for Mwingi District Beekeepers community based organisation	6th – 9th March 2012: Mwingi, Kenya	IFAD grant and Mwingi Joint Self Help Group	1350
Internal Control Systems (ICS) and organic certification training for Mt. Kenya Region Field Officers	5–8th March 2012: Embu, Kenya	IFAD grant, MKEPP and Ministry of Livestock	26
On-site training and installation of beehives for beekeeping community groups	1–5 March 2012: Taita Hills, Kenya	CEPF	20
Internal Control Systems (ICS) and organic certification training for Mt. Kenya beekeepers	23–25 November 2011	IFAD, MKEPP and Ministry of Livestock	820
The First Africa-Wide Training Course and Workshop on Strategic Partnership Networking in Bee Health and Pollination Services for Food Security in Africa. Trainees and Trainers: Uganda, Egypt, Congo, Somaliland, Tanzania, Ethiopia, Sudan, Yemen, South Sudan, Cameroon, Niger, Burkina Faso, Ghana, Kenya, Germany, France, China, USA, Sweden	10–19 October 2011: *icipe*	Netherlands Ministry of Foreign Affairs, IFAD, *icipe*	32
Training course on beekeeping for livestock officers and foresters from Mt. Kenya region	29 August–9 September 2011: *icipe*	IFAD, MKEPP and Ministry of Livestock	8
IFAD Project Inception Workshop and Training	21–24 November 2010: ILRI Campus, *icipe* Research Station Addis Ababa and Tolay Field Site	IFAD and Biovision	90
Training course on mulberry silk farming for Isiolo group representatives	16–27 August 2010	CORDAID	14

Title	Duration and location	Sponsor	Number of Trainees
Training course on beekeeping for trainees from Kinangop, Nyandarua County, Kenya	22 March–1 April 2010: *icipe*	EARPO WWF	20
Training course on beekeeping for trainees from Isiolo, Eastern Province of Kenya	15–26 February 2010: *icipe*	CORDAID	36
Trainers' Course and the 5th International Workshop on Scaling up Apiculture and Sericulture Enterprises to Promote Rural Livelihoods. Trainees: Yemen, Ethiopia, Uganda, Kenya, Rwanda, The Sudan, Tanzania, Malawi, Nigeria, Burundi, Eritrea and Egypt	21–30 October 2009	IFAD, IDB, OPEC Fund, Netherlands Ministry of Foreign Affairs and *icipe*	30
Training of Trainers in beekeeping/stingless bees, and silkworm rearing and post-harvest for new Othoro and Kakamega groups in Kenya	May 2009	IFAD, KFS and Local Government	205
Training on administration of questionnaires for data collection for impact assessment in Mwingi district	9–13 February 2009	IFAD, Ministry of Livestock and Local Government	40
Trainers Course in Honey Beekeeping, Stingless Bees and Wild Silkmoths	3–16 December 2008: *icipe* Headquarters, Nairobi and on-site, from three Kenyan forests, Mwingi, Kakamega and Arabuko-Sokoke	UNDP-GEF, IFAD, KFS	643 community members 20 ToTs
Trainers Course in Apiculture and Sericulture Technologies	25 November–6 December 2008: *icipe*	Self-sponsored	16
WWF Trainers Course in Beekeeping and Sericulture	21 October–7 November 2008: *icipe* Headquarters, Nairobi, Kenya	EARPO WWF	12
Trainers Course in Honey Beekeeping, Stingless Bees and Wild Silkmoths	25 August–7 September 2008 *icipe* Headquarters, Nairobi and on-site, in Arabuko-Sokoke Forest, Kenya	UNDP-GEF, IFAD, KFS	544 community members 18 ToTs
Training of Burundi participants in beekeeping and honey processing technologies	11–22 August 2008: *icipe*	Ministry of Agriculture Burundi and IFAD Loan Grants	14
Economic Valuation of Ecosystem Services and Goods	April 2012	Sokoine University of Agriculture - WP3	8
Soil and Water Assessment Tools	April 2012	University of Dar es Salaam - WP6	15
Introduction to Geographic Information Systems	April 2012	University of Helsinki - WP3	15

Capacity Building

Title	Duration	Sponsor	Number of participants
Course on modern research techniques in insect behaviour, sensory physiology and chemical ecology	February 2008 and October 2009		17
Scaling Up Apiculture and Sericulture Enterprises to Promote Rural Livelihoods	October 2009	Dutch MFA	22
Mass Spectrometry and Organic Synthesis	October 2010	DAAD	17
Arbovirus Infection and Diversity (AVID) Training on Field Sampling and Biobanking	November 2010	SIDA	16
ToT Training on Tick Identification for Tick-borne Disease Surveillance	December 2010	Dutch MFA	15
Introduction to GIS and GPS Software for Data Sampling, Visualisation and Analysis	December 2010	SIDA	13
Intergrating Morphology and DNA Barcoding in Species Identification	December, 2011	SIDA	25
Science Communication	November 2011	Dutch MFA	29
International Group Training Course in Ecology	October to November 2011	MPFS, Swedish University of Agricultural Sciences	16
Improving Monitoring and Management of Exotic Invasive Insect Pests in Vegetable Cropping Systems in the Eastern Africa Countries	June 2012	Dutch MFA	14
Proposal Writing for Resource Mobilization	May 2012	Dutch MFA & ASARECA	47
Stakeholders' Consultation on Meat versus Milk Value Chain Analysis	August 2012	Dutch MFA	38
Statistics Training	February 2012	Dutch MFA	20
Tsetse Genomics, Annotations and Science Writing Workshop	March 2012	Dutch MFA & NIH	31
Introduction to Biosystematics & Taxonomy	November 2008	Dutch MFA/DAAD	7
Introduction to Biostatistics and R software for Analysis	November 2008	Dutch MFA/DAAD	7
Research Project Management & Proposal Development	November 2008	Dutch MFA/DAAD	7
Climate Change: Threats and Opportunities	December 2008	Dutch MFA/DAAD	7
Legal Considerations in Research and Commercialization	December 2008	Dutch MFA/DAAD	7
Introduction to Biostatistics & Statistical Software	March 2009	Dutch MFA/DAAD	7
Molecular Biology, Genomics and Bioinformatics	May 2009	Dutch MFA/DAAD	7
Introduction to Geographical Information Systems	April 2009	Dutch MFA/DAAD	5
Scientific Writing, Communication and Publishing Course	April 2009	Dutch MFA/DAAD	7
Basic Taxonomy and Systematics	April 2009	Dutch MFA/DAAD	7
Basic Entomology	February 2010	Dutch MFA/DAAD	7

Title	Duration	Sponsor	Number of participants
GPS and GIS	February 2010	Dutch MFA/DAAD	7
Biostatistics	February 2010	Dutch MFA/DAAD	7
Chemical Ecology	March 2010	Dutch MFA/DAAD	7
Pest Management	April 2010	Dutch MFA/DAAD	7
Molecular Biology	May 2010	Dutch MFA/DAAD	7
Ecosystem Services	April 2010	Dutch MFA/DAAD	7
Statistical Research	November 2010	Dutch MFA/DAAD	7
Information Literacy	November 2011	Dutch MFA/DAAD	7
Forest Biodiversity	November 2012	Dutch MFA/DAAD	7
Chemical Ecology	February 2011	Dutch MFA/DAAD	11
Basic Entomology	February 2011	Dutch MFA/DAAD	11
Molecular Biology	February 2011	Dutch MFA/DAAD	11
GPS and GIS	June 2011	Dutch MFA/DAAD	11

ANNEX 7: Presentations at national and international conferences/ meetings

PLANT HEALTH

PUSH–PULL

2010

Midega C. Landscape effects on pest management. Paper presented at the Congress on Importance of Landscape and Local Structure on Biological Control of Pests, Uppsala, Sweden on 12 and 13 May 2010.

2011

Midega C. Companion cropping for pest management in Africa: The case of push–pull technology in East Africa. Paper presented at the 1st Workshop on Developing a Push–Pull Approach for Management of Cotton Pests in Africa and Northeast Brazil, Campina Grande, Brazil, from 22 to 25 October 2011.

Midega C. Innovative farm intensification is key to enhancing farming system productivity in Africa: Push–pull technology as an example. Plenary Lecture presented at the 1st Pan African Chemistry Network (PACN) Congress on Agricultural Productivity, Accra, Ghana from 21 to 23 November 2011.

Midega C. Remembering smallholder farming systems for attainment of food security. Paper presented at the Eastern Africa JSPS (Japanese Society for the Promotion of Sciences) workshop on 'Africa–Japan Science and Technology Partnership for Sustainable Development, Science for Development, Nairobi, Kenya on 2 to 3 November 2011.

Midega C. Saving the smallholder dairy industry: Managing the Napier stunt disease. Paper presented at the 3rd McKnight Foundations' Annual East and Horn of Africa Community of Practice conference, Nairobi, Kenya, from 26 to 30 September 2011.

Midega C. and Jaramillo J. Presentation in the Collaborative Project Planning Meeting on the Importance of Landscape and Local Structure on Biological Control of Pests, Uppsala, Sweden on 12 to 13 May 2011.

Midega C. and Pittchar J. Presentation in the McKnight Foundation Collaborative Crop Research Program (CCRP), Third Meeting of East and Horn of Africa Community of Practice Meeting, Kampala, Uganda from 2 to 6 May 2011.

Pittchar J. An integrated approach to developing smallholder cereal–livestock systems in sub-Saharan Africa. Paper presented at the KARI Stakeholder Workshop on Push–Pull Technology, Homa Bay, Kenya on 15 June 2011.

Pittchar J., Margiotta M. and Corrado P. Developing a sustainable framework for dissemination and scaling-up push-pull technology. Paper presented at the Meeting organized by AFAAS, in Kampala, Uganda on 21 to 22 November 2011.

2012

Khan Z. Achieving food and environmental security: New approaches to close the gap. Paper presented at a scientific discussion meeting at The Royal Society, at Carlton House Terrace, London, Chicheley Hall, Buckinghamshire, UK from 1 to 11 December 2012.

Khan Z. Can Science help us get back to the countryside? Paper presented at a scientific discussion meeting at The Royal Society, at Carlton House Terrace, London, Chicheley Hall, Buckinghamshire, UK from 1 to 11 December 2012.

Khan Z. Exploiting chemical ecology of insect–plant and plant–plant interactions in developing novel IPM strategies for Africa. Paper presented at the XXIV International Congress of Entomology, Daegu, South Korea from 19 to 25 August 2012.

Khan Z. Push-pull: A platform technology for enhancing food security and environmental sustainability in Africa. Paper presented at the XXIV International Congress of Entomology, Daegu, South Korea from 19 to 25 August 2012.

Khan Z. Push–pull: A conservation agriculture technology for increasing food security in Africa. Paper presented at the TWAS General Conference 2012, Tianjin, China from 18 to 21 September 2012.

Khan Z., Midega C., Pittchar J. and Nyagol D. Achieving sustainable *Striga* control for poor farmers in Africa through integrated striga management. Paper presented at the Annual Review and Planning Meeting of the BMGF-funded project on Integrated Striga Management Programme (ISMA), held at the IITA Headquarters, Ibadan, Nigeria from 21 to 24 May 2012.

Midega C. and Pittchar J. Developing push-pull technology for smallholder cotton farmers in Africa and Brazil. Paper presented during the Forum 2012: Africa–Brazil LEC Agricultural Innovation Marketplace, EMBRAPA, Brasilia, Brazil from 1 to 3 August 2012.

Midega C. and Pittchar J. Presentation during the Review and Planning Meeting for Africa and Project for Smallhoder Cotton Farmers in Africa and North East Brazil, held at EMBRAPA, Brasilia, Brazil from 21 to 26 September 2012.

Midega C. Crop protection in smallholder farming systems: Exploiting chemical ecology of insect–plant interactions. Paper presented at the Pan Africa Chemistry Network Congress on Agricultural Productivity, Water and Waste, Addis Ababa, Ethiopia from 25 to 28 November 2012.

Midega C. Farming system intensification for agricultural productivity in sub-Saharan Africa. Paper presented during a workshop at the Royal Society of Chemistry, London, UK on 22 to 23 February 2012.

Pittchar J. Integrated pest and weed management in Africa: Opportunity of push-pull technology in upland rice Eastern African Agricultural Productivity Project (EAAPP). Paper presented at the Crop Management and Technology Deployment Workshop, held at the Ahero Multipurpose Centre, Kenya from 15 to 18 October 2012.

Pittchar J. Push-pull technology: An integrated approach to developing smallholder cereal–livestock systems in sub-Saharan Africa. Paper presented at the Central Agricultural Board (CAB) Stakeholders' Meeting to Strategize Mainstreaming *Striga* Control in the Public Sector, Kisumu, Kenya on 25 January 2012.

Pittchar J. Push–pull technology: An integrated approach to developing smallholder cereal–livestock systems in sub-Saharan Africa. Paper presented at the High Level Policy Dialogue between AGRA and Small African Farmers on the Priorities and Governance of Agricultural Research for West Africa, Accra, Ghana from 31 January to 4 February 2012.

FRUIT FLIES, APHIDS AND POD BORERS PROJECTS

2007

Ekesi S. Fruit research at *icipe*. Paper presented at the Consortium on High Value Fruits, Challenge Programme Pre-proposal Development Workshop, Nairobi, Kenya from 6 to 8 June 2007.

Ekesi S. and Maniania N.K. Integration of soil inoculation with *Metarhizium anisopliae* into bait-based technology for field suppression of *Bactrocera invadens* on mango. Paper presented at the 40th Annual Meeting of the Society of Invertebrate Pathology & 1st International Forum on Entomopathogenic Nematodes and Symbiotic Bacteria, held at the University of Laval, Quebec City, from 12 to 16 August 2007.

Ekesi S., Löhr B., Knapp M., Nyambo B. and Mithöfer D. Overview of *icipe* horticultural activities. Paper presented at the IITA Strategic Planning Workshop for the MTP on High Value Products, Lome, Togo from 22 to 27 April 2007.

2008

Ekesi S. Fruit fly bioloecology and their management. Paper presented at the First Tanzania National Group Training Course on Fruit Fly Management, held at the Kibaha Biological Control Centre, Kibaha, Tanzania from 15 to 28 September 2008.

Ekesi S. Fruit fly species composition in Africa and their management. Paper presented at the Workshop on Integrated Fruit Management Towards Sustainable Fruit Production in Sudan, Khartoum, Sudan on 27 to 28 August 2008.

Ekesi S. and Mohamed S.A. Bait station evaluation for management of native and invasive fruit fly species in Kenya. Paper presented at the Joint FAO/International Atomic Energy Agency (IAEA) Consultants' Group Meeting on Development of Bait Stations for Fruit Fly Suppression, Mazatlan, Mexico from 30 October to 1 November 2008.

Ekesi S., Hanna R., Rwomushana I., Goergen G. and De Meyer M. *Bactrocera invadens:* State-of-the-art, challenges and gaps in knowledge—Experience from Eastern, Western and Central Africa. Paper presented at the First Meeting of Tephritid Workers of Europe, Africa and the Middle East (TEAM), Mallorca, Spain on 7 to 8 April 2008.

Mohamed S.A. and Ekesi S. Biological control of fruit flies. Paper presented at The First Workshop on Fruit Fly Management, Khartoum, Sudan on 27 and 28 August 2008.

Mohamed S.A. Ekesi S. and Wharton R. Old and novel parasitoid fruit-flies association: Physiological suitability. Paper presented at the International Congress of Entomology held at the International Convention Centre, Durban, South Africa from 6 to 12 July 2008.

Mohamed S.A. Ekesi S. and Hannah R. Laboratory evaluation of parasitism of *Bactrocera invadens* and five *Ceratitis* species by the opiine parasitoids *Fopius arisanus* and *Diachasmimorpha longicaudata*. Paper presented at the 1st Meeting of the Tephritid Workers of Europe, Africa and the Middle East (TEAM), Palma de Mallorca, Spain on 7–8 April 2008.

2009

Ekesi S. Fruit fly surveillance and management: Experience from East Africa. Paper presented at the STDF/ECOWAS Donor Workshop on Fruit Fly Control in West Africa, Bamako, Mali, on 29 and 30 September 2009.

Ekesi S., Adamu R.S. and Maniania N.K. Evaluation of entomopathogenic fungi for the management of *Sternochetus mangiferae* on mango. Paper presented at the 42nd Annual meeting of the Society for Invertebrate Pathology (SIP), Park City, Utah, USA from 16 to 20 August 2009.

Ekesi S., Khamis F.M., Malacrida A., Mohamed S.A., Nderitu P.W. and Kiilu J. Development and improvement of rearing techniques for *Bactrocera invadens* and four *Ceratitis* fruit flies of economic importance in Africa. Paper presented at the Final Research Coordination Meeting of the IAEA Coordinated Research Programme on "Development of Mass Rearing for the New World (*Anastrapha*) and Asian (*Bactrocera*) Fruit Fly Pests in Support of SIT", Perebyre, Mauritius from 21 to 25 September 2009.

2010

Ekesi S., Vayssieres J.-F., Hanna R., De Meyer M., Goergen G. and Malacrida A. Status of *Bactrocera invadens* management in Africa: Recent advances, successes and challenges. Paper presented at the 8th International Symposium on Fruit Flies of Economic Importance, Valencia, Spain, from 26 September to 1 October 2010.

Mohamed S.A., Ekesi S. and Hanna R. Effect of host rearing diet on fitness parameters of *Fopius arisanus* (Sonan) (Hymenoptera: Braconidae). Paper presented at The 8th International Symposium on Fruit Flies of Economic Importance, Valencia, Spain, from 26 September to 1 October 2010.

2011

Appiah E.F, Ekesi S., Mohamed S.A., Kwame A. and Obeng-Ofori D. Interactions involving the African weaver ant, *Oecophilla longinoda*, the invasive fruit fly, *Bacterocera invadens* and the egg–prepupal parasitoid, *Fopius arisanus*. Paper presented at the Semio 2011, Nairobi, Kenya from 12 to 15 November 2011.

Ekesi S. and Maniania N.K. Field suppression of the mango seed weevil, *Sternochetus mangiferae* with two formulations of *Metarhizium anisopliae* on mango orchard. Paper presented at the 2011 International Congress on Invertebrate Pathology and Microbial Control, OECD Symposium on Diseases in Aquatic Crustaceans & 44th Annual Meeting of the Society for Invertebrate Pathology, Halifax, Canada, from 7 to 11 August 2011.

Ekesi S., Hanna R., Maniania N.K. and Sevgan S. Ecosystem services provided by biological control agents for improving food security and livelihoods: Some examples from Africa. Paper presented at the Africa College International Food Security, Impact Knowledge Conference held at the University of Leeds, UK from 21 to 24 June 2011.

Kachigamba D., Ekesi S., Ndungu M., Gitonga L., Teal P. and Torto B. Host-marking behavior in African fruit flies (Diptera: Tephritidae). Paper presented at the SEMIO 2011, Nairobi, Kenya from 12 to 15 November 2011.

Kimbokota F., Njagi P., Nkunya M.H.H., Hassanali A., Ekesi S. and Torto B. Candidate kairomone for *Bactrocera invadens* (Diptera; Tephritidae) male flies from *Gynandopsis gynandra* (Capparidaceae). Paper presented at the 19th Conference of the African Association of Insect Scientists, Nairobi, Kenya from 9 to 12 November 2011.

Mohamed S.A. and Ekesi S. Participatory dissemination and promotion of management technologies for *Bactrocera invadens, Ceratitis* fruit flies and mango seed weevil that constrain production and export of mango and avocado in East Africa. Paper presented at the Intergovernmental Group on Bananas and Tropical Fruits, Fifth Session, Yaoundé, Cameroon, from 3 to 5 May 2011.

Mohamed S. and Ekesi S. Sustainable fruit fly management practices at the farm level: *icipe's* experience. Paper presented at the Workshop on Enhancing Participation in the Value Chain and Establishing Links to the Market for Tropical Fruit Smallholders in Africa, Lagos, Nigeria on 28 and 29 April 2011.

Tanga M. C., Ekesi S., Samira A. M., Suresh S. and Govender P. Exploratory survey for natural enemies of *Rastrococcus iceryoides* Green (Hemiptera: Pseudococcidae) in India and climatic matching to guide their introduction into Africa. Paper presented at the 19th Conference of the African Association of Insect Scientists, Nairobi, Kenya from 9 to 11 November 2011.

2012

Appiah E.F., Ekesi S., Mohamed S.A., Afreh-Nuamah K. and Obeng-Ofori D. Effect of temperature on developmental time, parasitism rates and longevity of *Fopius arisanus* and *Diachasmimorpha longicaudata* reared from *Bactrocera invadens*. Paper presented at the 2nd International Symposium of TEAM, Kolymbari, Crete, Greece from 2 to 6 July 2012.

Ekesi S., Mohamed S.A., Khamis F.M. and Maniania N.K. Compatibility of fruit fly attractants with *Metarhizium anisopliae* for the management of *Bactrocera invadens*, an invasive pest of horticulture in Africa. Paper presented at the 45th Annual Meeting of the Society for Invertebrate Pathology and 2012 International Congress on Invertebrate Pathology, Puerto Madero, Buenos Aires, Argentina from 5–9 August 2012.

Ekesi S., Mohamed S.A., Khamis F.M. and Maniania N.K. Management strategies for the invasive fruit fly, *Bactrocera invadens* in Africa. Paper presented at the XXIV International Congress of Entomology "A New Era in Entomology", Daegu, Korea, from 19–25 August 2012.

Khamis F., Ekesi S. and Malacrida A. Inferences to the origin and invasion history of the fruit fly pest, *Bactrocera invadens* (Diptera: Tephritidae) in Africa. Paper presented at the 2nd International Symposium of TEAM, Kolymbari, Crete, Greece from 2 to 6 July 2012.

Khamis F., Mohamed S. and Ekesi S. Unveiling the real *Bactrocera invadens* Drew Tsuruta & White using morphometrics and DNA Barcoding. Paper presented at the 2nd FAO/IAEA Research Coordination Meeting on "Resolution of Cryptic Species Complexes of Tephritid Pests to Overcome Constraints to SIT Application and International Trade" held at Griffith University, Brisbane, Australia from 30 January to 3 February 2012.

Merkel K., Ekesi S. and Hoffmeister T. An invasive fruit fly benefits from a spatial and behavioural refuge against its introduced egg parasitoid. Paper presented at the XXIV International Congress of Entomology on "A New Era in Entomology", Daegu, Korea, from 19 to 25 August 2012.

Merkel K., Ekesi S. and Hoffmeister T.S. Mutual interference between parasitoids of *Bactrocera invadens*—the drawback of being many. Paper presented at the 2nd International Symposium of TEAM, Kolymbari, Crete, Greece from 2 to 6 July 2012.

Migani V., Ekesi S. and Hoffmeister T. S. Physiological state versus fruit characteristics: What is more important for *Bactrocera invadens* oviposition decision? Paper presented at the 2nd International Symposium of TEAM, Kolymbari, Crete, Greece from 2 to 6 July 2012.

Mohamed S.A. and Ekesi S. Detection and subsequent spread of *Bactrocera invadens* (Diptera: Tephritidae) in Africa and its implications on regional and international trade. Paper presented at the 2nd International Symposium of TEAM, Kolymbari, Crete, Greece from 2 to 6 July 2012.

Mohamed S.A., Ekesi S. and Khamis F. Biology and management of fruit flies in Africa, their risk of invasion and potential impact in the Near East. Paper presented at the Regional Symposium

on the Management of Fruit Flies in the Near East Countries, Hammamet, Tunisia, from 6 to 8 November 2012.

Tanga C.M., Ekesi S., Mohamed S.A. and Govender P. Effect of host plant species on bionomics and life history parameters of *Anagyrus pseudococci* Girault (Hymenoptera: Encryrtidae), a parasitoid of the mealybug *Rastrococcus iceryoides* Green. Paper presented at the XXIV International Congress of Entomology "A New Era in Entomology", Daegu, Korea, from 19 to 25 August 2012.

Tumuhaise V., Ekesi S., Mohamed S.A., Ndegwa P.N., Irungu L. and Maniania N.K. Pathogenicity of *Metarhizium anisopliae* and *Beauveria bassiana* to the legume pod borer, *Maruca vitrata* and the performance of two isolates in four liquid culture media. Paper presented at the 45th Annual Meeting of the Society for Invertebrate Pathology and 2012 International Congress on Invertebrate Pathology, Puerto Madero, Buenos Aires, Argentina from 5 to 9 August 2012.

THRIPS PROJECT

2009

Niassy S., Maniania N.K., Subramanian S., Gitonga M. L. and Maranga R. Pathogenicity of *Metarhizium anisopliae* and *Beauveria bassiana* to second instar larvae of the western flower thrips *Frankliniella occidentalis* Pergande (Thysanoptera: Thripidae). Paper presented at the AAIS 18th Biennial Meeting, Burkina Faso from 16 to 20 November 2009.

Nyasani J.O., Meyhöfer R., Subramanian S. and Poehling H.-M. Thrips species composition and abundance on French beans, associated crops and weed species in Kenya. Paper presented at the Ninth International Symposium on Thysanoptera and Tospoviruses, Queensland, Australia from 31 August to 4 September 2009.

Subramanian S., Myamba A., Muia B., Serruwagi P., Ndunguru J., Waiganjo M., Abang M. and Moritz G. W. Altitudinal differences in diversity of thrips on tomatoes (*Lycopersicon esculentum* Mill.) in East Africa. Paper presented at the Ninth International Symposium on Thyasanoptera and Tospoviruses, Queensland, Australia from 31 August to 4 September 2009.

2010

Birithia R.K., Subramanian S., Muthomi J. and Narla R.D. Diversity of *Iris yellow spot virus* in Kenya. Presentation at the 10th Workshop on Sustainable Horticultural Production in the Tropics held at JKUAT, Kenya from 8 to 11 December 2010. (Received Best Poster Presentation Award)

Muvea A.M., Kutima H.L., Waiganjo M.M., de Kogel W.J., Teulon D.A.J., Lagat Z.O. and Subramanian S. The potential of coloured sticky traps with LUREM TR attractants for determining population dynamics of pest thrips on tomatoes in Kenya. Oral presentation at the 10th Workshop on Sustainable Horticultural Production in the Tropics held at JKUAT, Kenya from 8 to 11 December 2010. (Awarded the Second Best Oral Presentation)

Nielsen M.-C., Worner S., Chapman B., de Kogel W.-J., Perry N., Sansom C., Murai T., Muvea A., Subramanian S., Davidson M. and Teulon D. Optimising the use of allelochemicals for thrips pest management. Abstract presented at the International Society of Chemical Ecology Conference and 26th Annual Meeting, Tours, France from 31 July to 4 August 2010.

2011

Birithia R., Subramanian S., Muthomi J. and Narla R.D. Competence of key thrips pests of onions in Kenya in vectoring *Iris yellow spot virus*. Paper presented at the 4th Conference of the International Working Group on Legume and Vegetable Viruses (IWGLVV), held at the Centro Cultural Santa Clara, Antequera (Malaga, Spain) from 17 to 20 May 2011.

Moritz G., Subramanian S., Brandt S. and Triapitsyn S. Development of a user-friendly identification system for the native and invasive pest thrips and their parasitoids in East Africa. Paper presented at the APS-IPPC 2011 Joint Meeting in Honolulu, Hawaii, from 6 to 10 August 2011.

Niassy S., Fombong A.T., Torto B., Ekesi S., Subramanian S. and Maniania N.K. A lure-and-kill management strategy using *Metarhizium anisopliae* for the control of thrips. Paper presented at the Semio-11 on "Insect Chemical Ecology and Multilevel Pest Management towards Food Security and Sustainable Development", held at *icipe*, Nairobi, Kenya from 12 to 15 November 2011.

Niassy S., Maniania N.K., Subramanian S., Gitonga L.M., Maranga R., Obonyo A.B. and Ekesi S. Compatibility of *Metarhizium anisopliae* isolate ICIPE 69 with agrochemicals used in French bean production. Paper presented at the 19th Conference of the African Association of Insect Scientists, held at *icipe* Nairobi, Kenya from 9 to 12 November 2011.

Subramanian S., Pappu H.R., Birithia R., Shem O., Muthomi J., Sseruwagi P. and Narla R. Diversity and distribution of *Iris yellow spot virus* (genus *Tospovirus*) infecting onion in eastern Africa. Paper presented at the APS-IPPC 2011 Joint Meeting in Honolulu, Hawaii, from 6 to 10 August 2011.

Subramanian S., Pappu H.R., Birithia R., Shem O., Muthomi J., Sseruwagi P. and Narla R. Diversity and distribution of *Iris yellow spot virus* (genus *Tospovirus*) infecting onion in eastern Africa. Paper presented at the 4th Conference of the International Working Group on Legume and Vegetable Viruses (IWGLVV), held at the Centro Cultural Santa Clara, Antequera (Malaga, Spain) from 17 to 20 May 2011.

2012

Birithia R.K., Narla R.D., Muthomi J. and Subramanian S. Resistance of onion cultivars to thrips (Thysanoptera: Thripidae) and *Iris yellow spot virus* in Kenya. Oral presentation number O401M15 at the XXIV International Congress of Entomology, Daegu, Korea from 19 to 25 August 2012.

Muvea A.M., Subramanian S., Kutima H., Osiemo Z.B., Waiganjo M. and De Kogel W.J. Field evaluation of trap capture based threshold for application of entomopathogenic fungi in management of thrips on French beans. Oral Presentation number S1011TU03 at the XXIV International Congress of Entomology, Daegu, Korea from 19 to 25 August 2012.

Niassy S., Maniania N.-K., Fombong A.T., Torto B., Subramanian S. and Ekesi S. Use of *Tithonia diversifolia* and *Metarhizuim anisopliae* in a lure-and-kill approach for thrips management. Paper presented at the XXIV International Congress of Entomology, Daegu, Korea from 19 to 25 August 2012.

Niassy S., Subramanian S., Ekesi S., Gitonga L.M., Mburu D.M., Masiga D. and Maniania N.K. Selection of promising fungal biological control agent of the western flower thrips *Frankliniella occidentalis* and development of application strategy. Paper presented at the 2012 International Congress on Invertebrate Pathology and Microbial Control and 45th Annual Meeting of the Society for Invertebrate Pathology, Buenos Aires, Argentina from 5 to 9 August 2012.

Nyasani J., Meyhofer R., Subramanian S. and Poehling H.-M. Feeding and oviposition preference of *Frankliniella occidentalis* for crop and weed species commonly occurring in French bean fields in Kenya. Oral Presentation number S603W02 at the XXIV International Congress of Entomology, Daegu, Korea from 19 to 25 August 2012.

Subramanian S., Kumm S., Nyasani J., Waiganjo M., Muchemi S. and Moritz G. Diversity, distribution and plant association of thrips belonging to *Frankliniella* genus in East Africa. Oral Presentation number O301TU12 at the XXIV International Congress of Entomology, Daegu, Korea, from 19 to 25 August 2012.

LEAFMINERS PROJECT

2007

Kroschel J., Mujica N., Canedo V. and Alcazar J. Functional agrobiodiversity in potato-based production systems—Its monitoring and use. Oral presentation at the XVI International Plant Protection Congress, CGIAR/SP-IPM Symposium "Emerging Themes in Agroecosystems Health and Food Safety", Glasgow, Scotland, UK, from 15–18 October 2007.

2008

Burgos A., García G., Mujica N. and Kroschel J. Crecimiento alométrico de las larvas de *Liriomyza huidobrensis* (Blanchard) (Diptera: Agromyzidae). Poster presentation at the Congress of the Entomological Society of Peru, Tacna, Peru.

Chabi-Olaye A., Löhr B. and Kroschel J. Role of agroecosystem in the abundance and diversity of *Liriomyza* leafmining flies and their natural enemies. Paper presented at the International Conference of Entomology, Durban, South Africa, from 6 to 12 July 2008.

Chabi-Olaye A., Löhr B. and Kroschel J. Role of agroecosystem in the abundance and diversity of *Liriomyza* leafmining flies and their natural enemies. Abstract presented at the International Conference of Entomology, Durban, South Africa, from 6 to 12 July 2008.

Ekesi S., Chabi-Olaye A. and Mohamed S. Improving productivity and trade of fruit and vegetables through the development and implementation of IPM strategies for leafminers, fruit flies and mango seed weevil in Africa. Paper presented at the Tropentag 2008, "Competition for Resources in a Changing World: New Drive for Rural Development", Stuttgart-Hohenheim, Germany, from 7 to 9 October 2008.

García G., Burgos A., Mujica N. and Kroschel J. Estimado de la biomasa de artrópodos terrestres asociados al cultivo de papa en la costa central del Perú. Poster presentation at the Congress of the Entomological Society of Peru, Tacna, Peru.

Mujica N. and Kroschel J. Agromyzidae (Diptera) leafminer fly–parasitoid relationships in potato agroecosystems on the Peruvian coast. Oral presentation at the XXIII International Congress of Entomology (ICE2008), Durban, South Africa from 6 to 12 July 2008.

Mujica N. and Kroschel J. Investigación agroecológica en el CIP. Oral presentation at the Bases científicas para el Manejo Integrado de Plagas Taller "Principios Básicos en Manejo Integrado de Plagas", held at INIA, La Molina, Lima, Peru, on 16 April 2008.

2009

Barmosho M., Chabi-Olaye A. and Ogol C.K.P.O. Biological control of invasive *Liriomyza* leafminers in Kenya using the endoparasitoid *Phaedrotoma scabriventris*. Abstract presented at the 18th African Association of Insect Scientists (AAIS) Congress, Ouagadougou, Burkina Faso, from 16 to 20 November 2009.

Mujica N., García G., Burgos A. and Kroschel J. Efecto de la estructura del paisaje y el sistema de cultivo en el nivel de daño y parasitismo de la mosca minadora *Liriomyza huidobrensis* en el cultivo de papa en la costa central del Perú. Oral presentation at the 51st Congress of the Entomological Society of Peru, Lima, Peru.

Mujica N., Valencia C., Ramírez L., Prudencio C. and Kroschel J. Temperature-dependent developments of three parasitoids of the leaf mining fly *Liriomyza huidobrensis*. Poster presentation at the 15th

Triennial Symposium of the International Society for Tropical Root Crops (ISTRC), Lima, Peru, from 2 to 6 November 2009.

2011

Akutse K.S., Maniania N.K., Fiaboe K.K.M., Van den Berg J. and Ekesi S. Colonization of *Liriomyza* leafminer's host plants, *Vicia faba* and *Phaseolus vulgaris* by endophytic fungal pathogens. Poster presented on *icipe* Science Day, 16 November 2011.

Guantai M.M., Chabi-Olaye A., Ogol C.K.P.O., Salifu D., Kasina J.M. and Fiaboe K.K.M. Effect of local parasitoids and pesticides on leafminer flies in Central Kenya. Poster presented on *icipe* Science Day, 16 November 2011.

Namikoye E. S., Chabi-Olaye A., Ogol C.K.P.O., Salifu D. and Fiaboe K.K.M. Effect of selected concentrations of neem and pyrethrum on leafminer parasitoid *Phaedrotoma scabriventris* parasitoid. Poster presented on *icipe* Science Day, 16 November 2011.

Okoth C.A., Chabi-Olaye A., Fiaboe K.K.M., Deng A.L. and Tabu I.M. Effect of host plant on feeding, oviposition and developmental time of *Liriomyza sativae* (Blanchard) (Diptera: Agromyzidae). Poster presented on *icipe* Science Day, 16 November 2011.

2012

Akutse K.S., Maniania N.K., Fiaboe K.K.M., Van den Berg, J. and Ekesi S. Effects of entomopathogenic fungal endophytes on mortality, oviposition, emergence and longevity of *Liriomyza huidobrensis* (Diptera: Agromyzidae). Paper presented at the ICE2012 held in Daegu, Korea from 19 to 25 August 2012.

Guantai M.M., Fiaboe K.K.M., Ogol C.K.P.O., Salifu D., Kasina J.M. and Chabi-Olaye A. Effects of commonly used synthetic pesticides in pea production systems on *Liriomyza huidobrensis* and its parasitoids in Central Kenya. Paper presented at the XXIV International Congress of Entomology ICE2012 held in Daegu, Korea from 19 to 25 August 2012.

Namikoye E.S., Chabi-Olaye A., Fiaboe K.K.M., Salifu D. and Ogol C.K.P.O. Effect of selected doses of neem and pyrethrum based bio-pesticides on parasitism of *Liriomyza huidobrensis* (Blanchard) by *Phaedrotoma scabriventris* Nixon. Paper presented at the XXIV International Congress of Entomology ICE2012 held in Daegu, Korea from 19 to 25 August 2012.

Okoth C.A., Chabi-Olaye A., Fiaboe K.K.M., Deng A.L. and Tabu I.M. Effect of host plant on feeding, biological and morphological parameters of *Liriomyza huidobrensis* Blanchard (Diptera: Agromyzidae). Paper presented at the XXIV International Congress of Entomology ICE2012 held in Daegu, Korea from 19 to 25 August 2012.

RED SPIDER MITES PROJECT

2007

Knapp M. Important mite crop pests in Africa. Paper presented at the 11th International Congress of Acarology, Merida, Mexico, from 8 to 13 September 2007.

Knapp M. Exploration and evaluation of natural enemies for the invasive spider mite *Tetranychus evansi*. Paper presented at the 1st Meeting, IOBC/WPRS Study Group on Plant Feeding Mites, Jerusalem, Israel, from 12 to 14 March 2007.

Murungi L. K., Knapp M., Nyende A. B., Masinde P. W. and Wesonga J. M. Effects of African nightshade species on fecundity and longevity of *Tetranychus evansi* Baker and Pritchard (Acari: Tetranychidae). Paper presented at the 7th Horticultural Association of Kenya Workshop, held at the University of Nairobi, Kenya, from 28 November to 1 December 2007.

Murungi L. K., Knapp M., Nyende A. B., Masinde P. W. and Wesonga J. M. The developmental time of *Tetranychus evansi* Baker & Pritchard (Acari: Tetranychidae) on different African nightshade species. Paper presented at the 4th African Acarology Symposium, held in Yasmine Hammamet, Tunisia, from 22 to 26 October 2007.

2008

Bugeme D.M., Knapp M., Maniania N.K., Wekesa V.W., Furtado I.P. and de Moraes G.J. Possibilities for biological control of the invasive spider mite *Tetranychus evansi* in Africa. Paper presented at the 24th International Congress of Entomology, Durban, South Africa from 6 to 12 July 2008.

Migeon A., Ferragut F., Knapp M., Escudero-Colomar A.L., Fiaboe K.K.M., de Moraes G.J., Ueckermann E.A. and Navajas M. Potential distribution of the invasive mite *Tetranychus evansi* (Tetranychidae) in the Mediterranean region: Integrative acarology. Paper presented at 6th Symposium of the European Association of Acarologists Montpellier, France, from 21 to 25 July 2008.

Murungi L. K., Wesonga J. M., Masinde P. W., Nyende A. B. and Knapp M. Influence of leaf trichome density of selected African nightshade species on fecundity of *Tetranychus evansi* (Acari: Tetranychidae). Paper presented at the 8th Horticultural Association of Kenya Workshop, held at the Masinde Muliro University of Science and Technology, Kenya, from 8 to 11 December 2008.

Murungi L. K., Nyende A. B., Masinde P. W., Wesonga J. M. and Knapp M. Population density of *Tetranychus evansi* (Acari: Tetranychidae) on different African nightshade species. Paper presented at the 4th JKUAT Scientific, Technological and Industrialization Conference, held at Jomo Kenyatta University of Agriculture and Technology, Kenya, on 4 and 5 December 2008.

2009

Hoogerbrugge H., van Houten Y., Knapp M. and Bolckmans K. Comparative effectiveness of *Phytoseiulus persimilis* and *P. longipes* in the control of *Tetranychus urticae* on strawberries and roses. Paper presented at the IOBC/WPRS Working Group on "Integrated Control of Plant-Feeding Mites" meeting held at Florence, Italy, from 9 to 12 March 2009.

Murungi L. K., Wesonga J. M., Masinde P. W., Nyende A. B., Torto B. and Knapp M. A. Effect of different African nightshade species grown under screenhouse conditions on population densities of *Tetranychus evansi*. Paper presented at the 9th Workshop on Sustainable Horticultural Production in the Tropics held at SnowCrest Hotel, Arusha, Tanzania, from 2 to 5 December 2009.

2010

Bugeme D.M., Maniania N.K., Chabi-Olaye A., Boga H.I. and Knapp M. Field efficacy of the *Metarhizium anisopliae* isolate ICIPE 78 in controlling the red spider mite *Tetranychus evansi* in tomato field crop in Central Kenya. Paper presented at the 43rd Annual Meeting of the Society for Invertebrate Pathology, Trabzon, Turkey, from 11 to 15 July 2010.

2012

Fiaboe K.K.M., Knapp M., de Moraes G.J. and Furtado I.P. Tomato red spider mite, *Tetranychus evansi* Baker & Pritchard: Invasion and management in Africa. Paper presented at the 24th International Congress of Entomology, Daegu, Korea, from 19 to 25 August 2012.

CIRAD – IPM VEGETABLE COLLABORATION

2009

Houndete T.A., Ketoh G.K., Glitho I.A., Hema O.S.A. and Martin T. Évaluation de la résistance aux pesticides de différentes populations de *Bemisia tabaci* Gennadius (Homoptera: Aleyrididae) en Afrique de l'ouest. Paper presented at the 18ème Conférence de l'Association Africaine des Entomologistes, Ouagadougou, Burkina Faso, from 16 to 20 November 2009.

Pitalana F.M., Agboyi K.L., Houndete T.A., Ketoh G.K., Dabire R., Glitho I.A. and Martin T. Évaluation de l'impact des traitements phytosanitaires sur les systèmes agricoles maraicher et coton au Togo. Paper presented at the 18ème Conférence de l'Association Africaine des Entomologistes, Ouagadougou, Burkina Faso, from 16 to 20 November 2009.

2010

Cissé M.B.M., Zida A., Baldet T., Chandre F., Chabi J., Hougard J.M., Akogbeto M. and Martin T. Evidence of metabolic resistance to carbosulfan in addition to *kdr*-based mechanism resistance to pyrethroids within *Anopheles gambiae* in urban agriculture area in Benin. Paper presented at the Symposium International Paludisme et Trypanosomose Humaine Africaine: Nouvelles Stratégies de Prévention et de Contrôle, Cotonou, Bénin, on 7 and 8 October 2010.

Dabiré R.K., Yaro B., Namountougou M., Djogbenou L., Kegne P., Simard F., Baldet T., Martin T. and Diabaté A. The distribution of insensitive acetylcholinestérase (*ace-1R*) in *Anopheles gambiae* s.l. populations from Burkina Faso (West Africa). Paper presented at the Symposium International Paludisme et Trypanosomose Humaine Africaine: Nouvelles Stratégies de Prévention et de Contrôle, Cotonou, Bénin, on 7 and 8 October 2010.

Djogbénou L., Baldet T., Martin T., Akogbéto M. and Chandre F. Impact of human activities on the dynamics of insecticide resistance in *Anopheles gambiae*: Case of Benin (West Africa). Paper presented at the International Meeting of the EDEN Project, Montpellier, France, from 10 to 12 May 2010.

Martin T. and Chandre F. Relationship between agriculture and health: The case of malaria vectors in West Africa. Paper presented at the International Meeting of the EDEN Project, Montpellier, France, from 10 to 12 May 2010.

Martin T., Assogba-Komlan F. and Sidick I. An innovative approach to reduce chemicals in mite control. Paper presented at the 28th International Horticultural Congress, Lisboa, Portugal, from 22 to 27 August 2010.

Namountougou M., Dabiré R.K., Simard F., Baldet T., Martin T. and Diabaté A. Impact des stratégies de protection du coton sur l'homme et l'environnement: Sélection de la résistance des vecteurs du paludisme aux insecticides. Paper presented at the Symposium International Paludisme et Trypanosomose Humaine Africaine: Nouvelles Stratégies de Prévention et de Contrôle, Cotonou, Bénin, on 7 and 8 October 2010.

Yadouleton A., Chandre F., Djogbenou L., Martin T. and Akogbeto M. Situation de la résistance aux pyréthrinoïdes et aux carbamates chez *Anopheles gambiae* dans les sites cotonniers du Bénin en fonction des stratégies de protection appliquées par les producteurs. Paper presented at the Symposium International Paludisme et Trypanosomose Humaine Africaine: Nouvelles Stratégies de Prévention et de Contrôle, Cotonou, Bénin, on 7 and 8 October 2010.

2011

Martin T., Coffi H.K., Bizet G., Simon S. and Ryckwaert P. Oviposition behaviour of *Plutella xylostella* on cabbages covered with nets. Paper presented at the 19ème Conférence de l'Association Africaine des Entomologistes (AAIS 2011) held at *icipe*, Nairobi, Kenya, from 9 to 12 November 2011.

Martin T., Palix R., Kamal A., Delétré E. and Bonafos R. A repellent treated net for protecting cabbages against aphids. Paper presented at the SEMIO-11 Conference on Chemical Ecology and Integrated Pest Management, held at *icipe*, Nairobi, Kenya, from 13 to 15 November 2011.

Ngouajio M., Martin T., Wasilwa L. A., Komlan F. A., Adégbidi A., Ahouangassi D., Chabi-Olaye A., Guillet P., Muo K., Omari F., Saidi M., Parrot L., Simon S. and Sevgan S. BioNetAgro: Reducing pests and improving microclimate for small-scale vegetable production in Africa. Paper presented at the Horticulture CRSP Spring Meeting held at the University of California at Davis, California, USA in April 2011.

2012

Akodogbo J., Vidogbéna F., Adégbidi A., Assogba-Komlan F., Ngouajio M., Martin T., Simon S. and Parrot L. Farmer's preferences for ecofriendly nets adapted to vegetable production in Benin. Paper presented at the Symposium on Horticulture in Europe (SHE2012) Angers, France, from 1 to 5 July 2012.

Deletre E., Cadin A., Chandre F., Menut C., Bonafos R. and Martin T. Repellent, irritant and toxicity effect of 20 essential oils or plant extracts on *Anopheles gambiae*. Paper presented at the European Society of Vector Ecology "E-SOVE" 18th Conference, held in Montpellier, France, from 8 to 11 October 2012.

Deletre E., Mallent M., Chandre F., Menut C. and Martin T. Method to study the repellent, irritant and toxic effects of essential oils on *Bemisia tabaci* for a combination with insect proof net. Paper presented at the International Symposium on Essential Oils held in Lisboa, Portugal, from 5 to 7 September 2012.

Deletre E., Mallent M., Chandre F., Menut C. and Martin T. Method to study the repellent, irritant and toxic effects of essential oils on *Bemisia tabaci* for a combination with insect proof net. Paper presented at the Natural Products and Biocontrol 2012, held in the Palais des Congrès Perpignan, France, from 19 to 21 September 2012.

Ngouajio M., Martin T., Wasilwa L. A., Komlan F. A., Saidi M., Gogo E. O., Simon S., Subramanian S., Kasina M., Omari F., Adegbidi A., Parrot L., Ahouangassi D. and Guillet P. Improved small-scale vegetable production and productivity in Africa with the use of agricultural nets. Oral presentation at the American Society for Horticultural Science (ASHS) Annual Conference, held at the InterContinental Hotel, Miami, Florida, from 31 July to 3 August 2012.

Ngouajio M., Martin T., Wasilwa L.A., Komlan F.A., Saidi M., Gogo E.O., Muleke E.M., Simon S., Subramanian S., Kasina M., Omari F., Adégbidi A., Parrot L., Ahouangassi D. and Guillet P. Improving small-scale vegetable production and productivity in Africa with the use of agricultural nets. Paper presented at the American Society for Horticultural Science (ASHS) Annual Conference, held at the InterContinental Hotel, Miami, Florida, from 31 July to 3 August 2012.

Vidogbéna F., Akodogbo J., Adégbidi A., Tossou R., Assogba-Komlan F., Ngouajio M., Martin T., Simon S. and Parrot L. Farmer's perceptions of eco-friendly nets adapted to vegetable production in Benin. Paper presented at the Symposium on Horticulture in Europe (SHE2012) Angers, France, from 1 to 5 July 2012.

COFFEE ENTOMOLOGY

2008

Chapman E.G., Jaramillo J., Vega F.E. and Harwood J. Biological control of the coffee berry borer: The role of DNA-based gut content analysis in assessment of predation. Paper presented by Dr Eric Chapman, University of Kentucky, at the 3rd International Symposium on Biological Control of Arthropods, (ISBCA2008) held in Christchurch, New Zealand, from 8 to 13 February 2008.

Jaramillo J. Coffee entomology: An international perspective. Invited talk at the XXIII International Congress of Entomology (ICE2008), Symposium "Natural Enemies for Biological Control of the Coffee Berry Borer: Past, Present and Future", held at the International Convention Centre, Durban, South Africa, from 6 to 12 July 2008.

Jaramillo J. Molecular elucidation of the role of predatory thrips for biological control of the coffee berry borer. Paper presented at the 2008 Annual Meeting, Entomological Society of America, held in Reno, NV, USA, in November 2008.

2009

Jaramillo J. Back to Africa: Understanding the biology and biological control of the coffee berry borer. Invited talk presented at the International Coffee Organization Seminar on the Coffee Berry Borer, held in London, UK, on Tuesday, 17 March 2009.

2010

Jaramillo J. Too hot to drink? Climate change, coffee and the coffee berry borer. Invited talk at the Entomological Society of America (ESA) meeting of the Pacific branch – Symposium on "Invasive Species on an International Arena".

2011

Jaramillo J. and Harwood J.D. From Africa with love. Invited talk presented by Dr James D. Harwood, University of Kentucky at the Seminar on Coffee Berry Borer and Climate Change, USDA-ARS, Beltsville Maryland.

Jaramillo J. Climate change and coffee in East Africa. Invited talk at the Specialty Coffee Association of America's Annual Conference & Exposition held at the George R. Brown Convention Center, Houston, Texas from 28 April to 1 May 2011.

Jaramillo J. There is no little enemy: Climate change, coffee and the coffee berry borer. Invited talk at the Specialty Coffee Association of America's Annual Conference & Exposition "Symposium, the executive series", held at the George R. Brown Convention Center, Houston, Texas from 28 April to 1 May 2011.

Jaramillo J. Cambio y climatico y café: del reduccionismo a la integracion. Invited talk at the 10th Encuentro Cafetalero "RAMACAFE2011", Managua, Nicaragua, from 29 to 31 August 2011.

2012

Jaramillo J. Spare some change? Climate, coffee and its future. Paper presented at the 24th International Conference on Coffee Science "ASIC2012", San Jose, Costa Rica, in November 2012.

Jaramillo J. Coffee insects in a changing world. Invited keynote speaker at The 24th International Conference on Coffee Science "ASIC2012", San Jose, Costa Rica, in November 2012.

NSBB IRD/*icipe*

2007

Branca A., Dupas S., Le Ru B. and Silvain J. F. *Wolbachia* diversity and host specialization in an African parasitoid *Cotesia sesamiae* Cameron (Hymenoptera: Braconidae). Paper presented at the European Society for Evolutionary Biology XI Congress, Uppsala, Sweden, from 20 to 25 August 2007.

Calatayud P.-A., Frérot B., Chimtawi M., Wanjoya A., Le Ru B. and Silvain J.-F. Sensory equipments of the antennae, tarsi and ovipositor of the graminaceous stem borer *Busseola fusca* (Fuller) (Lepidoptera: Noctuidae) and their role in host plant detection and recognition. Paper presented at the 33rd Conference of the Zoological Society of Southern Africa, held at the North-West University, Potchefstroom, South Africa from 8 to 11 July 2007.

Félix A.-E., Calatayud P.-A., Le Ru B., Silvain J.-F. and Frérot B. Reproductive isolation among African stem borers (Lepidoptera: Noctuidae). Paper presented at the European Society for Evolutionary Biology XI Congress, Uppsala, Sweden, from 20 to 25 August 2007.

Juma G., Chimtawi M., Ahuya P. O., Njagi P. G. N., Le Ru B., Magoma G., Silvain J.-F. and Calatayud P.-A. Distribution of chemo- and mechanoreceptors on the antennae and maxillae of *Busseola fusca* (Lepidoptera: Noctuidae) larvae. Paper presented at the 13th Symposium on Insect–Plant Relationships, Uppsala, Sweden, from 29 July to 2 August 2007.

Mailafiya D.M., Le Ru B., Kairu E.W. and Dupas S. Assessment of the diversity and ecological preference of parasitoids associated with lepidopteran stem borers in Kenya. Paper presented at the ENDURE Summer School Course in Biodiversity, Volterra, Italy, from 10 to 14 September 2007.

Ndemah R., Schulthess F. and Le Ru B. Lepidopteran maize borers and parasitoids in Cameroon. Paper presented at the Annual Meeting of the Entomological Society of America (ESA) in San Diego, California, from 9 to 12 December 2007.

Obonyo M., Calatayud P.-A., Schulthess F., Le Ru B. and Van Den Berg J. Host recognition by the lepidopterous larval endoparasitoids: *Cotesia sesamiae* Cameron and *Cotesia flavipes* (Cameron) (Hymenoptera: Braconidae). Paper presented at the 33rd Conference of the Zoological Society of Southern Africa, held at the North-West University, Potchefstroom, South Africa, from 8 to 11 July 2007.

Ong'amo G., Le Ru B., Calatayud P.-A., Moyal P., Ogol C.K.P.O., Kokwaro E.D. and Silvain J.F. Host-plant diversity of *Sesamia calamistis* Hampson (Lepidoptera: Noctuidae): Cytochrome *b* gene sequence reveals genetic differentiation in host utilization. Paper presented at the International Workshop on Bioinformatics, Nairobi, Kenya, in May 2007.

Ong'amo G., Le Ru B., Moyal P., Calatayud P.-A., Ogol C. K. P. O., Kokwaro E. D. and Silvain J.-F. Host-plant diversity of *Sesamia calamistis* Hampson (Lepidoptera: Noctuidae): Cytochrome *b* gene sequence reveals genetic differentiation in host utilization. Paper presented at the 13th Symposium on Insect–Plant Relationships, Uppsala, Sweden, from 29 July to 2 August 2007.

Ong'amo G., Le Ru B., Calatayud P.-A., Moyal P., Ogol C.K.P.O., Kokwaro E.D. and Silvain J.F. Host-plant diversity of *Sesamia calamistis* Hampson (Lepidoptera: Noctuidae): Cytochrome *b* gene

sequence reveals genetic differentiation in host utilization. Paper presented at the International Workshop on Bioinformatics, Nairobi, Kenya, in May 2007.

Voise J., Jiang N., Le Ru B., Moyal P., Ong'amo G., Le Gall P., Calatayud P.-A., Ngala L., Musyoka B., Conlong D., Cugala D., Defabachew B., Kauma-Matama T., Pallangyo B., Van Den Berg J., Schulthess F. and Silvain J.F. Using GIS as a tool for determining ecological preferences and predict the distribution of wild noctuid stem borer genera in Africa. Paper presented at the International Research Conference on Biodiversity and the Sustainable Management of Natural Resources, Kigali, Rwanda, in July 2007.

2008

Calatayud P.-A., Juma J., Njagi P. G. N., Le Ru B., Silvain J.-F. and Frérot B. Differences in host plant recognition between wild and laboratory-reared *Busseola fusca* (Fuller). Paper presented at the SEMIO-08 Meeting in Chemical Ecology, Arusha, Tanzania, from 12 to 15 February 2008.

Juma G., Njagi P. G. N., Le Ru B., Silvain J.-F. and Calatayud P.-A. Antennal gustatory sensilla of *Busseola fusca* (Lepidoptera: Noctuidae) larvae potentially involved in host plant evaluation. Paper presented at the SEMIO-08 Meeting in Chemical Ecology, Arusha, Tanzania, from 12 to 15 February 2008.

Obonyo M., Schulthess F., Le Ru B., Silvain J.-F. and Calatayud P.-A. Discrepancy between host location from a distance and host suitability to *Cotesia flavipes* (Hymenoptera: Braconidae). Paper presented at the SEMIO-08 Meeting in Chemical Ecology, Arusha, Tanzania, from 12 to 15 February 2008.

Ong'amo G.O., Le Ru B.P., Calatayud P.-A., Capdevielle-Dulac C. and Silvain J.-F. Microsatellite analyses reveal fine scale genetic structure of *Busseola fusca* (Fuller) (Lepidoptera: Noctuidae). Paper presented at the XXIII International Congress of Entomology held at the International Convention Centre, Durban, South Africa, from 6 to 12 July 2008.

Fomumbod A., Ndemah R., Schulthess F., Hauser S., Le Ru B.P. and Ghogomu R. The effect of nitrogen and phosphorus on borer attacks and maize yields in the Western Highlands of Cameroon. Paper presented at the 56th Annual Meeting of the Entomological Society of America (ESA), held at the Reno-Sparks Convention Center in Reno, Nevada from 16 to 19 November 2008.

2009

Mithöfer K., Ong'amo G.O. and Le Ru B.P. Development of a species distribution model for lepidopteran stem borers and associated parasitoids in Kenya. Paper presented at the Tropentag 2009 "International Research on Food Security Natural Resource Management and Rural Development: Biophysical and Socio-economic Frame Conditions for the Sustainable Management of Natural Resources" held at the University of Hamburg, Hamburg, from 6 to 8 October 2009.

Mithöfer K., Ong'amo G.O. and Le Ru B.P. Species distribution model for lepidopteran stemborers in Kenya. Paper presented at the AfricaGIS Conference "Geospatial Information and Sustainable Development in Africa: Facing Challenges of Global Changes", from 26 to 30 October 2009.

Moolman H.J., Van den Berg J., Conlong D., Cugala D. and Le Ru B.P. Lepidopteran stem borer distribution in southern Africa: The importance of surveys and a review of the CORUS project. Paper presented at the 35th Conference of the Zoological Society of Southern Africa, held at Stellenbosch University, Stellenbosch, South Africa, on 6 and 7 July 2009.

2010

Assefa Y., Mitchell A., Le Ru B.P. and Conlong D.E. Population genetics of *Eldana saccharina* Walker (Lepidoptera: Pyralidae) and the implications for management using biocontrol. Paper presented at the 62nd International Symposium on Crop Protection held in Gent, Belgium on 18 May 2010.

Calatayud P.-A. Ecologie et lutte contre les insectes foreurs de Graminées en Afrique de l'Est. Paper presented at the Séminaire «Ecologie Chimique», AgroParisTech on 11 February 2010.

Calatayud P.-A., Frérot B., Le Ru B., Juma G. and Silvain J.-F. Mécanismes de reconnaissance de la plante hôte par les femelles de *Busseola fusca*. Paper presented at the Legsériales on 16 February 2010.

Calatayud P.-A. and Le Ru B. Interactions maniocs–cochenilles farineuses. Paper presented at the Séminaire Formation Doctorale de l'Université de Picardie, module «Plantes–Insectes–Pathogènes», Amiens on 4 May 2010.

Calatayud P.-A. and Frerot B. Influencia de las señales químicas en las relaciones plantas – insectos. Paper presented at the Séminaire d'un Workshop international sur les forêts de l'Amazonie occidentale: Mécanismes biologiques de la mise en place de la biodiversité et utilisations innovantes de la diversité moléculaire et génétique, Iquitos, Peru, from 24 to 26 November 2010.

Calatayud P.-A. Mécanismes de recherche et d'acceptation de la plante hôte par les Lépidoptères foreurs de Graminées. Paper presented at the Séminaire de master «Biologie Intégrée et Physiologie», Unité de valeur «Relations Insectes Plantes Xénobiotiques», Université Pierre et Marie Curie, Paris on 10 December 2010.

Chardonnet F., Le Ru B.P., Silvain J.-F. and Kaiser L. Automatisation de l'enregistrement de déplacements alimentaires chez une *Sésamie*. Paper presented at the Colloque Biologie de l'Insecte, Lyon, France from 18 to 20 Octobre 2010.

Chouquet B., Chardonnet F., Le Ru B.P., Capdevielle C., Silvain J.-F. and Kaiser L. Le gène for ferait-il des ravages! Paper presented at the Colloque Biologie de l'Insecte, Lyon, France from 18 to 20 October 2010.

Dupas S., Gitau C., Mbugi P.J., Le Ru B. and Silvain J.-F. The genetic constraints and ecological forces driving the coevolution between *Cotesia sesamiae* (Hymenoptera: Braconidae) and *Busseola fusca* (Lepidoptera: Noctuidae). Paper presented at the Entom2010 "37è journées des entomophagistes", Antibes Juan les Pins from 5 to 7 May 2010.

Kaiser L., Dupas S., Le Ru B., Branca A., Kaoula F. and Silvain J.-F. Ecological specialisation, virulence variability, and biological control in the parasitoid *Cotesia sesamiae*. Paper presented at the Entom2010 "37è journées des entomophagistes", Antibes Juan les Pins from 5 to 7 May 2010.

Kaiser L., Kaoula F., Branca A., Dupas S., Le Ru B. and Silvain J.-F. Variabilité de la virulence, spécialisation écologique et lutte biologique chez le parasitoïde *Cotesia sesamiae*. Paper presented at the Entom2010, 37è journées des entomophagistes, Antibes Juan les Pins from 5 to 7 May 2010.

Le Gall P. and Le Ru B. L'origine des espèces afromontagnardes de la Ligne Volcanique du Cameroun. Paper presented at the VII Conférence Internationale Francophone d'Entomologie, Louvain la Neuve from 5 to 10 July 2010.

2011

Calatayud P.-A. Interactions chimiques chez les noctuelles foreuses de Graminées en Afrique de l'Est. Paper presented at the Séminaire «Ecologie Chimique», AgroParisTech, on 24 February 2011.

Calatayud P.-A., L'électropénétrographie ou comment suivre électriquement le comportement alimentaire des insectes? Paper presented at the Séminaire du Legs held at CNRS, Gif-sur-Yvette, on 29 April 2011.

Kergoat G.J., Delobel A., Toussaint E., Silvain J.-F., Capdevielle-Dulac C., Genson G. and Le Ru B.P. Is there a common pattern underlying the evolution of internal insect feeders? Paper presented at the SMBE 2011, Kyoto, Japan from 26 to 30 July 2011.

Mitchell A., Le Ru B. and Sallam S. Tools to help secure 60% of the world's food supply: DNA barcoding the pest fauna of graminaceous crops. Paper presented at the 4th International Barcode of Life Conference held in Adelaide, Australia from 30 November to 3 December 2011.

Moolman H.J., Van den Berg J., Conlong D., Le Ru B.P. and Cilliers D. The distribution of Lepidoptera (Noctuidae) genera *Manga, Sesamia* and *Acrapex* in southern Africa. Paper presented at the XVII Congress of the Entomological Society of Southern Africa, held at the University of the Free State, Bloemfontein, South Africa, from 3 to 6 July 2011.

Obonyo M., Schulthess F., Van Den Berg J., Le Ru B. and Calatayud P.-A. Basis of host recognition and acceptance in *Cotesia sesamiae* and *Cotesia flavipes*, parasitoids of gramineous stemborers in Africa. Paper presented at the Semio-11 Insect Chemical Ecology and Multilevel Pest Management towards Food Security and Sustainable Development held at *icipe*, Nairobi, Kenya, from 12 to 15 November 2011.

2012

Calatayud P.-A. Biological control against insect pests of maize in Kenya. Oral communication presented at the Cycle de conférence au Lycée Denis Diderot, Nairobi, Kenya, on 11 May 2012.

Glaser N., Poivet E., François M.-C., Demondion E., Monsempès C., Kaoula F., Le Ru B., Calatayud P.-A. and Jacquin-Joly E. Chemosensory adaptation to host-plant in a noctuid. Paper presented at the XVI International Symposium on Olfaction and Taste, Stockholm, Sweden, from 23 to 27 June 2012.

Chardonnet C., Capdevielle-Dulac B., Chouquet N., Joly B., Le Ru B., Silvain J.-F. and Kaiser L. Involvement of the foraging gene in the acquisition of the pest status in a Lepidoptera species. Paper presented at the Colloque EBM de Marseille, September 2012.

Kaiser L., Dupas S., Le Ru B., Herniou E., Jancek S., Paillusson C., Kaoula F. and Silvain. J.-F. From ecological specialization to cryptic speciation: An integrative study in *Cotesia sesamiae,* a parasitoid of cereal pests. Paper presented at the Colloque EBM de Marseille, September 2012.

HUMAN HEALTH

2008

Mwangi J. Aquatic habitat productivity to adult *Anopheles arabiensis* and *Culex quinquefasciatus* in Mwea rice agro-ecosystem, Kenya.

Shililu J. Mosquito species diversity and abundance in relation to land use in a riceland ecosystem in Mwea, Kenya.

Muriu S. Malaria risk and the potential role of microbial larvicides in irrigated rice agro-ecosystems.

Shililu J. Experimental hut trials of the long-lasting and conventional insecticide treated mosquito bed nets commonly used in Kenya on free flying adult *Anopheles gambiae*.

2009

Mukabana R. Development of synthetic odours that attract more mosquitoes than humans: Field and semi-field studies. Paper presented at the 5th Annual Grand Challenges in Global Health (GCGH) Meeting, Arusha, Tanzania, from 18 to 21 November 2009.

Mukabana R. A novel water recirculation system for use in the mass rearing of *Anopheles arabiensis* mosquitoes. Paper presented at the FAO/IAEA Mosquito Mass Rearing Research Committee Meeting, Bologna, Italy, from 21 to 25 September 2009.

Githure J. Community-based malaria control programme in Mwea, Nyabondo, Kisii and Malindi.

2010

Mukabana R. Field Test of Sterile Male Mosquitoes Meeting, on 9 to 10 December 2010.

2011

Mukabana R. The silver cyprinid fish *Rastrineobola argentae* as a diet source for larval *Anopheles arabiensis* mosquitoes, from 7 to 11 March 2011.

Mukabana R. Role of scientists in knowledge and information generation, on 24 February 2011.

2012

Mukabana R. Using Attractants to Sample Mosquitoes of Different Abdominal Status in the Field meeting, from 12 to 16 November 2012.

Mukabana R. Field Test of Sterile Male Mosquitoes Meeting, from 25 to 27 January 2012.

ANIMAL HEALTH

2008

Saini R. K. Tsetse survey in Swaziland and tsetse, trypanosomiasis and related scientific research activities at *icipe*. Invited paper presented at the 14th FAO PAAT Advisory Group Co-ordinators Meeting and 33rd Executive Committee Meeting of the International Scientific Council for Trypanosomiasis Research and Control (ISCTRC), Kampala Uganda, from 14 to 17 October 2008.

Saini R. K. Potential of repellents in the control of tsetse and other disease vectors. Invited paper presented at the XXIII International Congress of Entomology (ICE), Symposium on Global Repellent Research, held in Durban, South Africa, from 6 to 12 July 2008.

Saini R. K. Discovering potent tsetse repellents from odours of refractory hosts and structure & blend optimization studies. Invited paper presented at the XXIII International Congress of Entomology (ICE), Symposium on African Trypanosomiasis, Durban, South Africa, from 6 to 12 July 2008.

2009

Saini R.K. Recent advances in tsetse biology and control. Invited keynote paper presented at the 30th International Scientific Council for Trypanosomiasis Research and Control (ISCTRC) Scientific Meeting, Kampala, Uganda, from 21 to 25 September 2009.

Saini R.K. Tsetse survey in Swaziland. Paper presented at the 30th International Scientific Council for Trypanosomiasis Research and Control (ISCTRC) Scientific Meeting, Kampala, Uganda, from 21 to 25 September 2009.

Saini R.K. Invited speaker at the PATTEC Workshop on Tsetse Control Methods, held in Nakuru, Kenya, from 3 to 5 December 2008.

2010

Saini R.K. Healthy camels—Development of innovative technologies for use by nomadic and pastoral communities for the control of surra and its vectors. Paper presented at the International Camel Symposium "Linking Camel Science and Development for Sustainable Livelihoods", held in Garissa, Kenya, from 7 to 10 June 2010.

2011

Saini R.K. Development of innovative vector and disease control technologies for enhancing livestock productivity and improvement of food security in Africa. Paper presented at the Africa College Food Security, Health and Impact Knowledge Brokering Conference held at the University of Leeds, UK, from 22 to 24 June 2011.

Saini R.K. Development of tools and strategies for integrated control of arthropod vectors of important veterinary diseases in sub-Saharan Africa. Paper presented at the Global Conference on Entomology "GCE2011", Chiang Mai, Thailand, from 5 to 9 March 2011.

2012

Saini R.K. Potent repellents for control of savannah tsetse (*Glossina* spp.). Paper presented at the XXIV International Congress of Entomology "A New Era in Entomology" held in Daegu, Korea, from 19 to 25 August 2012.

Saini R.K. Potent repellents for control of savannah tsetse (*Glossina* spp.). Paper presented at the Semio-11 Insect Chemical Ecology and Multilevel Pest Management towards Food Security and Sustainable Development, held at *icipe,* Nairobi, Kenya, from 12 to 15 November 2012.

Saini R.K. Biology of tsetse. Paper presented at the Department of Entomology, Faculty of Agriculture Seminar, held at the Kasetsart University, Thailand, on 16 August 2012.

ENVIRONMENTAL HEALTH

COMMERCIAL INSECTS PROGRAMME

2007

Nguku E. The International Conference on Micro, Small and Medium Enterprises (MSMES07), organised by the Centre for Entrepreneurship and Enterprise Development (CEED), School of Business, Kenyatta University, from 14 to 17 November 2007.

Raina S. International Centre for Agricultural Research in Dry Areas Seminar held at ICARDA, in Aleppo, Syria, from 15 to 18 April 2007.

Raina S. Seminar on Commercial Insects Programme at *icipe*. OPEC Funds Office in Austria, on 10 June 2007.

Raina S. Seminar on the Constraints in Beekeeping in North Africa, held at the IDB headquarters, Saudi Arabia, on 14 May 2007.

2008

Nguku E. The 5th International Conference of Textile Research Division on "Textile Processing: State of the Art & Future Developments, held at the National Research Centre, Cairo, Egypt, from 6 to 8 April 2008.

Raina S. Seminar on AgriBusiness Forum 2008, Rome, Italy, from 18 to 20 June 2008.

Raina S. Seminar on Beekeeping, Crop Protection Department (Apiculture Section), University of Eden, Yemen, in August 2008.

2009

Kiilu F.K. The BioFach Trade Fair, Nuremberg, Germany courtesy of the International Trade Centre (ITC) Geneva, and represented the organic beekeeping project in Mwingi, from 19 to 23 February 2009.

Nguku E. Textile and Garment Industry Workshop organized by the Rwanda Development Board with the support of the ACP Business Climate Facility (BizClim), held in Kigali, Rwanda, from 4 to 7 May 2009.

Raina S. Land Use Plan Dissemination Workshop Organized by World Wide Fund for Nature Eastern Africa Regional Programme Office (WWF-EARPO), Lake Naivasha-Malewa Conservation Project, held in Naivasha, Kenya, on 21 to 22 May 2009.

Raina S. Textile and Garment Industry Workshop organized by the Rwanda Development Board with the support of the ACP Business Climate Facility (BizClim), held in Kigali, Rwanda, from 4 to 7 May 2009.

2011

Nguku E. The 10th International SAAFECS Conference on "Building a New Identity", held at the Saint George Hotel and Conference Centre, Pretoria, South Africa, from 7 to 11 March 2011.

Nguku E. International Symposium on the "Revitalization of the Textile Industry through Research", held at the Kisumu Hotel, Kenya, on 11 and 12 February 2011.

2012

Kiatoko N. Workshop on Ecological Methods for the Bee Health Project at Wageningen University and Research Centre, The Netherlands, from 5 September to 13 October 2012.

Raina S. ApiExpo Africa 2012 Conference held in Ethiopia on 26 September 2012.

Raina S. Seminar on Bee Diseases and Pollination Services, held at the Swedish University of Agricultural Sciences, Department of Ecology, Uppsala, Sweden, from 23 to 25 April 2012.

Raina S. Seminar on Commercial Insects, Wageningen University and Research Centre, The Netherlands, from 15 to 19 April 2012.

APPLIED BIOPROSPECTING

2007

Lwande W. ABS and TK: The medicinal plant *Ocimum kilimandscharicum*. Paper presented at the Second ABS Capacity Development Workshop for Africa, Nairobi, Kenya, from 3 – 7 December 2007.

Lwande W. Biodiversity products in Kenya. Uganda biodiversity: Key to poverty reduction and economic transformation strategy for Uganda. Paper presented at a Uganda Government Consultation Briefing, Kampala, Uganda, on 19 to 20 March 2007.

Lwande W. Bioprospecting as a means to conservation of biodiversity: Examples from East Africa. Paper presented at the International Research Conference on Biodiversity and the Sustainable Management of Natural Resources, held at the Hilton Hotel, Kigali, Rwanda, from 23 to 25 July 2007.

2008

Lwande W. The Kenya Example, Promoting Biosafety/Biodiversity Legislation to Accelerate Uganda's Economic Growth: A Roundtable Meeting for Members of Parliament of the Republic of Uganda, Entebbe, Uganda, from 2 to 5 October 2008.

2009

Lwande W. Bioprospecting as a tool for economic development. Launch of the Intellectual Property Initiative (IPI) project by the Institute of Economic Affairs (IEA), Kenya Industrial Property Institute (KIPI) and Kenya Wildlife Service (KWS), held at the Norfolk Hotel, Nairobi, Kenya, on 15 January 2009.

Lwande W. An Initiative towards discovery and development of naturally-derived products as a means to biodiversity conservation and economic development. Paper presented at a Cabinet and Senior Government Officials Roundtable Meeting: Towards Effective Utilization of Biodiversity for Economic Growth and the Attainment of Kenya's Vision 2030, held at the White Sands Hotel, Mombasa, Kenya, from 19 – 21 March 2009.

2010

Lwande W. KWS/*icipe* Biodiscovery Programme: Achievements and Lessons Learned. Paper presented at the KWS Bioprospecting Awareness Workshop, held at the Merica Hotel, Nakuru, Kenya, from 9 to 12 June 2010.

2011

Lwande W. Herbal-based pesticides development for bee diseases and pests, and application methods. Paper presented at The First Africa-wide Training Course and Workshop on Strategic Partnership Networking in Bee Health and Pollination Services for Food Security in Africa, held at *icipe* Duduville Campus, Nairobi, Kenya, from 10 to 19 October 2011.

2012

Lwande W. Bioprospecting and benefit sharing. Paper presented to the Soda Lakes Benefit Sharing Plan - Republic of Kenya Ministry of Forestry and Wildlife, held at the Lake Bogoria Spa Resort, Bogoria, Kenya, on 20 and 21 May 2012.

Lwande W. Bioprospecting by *icipe*. Paper presented at the Continuous Medical Education (CME) Seminar, held at the Armed Forces Memorial Hospital, Nairobi, Kenya, on 28 March 2012.

Lwande W. Natural products discovery by *icipe*. Paper presented at the Continuous Medical Education (CME) Seminar, held at Kakamega Provincial Government Hospital, Kakamega, Kenya, on 12 May 2012.

CHIESA

2011

Johansson T. Climate and land cover change—Impacts on pollination services in Eastern Afromontane Biodiversity Hotspots. Paper presented at the First Africa-Wide Training Course and Workshop on Bee Health and Pollination Services for Food Security in Africa Workshop held at the i*cipe* Duduville Campus, Nairobi, Kenya, on 12 October 2011.

Johansson T. Climate change impacts on pollinators, insect pests and food security—Filling critical gaps of knowledge. Paper presented at the AAS–*icipe*–TWAS-ROSSA Conference on "Climate Change and Food Security: The Road for Africa", at the African Academy of Sciences Headquarters, Karen, Nairobi, Kenya, on 11 November 2011.

Johansson T. Introduction to the CHIESA Project. Paper presented for the University of Helsinki Delegation at the *icipe* campus, Nairobi, Kenya, on 23 September 2011.

Johansson T. Introduction to the CHIESA Project. Paper presented for the Kauniainen Upper Secondary School Delegation visit at the *icipe* Duduville Campus, Nairobi, Kenya, on 5 December 2011.

Johansson T. Introduction to the CHIESA Project. Paper presented for the McGill University (Canada) delegation visit at the *icipe* Duduville Campus, Nairobi, Kenya, on 6 December 2011.

Johansson T. The CHIESA Project. Paper presented at the International Conference on East African Mountains (ICEAM2011), held at the Mbale Resort Hotel, Mbale, Uganda, on 15 November 2011.

Johansson T. The CHIESA Project. Paper presented at the Management of Functional Diversity of Landscapes in the Context of the High Plateaus of East Africa (HPEA2011) CIRAD Workshop, held at the ICRAF Headquarters, Nairobi, Kenya, on 22 November 2011.

Johansson T. The CHIESA Project. Paper presented at the ILRI Agricultural Adaptation and Mitigation Professional Group, Breakfast Roundtable Meeting at Crowne Plaza Hotel, Nairobi, 12 October 2011, Kenya.

Johansson T. The Climate Change Impacts on Ecosystem Services and Food Security in Eastern Africa Project. Paper presented at the Applied Geoinformatics for Society and Environment Conference (AGSE2011), held at at the Jomo Kenyatta University of Agriculture and Technology, Nairobi, Kenya, on 17 August 2011.

Johansson T., Njui A., Sevgan S. and Nyambo B. The CHIESA Project. Poster presentation at the ASARECA 2011 General Assembly, held at the Imperial Beach Hotel, Entebbe, Uganda, from 14 to 16 December 2011.

Johansson T., Wambui K. and Achola S. CHIESA Project Poster presentation at the *icipe* Science Day, *icipe*'s 40th Anniversary, held at the *icipe* Duduville Campus, Nairobi, Kenya, on 16 November 2011.

2012

Johansson T. and Achola S. Climate change impacts on invertebrates relevant to agriculture: Possible adaptation options. Paper presented at the ARD Workshop organised by the Embassy of Finland, Nairobi, Kenya, on 15 March 2012.

Johansson T. CHIESA Project—An Introduction. Paper presented for the Delegation of the Alumni of the University of Helsinki, Finland at the *icipe* Duduville Campus, Nairobi, Kenya, on 11 September 2012.

Johansson T. CHIESA Project—Automatic Weather Stations. Paper presented for the McGill University (Canada) delegation visit at the *icipe* Duduville Campus, Nairobi, Kenya, on 8 March 2012.

Johansson T. CHIESA Project. Paper presented at the World University Network Workshop on "Resilient Pasts and Sustainable Futures? The Social–Ecological Dynamics of East Africa Landscapes", held at the Beachcomber Hotel, Dar es Salaam, Tanzania, on 17 September 2012.

Johansson T. CHIESA Project. Paper presented to the Genetic Resources and Intellectual Property Rights (GRIP) Group at the *icipe* Duduville Campus, Nairobi, Kenya, on 21 November 2012.

Johansson T., Achola K., Nyambo B., Wambui K. and Gathendu M. CHIESA Project poster presentation at the Save the Earth Expo on "Building Resilience Against Climate Risks", organised by the Kenya Meteorological Society, held at the Kenyatta International Conference Centre, Nairobi, Kenya, on 13 and 14 November 2012.

Johansson T., Nyambo B., Achola S. and Wambui K. Poster presentation at the Europe Day Expo organised for the European Embassies in Kenya and for key collaborating stakeholders, held at the *icipe* Duduville Campus, Nairobi, Kenya, on 9 May 2012.

Sevgan S., Johansson T., Le Ru B., Fiaboe K., Ekesi S., Jaramillo J., Landmann T. and Borgemeister C. Pest risk assessment and activities on modelling impacts of climate change on pest dynamics at *icipe*. Paper presented at the Climate Change, Agriculture and Food Security Scientific and Planning Workshop on "Modelling Climate Impacts on Pests and Diseases", at the International Potato Center, Lima, Peru, on 10 December 2012.

MBBU

2008

Masiga D. Genome perspectives on host–pathogen interactions: Expression profiling of variant surface glycoprotein (VSG) genes of *Trypanosoma brucei rhodesiense*. Cambridge, UK, 2008.

Masiga D. Consortium for the Barcode of Life: An African perspective. Paper presented at the XXIII International Congress of Entomology (ICE2008), Durban, South Africa, from 6 July to 12 July 2008.

Mururi C. Basic Molecular Phylogeny Workshop, ILRI, Nairobi, from 28 to 29 August 2008.

Mururi C. Project Development Workshop held at KARI-TRC sponsored by WHO/TDR and BecANet, KARI-TRC, from 26 to 30 May 2008.

Mururi C. Third Regional WHO/TDR and KARI-TRC HAT Capacity Strengthening Introductory Course on Tsetse and Trypanosomiasis, held at KARI-TRC, Muguga, from 5 to 23 May 2008.

Mururi C. Entomology Course at *icipe* organised by Dr Fabian Haas, *icipe* Duduville, Nairobi in January 2008.

2009

Masiga D. Applying DNA barcoding for wildlife forensics and conservation. Paper presented at the Wildlife Law Enforcement Stakeholders' Capacity Building Workshop, Narok, Kenya, in March 2009.

Masiga D. Analysis of mitochondrial cytochromes reveal key sources of tsetse fly bloodmeals in East Africa. Paper presented at the 3rd International DNA Barcode of Life Conference, Mexico City, Mexico, from 7 to 13 November 2009.

Mururi C. Analysis of tsetse fly (Diptera: Glossidae) blood meals using mitochondrial cytochrome genes for vertebrate host identification in East Africa. Paper presented at the 30th International Scientific Conference on Tsetse and Trypanosomiasis Research Council (ISCTRC), Kampala, Uganda, on 25 September 2009.

Mururi C. Workshop on Tsetse Vector Biology in Kampala, Uganda jointly organized by Yale University, KARI-TRC and NaLIRRI, Kampala, Uganda, from 19 to 20 September 2009.

2010

Fischer A. AVID – Arthropod-borne Viruses Incidence and Diversity. Poster presented at the Emerging Vector-borne Diseases in a Changing European Environment (EDEN) conference, Montpellier, France, from 10 to 12 May 2010.

2011

Masiga D. Implementing a national DNA barcoding node from scratch—The experience of KenBOL. Paper presented at the 4th International Barcode of Life Conference, held at the University of Adelaide, Adelaide, Australia, from 28 November to 3 December 2011.

Muturi C. Capacity Enhancement in Research Publication Course for Egerton University postgraduate students, held at the Egerton University, Njoro, Kenya on 19 May 2011.

Muturi C. e-Biokit Workshop sponsored by WHO and SANBI-South Africa, held at Egerton University Njoro campus, from 26 to 28 April 2011.

Villinger J. and Sang R. Early warning systems: Arbovirus surveillance. Invited talk at the EAC/EAPHLN Experts Meeting on Viral Haemorrhagic Fevers and Integrated Disease Surveillance & Response for EAC Partner States, held at the Uganda Virus Research Institute (UVRI), Entebbe, Uganda, from 11 to 15 July 2011.

Villinger J. First Medical and Veterinary Virus Research in Kenya (MVVR-K) Symposium, Nairobi, on 8 and 9 September 2011.

Villinger J. High resolution melting analysis for virus and insect identification. Poster presentation at the *icipe* Science Day, *icipe*'s 40th Anniversary Celebrations, held at Duduville, Nairobi, on 16 November 2011.

Villinger J. MassCode for pan-arbovirus surveillance in East Africa. Invited talk at the 2nd International Forum for Surveillance and Control of Mosquitoes and Mosquito-Borne Diseases, Beijing, China, from 23 to 27 May 2011.

Villinger J. MassCode for pan-arbovirus surveillance in East Africa. Invited talk at the WHO BSL-3 training (Infectious Agents Shipping Certificate and BSL-3 Practices Certificate), from 15 to 19 August 2011.

Villinger J. MassCode for pan-arbovirus surveillance in East Africa. Poster presentation at the *icipe* Science Day, *icipe*'s 40th Anniversary Celebrations, held at Duduville, Nairobi, on 16 November 2011.

Villinger J. MassCode for pan-arbovirus surveillance. Invited talk at the AVID Scientific Meeting, held at *icipe*, on 7 and 8 June 2011.

Villinger J. MassCode for viruses in East Africa. Invited talk at the EMBO Global Exchange Lecture Course on Bioinformatics and Comparative Genome Analysis, held at the Institut Pasteur, Tunis, Tunisia, from 13 to 18 December 2011.

2012

Fischer A. Insect-transmitted plant pathogens. Talk at the Workshop "Bringing Diagnostics to the Point-of-Care" organised by the University of Alberta, Canada, Nairobi, Kenya, from 25 to 29 June 2012.

Fischer A. The origin of the '*Mycoplasma mycoides* Cluster' coincides with domestication of ruminants. Talk at the "Capacity Building and Bioinformatics Challenges" Workshop, Uppsala, Sweden, from 12 to 14 June 2012.

Fischer A. The origin of the '*Mycoplasma mycoides* Cluster' coincides with domestication of ruminants. Talk at the Tropentag Conference, Goettingen, Germany, from 19 to 21 September 2012.

Fischer A. Viral metagenomics demonstrates that domestic pigs are a potential reservoir for Ndumu virus. Talk at the Medical and Veterinary Virus Research Conference (MVVK), Nairobi, Kenya, on 18 and 19 October 2012.

Masiga D. Insect genome resources. PhD Training Workshop for EU funded Mosquito Immunity Project, Strasbourg, France, April 2012.

Masiga D. One health—Old paradigm, new relevance. Paper presented at the first Africa Science Journalists Conference (ASJC) on Promoting Science Journalism for Socio-Economic Development, Nakuru, Kenya from 20 to 23 August 2012.

Masiga D. The Future of Biodiversity Research in Africa: Scope, Opportunities, Collaborations, Access and Sharing Benefits in the Humboldt-Kolleg held at the Taita Taveta University College, Voi, Kenya from 17 to 20 July 2012.

Villinger J. Arbovirus MassCode and high resolution melting profiles. Paper presented at the Second Medical and Veterinary Viral Research (MVVR-2) Symposium, Nairobi, Kenya, on 19 October 2012.

Villinger J. Current trends in real time PCR applications. Keynote speaker at the Roche Lightcycler Nano launch event held in Nairobi, on 4 September 2012.

Villinger J. Developing molecular tools for studying the population biology of genus *Mansonia*, a vector of arboviruses. Paper presented at the 4th THRiVE Annual General Meeting, held at *icipe* Duduville, Nairobi, Kenya, on 18 June 2012.

Villinger J. High resolution melting analysis for virus and insect identification. Poster presentation at the Capacity Building and Bioinformatics Challenges Workshop held at the Swedish University of Agricultural Sciences SLU, Sweden, from 12 to 14 June 2012.

Villinger J. MassCode for pan-arbovirus surveillance in East Africa. Poster presentation at the Capacity Building and Bioinformatics Challenges Workshop held at the Swedish University of Agricultural Sciences SLU, Sweden, from 12 to 14 June 2012.

Villinger J. MassTag and HRM applied to multiplex viral screening and typing. Paper presented at the ILRI Virus Discovery Workshop, Nairobi, Kenya, on 6 November 2012.

BCED

2007

Torto B. Multi-trophic interaction in a honeybee coleopteran pest. Paper presented at the Chemrawn XII Conference, Stellenbosch, South Africa, from 2 to 6 December 2007.

2008

Torto B. Exploitation of pheromone in locust control: Short-term contact responses of two locust species to phenylacetronitrile. Paper presented at the Semiochemicals in Insect Pest and Disease Vector Management: The African Perspective (Semio-08), Arusha, Tanzania, from 11 to 15 February 2008.

Torto B. From release to absorption: Elucidating the effects of a desert locust pheromone. Paper presented at the MARA-08 "Molecules to Migration: The Pressures of Life" 4th International meeting in Africa for Comparative Physiology and Biochemistry, held at the Mara Simba and Keekorok Lodges in the Maasai Mara Game Reserve, Kenya, from 19 to 25 July 2008.

2009

Murungi L. K., Wesonga J. M., Masinde P. W., Nyende A. B., Torto B. and Knapp M. A. Effect of different African nightshade species grown under screenhouse conditions on population densities of *Tetranychus evansi*. Paper presented at the 9th Workshop on Sustainable Horticultural Production in the Tropics, held at the SnowCrest, Hotel, Arusha, Tanzania, from 2 to 5 December 2009.

Torto B. Chemical ecology of afrotropical disease vectors: Lessons learned and future challenges. Paper presented at the 25th International Society of Chemical Ecology Annual Meeting (ISCE 2009), Neuchatel, Switzerland, from 23 to 30 August 2009.

Torto B. Physiological basis of the sub-lethal effects of the desert locust pheromone phenylacetronitrile. Paper presented at the 10th International Congress of Orthopterology (IOC 2009), Antalya, Turkey, from 21 to 25 June 2009.

2010

Torto B. Natural products research and development in East Africa: The *icipe* experience. Paper presented at the Symposium on Commercialization of Botanicals, held at the University of Nairobi, Kenya, on 15 March 2010.

Torto B. The importance of bee health for the African Pollinator Initiative: The *icipe* contribution. Paper presented at the International Conference on Pollinator Biology, Health & Policy, held at the Penn State University, USA, from 24 to 28 July 2010.

2011

Cheseto X., Ndung'u M., Teal P. E. A. and Torto B. Conversion of cholesterol to 7- dehydrocholesterol and other sterols by gut of the desert locust. Paper presented at the International Conference "Semio-11 workshop on Insect Chemical Ecology and Multilevel Pest Management Towards Food Security and Sustainable Development", held at the *icipe* Duduville Campus, Nairobi, Kenya, from 12 to 15 November 2011.

Egonyu J.P., Ekesi S., Kabaru J., Irungu L. and Torto B. Host odour responses and experience-induced learning in the coconut bug, *Pseudotheraptus wayi* Brown (Heteroptera: Coreidae). Paper presented at the 14th Symposium on Insect–Plant Interactions, Wageningen, The Netherlands, from 13 to 18 August 2011.

Egonyu J.P., Ekesi S., Kabaru J., Irungu L. and Torto B. Inter and intraspecific olfactory behaviour of the coconut bug, *Pseudotheraptus wayi*: Do males search for the food then invite females? Paper presented at the International Conference "Semio-11 workshop on Insect Chemical Ecology and Multilevel Pest Management Towards Food Security and Sustainable Development", held at the *icipe* Duduville Campus, Nairobi, Kenya, from 12 to 15 November 2011.

Egonyu J.P., Ekesi S., Kabaru J., Irungu L. and Torto B. Semiochemicals mediating behavioural response of the coconut bug, *Pseudotheraptus wayi* to conspecific volatile cues. Paper presented at the 19th Conference of the African Association of Insect Scientists, held at *icipe* Duduville Campus, Nairobi, Kenya, from 9 to 12 November 2011.

Fombong A. T. Life history of *Oplostomus haroldi* (Coleoptera: Scarabaeidae) under laboratory conditions. Paper presented at the Learning event and SMOKE ART workshop/exhibition held at the Laico Regency Hotel, Nairobi, Kenya on 1 April 2011.

Fombong A.T., Arbogast R.T., Teal P.E.A. and Torto B. Evidence of contact sex pheromone in the scarab *Oplostomus haroldi*, a pest of honeybees in East Africa. Paper presented at the International Conference "Semio-11 workshop on Insect Chemical Ecology and Multilevel Pest Management Towards Food Security and Sustainable Development", held at the *icipe* Duduville Campus, Nairobi, Kenya, from 12 to 15 November 2011.

Fombong A.T., Arbogast R.T., Teal P.E.A. and Torto B. Potential of banana and mango as alternate host fruits of the small hive beetle *Aethina tumida* and implications in its ecology. Paper presented at the 19th Biennial Meeting and Scientific Conference of the African Association of Insect Scientists (AAIS) held at *icipe* Duduville Campus, Nairobi, Kenya on 9 to 12 November 2011.

Fombong A.T., Arbogast R.T., Teal P.E.A., Ndegwa P.N., Irungu L.W. and Torto B. Chemoecological insights into the sex discrimination and mating behaviour in *Oplostomus harold* (Witte), a scarab pest of honeybees. Paper presented at the 27th Annual Meeting of the International Society of Chemical Ecology (ISCE11) held at SFU-Burnaby, Vancouver, Canada on 24 to 28 July 2011.

Murungi L.K., Knapp M. and Torto B. Effect of leaf trichomes and volatiles of different *Solanum* species on fecundity and behavioral responses of *Tetranychus evansi* (Acari: Tetranychidae). Paper presented at the International Conference "Semio-11 workshop on Insect Chemical Ecology and Multilevel Pest Management Towards Food Security and Sustainable Development", held at the *icipe* Duduville Campus, Nairobi, Kenya, from 12 to 15 November 2011.

Murungi L.K., Knapp M., and Torto B. Effect of leaf trichomes and volatiles of different *Solanum* species on fecundity and behavioral responses of *Tetranychus evansi* (Acari: Tetranychidae). Paper presented at the International Conference "Semio-11 workshop on Insect Chemical Ecology and Multilevel Pest Management Towards Food Security and Sustainable Development", held at the *icipe* Duduville Campus, Nairobi, Kenya, from 12 to 15 November 2011.

Nyasembe V.O and Torto B. Identification of plant volatiles attractive to the malaria vector *Anopheles gambiae*. Paper presented at the International Conference "Semio-11 workshop on Insect Chemical Ecology and Multilevel Pest Management Towards Food Security and Sustainable Development", held at the *icipe* Duduville Campus, Nairobi, Kenya, from 12 to 15 November 2011.

Nyasembe V.O. and Torto B. *Anopheles gambiae*–host plant interaction: The effect of *Plasmodium falciparum* infection of plant nectar feeding. Paper presented at the 19th Conference of the African Association of Insect Scientists, held at Duduville Campus, Nairobi, Kenya, from 9 to 12 November 2011.

Torto B. Beetles associated with honey bees in Kenya. Paper presented at The First Africa-wide Training Course and Workshop on Strategic Partnership Networking in Bee Health and Pollination Services for Food Security in Africa, held at *icipe* Duduville Campus, Nairobi, Kenya, from 10 to 19 October 2011.

Torto B. Chemoecological insights into the sex discrimination and mating behavior in *Oplostomus haroldi* (Witte), a scarab pest of honeybees. Paper presented at the International Society of Chemical Ecology (ISCE) Annual Meeting held at the Simon Fraser University, Burnaby, BC, Canada, from 24 to 28 July 2011.

Torto B. Colony Collapse Disorder. Paper presented at the 7th COLOSS Myth or Reality in Africa Conference/MC Meeting & Workshops, Belgrade, Serbia, from 25 to 28 August 2011.

Torto B. Honeybee–*Varroa* mite interaction: Role of olfactory cues in phoretic mite behaviour. Paper presented at the International Conference "Semio-11 workshop on Insect Chemical Ecology and Multilevel Pest Management Towards Food Security and Sustainable Development", held at the *icipe* Duduville Campus, Nairobi, Kenya, from 12 to 15 November 2011.

Torto B. Linkages between centers of excellence and academia: The *icipe* experience and vision for sustainability. Paper presented at the Conference of Rectors, Vice Chancellors & Principals (COREVIP11) of AAU, Stellenbosch, South Africa, from 30 May to 4 June 2011.

Torto B. New thinking for the use of semiochemicals in tropical pest management. Paper presented at the 1st PACN Congress on Increasing Africa's Agricultural Productivity, Accra, Ghana, from 21 to 23 November 2011.

Torto B. Surveillance of mosquito vectors of Rift Valley fever in the Rift Valley of Kenya with semiochemical baits. Paper presented at the International Society of Chemical Ecology (ISCE) Annual Meeting held at the Simon Fraser University, Burnaby, BC, Canada, from 24 to 28 July 2011.

2012

Bendera M., Ekesi S., Ndung'u M., Srinivasan R. and Torto B. Effect of cowpea volatiles on sexual behavior of the legume pod borer, *Maruca vitrata*. Paper presented at the Phytochemical Society of Europe Congress on Bio-Communication (Biocom12) Conference on Semiochemicals involving Plants, Cadiz, Spain, from 9 to 12 September 2012.

Murungi L.K., Knapp M., Nyende A.B., Wesonga J., Masinde P. and Torto B. Volatiles in African nightshades influence response of the tomato spider mite. Paper presented at the 12th Workshop on Sustainable Horticultural Production in the Tropics held at the Bondo University College, Bondo, Kenya, from 4 to 7 December 2012.

Murungi L.K., Kuate P., Kirwa H. and Torto B. Harnessing the potential of constitutive defense in *Solanum sarrachoides* for management of the tomato red spider mite (Acari: Tetranychidae). Paper presented at the 7th JKUAT Scientific, Technological and Industrialization Conference held at the African Institute for Capacity Development, Juja, Kenya, on 15 and 16 November 2012.

Murungi L.K., Knapp M., Nyende A.B., Wesonga J., Masinde P. and Torto B. Volatiles in African nightshades influence response of the tomato spider mite. Paper presented at the 12th Workshop on Sustainable Horticultural Production in the Tropics held at Bondo University College, Bondo, Kenya, from 4 to 7 December 2012.

Torto B. 26 Innovative ideas, responsibility and ownership. Commencement Lecture at the Bowen University, Lagos, Nigeria on 6 September 2012.

Torto B. Host plant attractants for the malaria vector. Paper presented at the Phytochemical Society of Europe Congress on Bio-Communication (Biocom12) Conference on Semiochemicals involving Plants, Cadiz, Spain, from 9 to 12 September 2012.

Torto B. *icipe* Bee Health Research. Paper presented at the 12th Annual NAPPC International Conference, US EPA, Crystal City, Virginia, USA from 17 to 19 October 2012.

Torto B. Opportunities for value addition to agricultural produce: A chemist's perspective. Paper presented at the 7th JKUAT Scientific, Technological and Industrialization Conference held at the African Institute for Capacity Development, Juja, Kenya, on 15 and 16 November 2012.

ENTOMOPATHOLOGY

2007

Maniania N.K., Nchu F. and Ekesi S. Fungal pathogen for biocontrol of ticks. Paper presented at the 40th Annual Meeting of the Society for Invertebrate Pathology and 1st International Forum on Entomopathogenic Nematodes and Symbiotic Bacteria, Quebec, Canada, from 12 to 16 August 2007.

Mwangi D.M., Maniania N.K., Hassanali A., Njagi P.A., Gitonga L.M. and Ndungu M.W. Avoidance of entomopathogenic strains of *Metarhizium anisopliae* by termites: An evolutionary perspective. Paper presented at the 40th Annual Meeting of the Society for Invertebrate Pathology and 1st International Forum on Entomopathogenic Nematodes and Symbiotic Bacteria, Quebec, Canada, from 12 to 16 August 2007.

Maniania N.K. Improving tsetse fly control through the use of entomopathogenic fungus. Paper presented at the First Research Co-ordination Meeting on "Improving SIT for Tsetse Flies through Research on their Symbionts and Pathogens", Vienna, Austria, from 1 to 5 October 2007.

2008

Maniania N.K., Nchu F., Dimbi S. and Ekesi S. Semiochemicals: A companion to entomopathogenic fungi? Paper presented at the Semiochemicals in Insect Pest and Disease Vector Management: The African Perspective (SEMIO-08), Arusha, Tanzania, from 11 to 15 February 2008.

Maniania N.K., Nchu F., Dimbi S. and Ekesi S. Entomopathogenic fungi vs semiochemicals: Mutualistic affair against pests. Paper presented at the XXIII International Congress of Entomology (ICE2008), Durban, South Africa, from 6 to 12 July 2008.

Mburu M.D., Ochola L. and Maniania N.K. Termite–fungus interactions: Are semiochemicals involved in the defense behaviour of the termite *Macrotermes michaelseni*? Paper presented at the XXIII International Congress of Entomology (ICE2008), Durban, South Africa, from 6 to 12 July 2008.

Maniania N.K. The world of entomopathogenic fungi: *icipe*'s perspectives. Paper presented at the 3rd Consortium Workshop on Fungi for Adult Mosquito Control, Wageningen, The Netherlands, from 16 to 20 April 2008.

2009

Maniania N.K. Development of biopesticides for control of arthropod pests and disease vectors at *icipe*. Paper presented at the University of Cape Verde, Praia, Cape Verde, on 26 May 2009.

Maniania N.K. Experience of great partnership. Paper presented at the US–Africa Connections Workshop on Basic Science Research Collaborations for Agricultural Development, Naivasha, Kenya, from 19 to 22 June 2009.

Rajaonarison J.J.H., Maniania N.K., Njaka R. and Ramiliarijaona S. Successful introduction of Green Muscle® into Madagascar for the control of the migratory locust *Locusta migratoria capito*. Paper presented at the 42nd Annual Meeting of the Society for Invertebrate Pathology, Utah, USA, from 16 to 20 August 2009.

Mwangi D. M., Maniania N.K., Hassanali A., Njagi P.A., Gitonga L.M. and Ndungu M.W. Identification and blend effects of repellent volatiles of entomopathogenic fungi towards the termite *Macrotermes michaelseni*. Paper presented at the 42nd Annual Meeting of the Society for Invertebrate Pathology, Utah, USA, from 16 to 20 August 2009.

Maniania N.K. Spécificité de *Metarhizium anisopliae* var. *acridum* (Green Muscle®) à l'égard des larves de *Locusta migratoria capito*: Préalable à son Introduction à Madagascar. Paper presented at the Colloque sur la lutte Préventive antiacridienne, Antananarivo, Madagascar, on 17 and 18 September 2009.

Maniania N.K. Entomopathogenic fungi: A component of integrated tick management. Paper presented at the 4th BecANet Scientific Advisory Committee Meeting, Entebbe, Uganda, from 14 to 16 September 2009.

Maniania N.K. Improving tsetse fly control through the use of entomopathogenic fungus. Paper presented at the Second Research Co-ordination Meeting on "Improving SIT for Tsetse Flies through Research on their Symbionts and Pathogens", Bobo Dioulasso, Burkina Faso, from 16 to 20 February 2009.

2010

Bugeme D.M., Maniania N.K., Chabi-Olaye A., Boga H.I. and Knapp M. Field efficacy of the *Metarhizium anisopliae* isolate ICIPE 78 in controlling the red spider mite *Tetranychus evansi* in tomato field crop in Central Kenya. Paper presented at the 43rd Annual Meeting of the Society for Invertebrate Pathology, Trabzon, Turkey, from 11 to 15 July 2010.

Nchu F., Maniania N.K., Hassanali A. and Eloff K. Can *Metarhizium anisopliae* treated semiochemical-baited traps reduce *Amblyomma variegatum* populations in the field? Paper presented at the 43rd Annual Meeting of the Society for Invertebrate Pathology, Trabzon, Turkey, from 11 to 15 July 2010.

Maniania N.K. Integrated management of major insect pests and diseases of cashew in eastern and western Africa. Paper presented at the Second International Cashew Conference, Kampala, Uganda, from 27 to 29 April 2010.

Maniania N.K. Biological control of insect pests. Paper presented at the IUFRO Workshop on Tree Pests and Diseases in East Africa, Kampala, Uganda, from 3 to 7 May 2010.

Maniania N.K. Native pests on introduced trees—Case study: termites. Paper presented at the IUFRO Workshop on Tree Pests and Diseases in East Africa, Kampala, Uganda, from 3 to 7 May 2010.

Maniania N.K. Horizontal transmission of fungal inoculum in *Glossina fuscipes fuscipes* in semi-field conditions. Paper presented at the Third Research Co-ordination Meeting on "Improving SIT for Tsetse Flies through Research on their Symbionts and Pathogens", Nairobi, Kenya, from 26 to 30 July 2010.

Maniania N.K., Ekesi S., Odulaja O., Okech M.A. and Nadel D.J. Prospects of fungus-contaminated device for the control of tsetse flies. Paper presented at the Symposium on «Paludisme et Trypanosomose Humaine Africaine: Nouvelles stratégies de prévention et de contrôle», Cotonou, Bénin, on 7 and 8 October 2010.

2011

Akello J., Maniania N.K. and Sikora R. Systemic effects of fungal endophyte seed treatment on the development of the spotted stalk borer, *Chilo partellus* (Swinhoe). Paper presented at the IOBC-WPRS Working Group on "Insect Pathogens and Entomopathogenic Nematodes", 13th European Meeting "Biological Control in IPM Systems" at Innsbruck, Austria, from 19 to 23 June 2011.

Ekesi S. and Maniania N.K. Field suppression of the mango seed weevil, *Sternochetus mangiferae* with two formulations of *Metarhizium anisopliae* on mango orchard. Paper presented at the 44th Annual Meeting of the Society for Invertebrate Pathology, Halifax, Canada, from 7 to 11 August 2011.

Maniania N.K., Nana P., Boga H.I. and Kamtchouing P. Efficacy of spot-spray application of *Metarhizium anisopliae* formulated in oil extract of *Calpurnia aurea* in infecting and autodisseminating inoculum amongst adult *Rhipicephalus appendiculatus* ticks in semi-field experiments. Paper presented at the 44th Annual Meeting of the Society for Invertebrate Pathology, Halifax, Canada, from 7 to 11 August 2011.

Olotu M.I., Du Plessis H., Maniania N.K. and Seguni Z.S. Impact of African weaver ant *Oecophylla longinoda* Latreille (Hymenoptera: Formicidae) against *Helopeltis* spp. and *Pseudotheraptus wayi*, key pests of cashew in Tanzania. Paper presented at the 19th Conference of the African Association of Insect Scientists, Nairobi, Kenya, from 9 to 12 November 2011.

Niassy S., Maniania N. K., Subramanian S., Gitonga M. L., Maranga R., Obonyo A. B. and Ekesi S. Compatibility of *Metarhizium anisopliae* isolate ICIPE 69 with agrochemicals used in French bean production. Paper presented at the 19th Conference of the African Association of Insect Scientists, Nairobi, Kenya, from 9 to 12 November 2011.

Maniania N.K. and Kiatoko N. Prospects of entomopathogenic fungi for the control of honeybee pests with special reference to varroa mites. Paper presented at The First Africa-Wide Training Course and Workshop on Strategic Partnership Networking in Bee Health and Pollination Services for Food Security in Africa, Nairobi, Kenya, from 10 to 19 October 2011.

Maniania N.K., Agboton B.V., Olotu M.I., Onzo A., Seguni Z., Shomari S., Sijoana M. and Tamo M. Integrated management of major insect pests and diseases of cashew in eastern and western Africa. Paper presented at the First International Symposium on Cashew Nut, Madurai, Tamil Nadu, India, from 9 to 12 December 2011.

2012

Maniania N.K. and Ekesi S. The use of entomopathogenic fungi in the control of tsetse flies. Paper presented at the Fourth Research Co-ordination Meeting on "Improving SIT for Tsetse Flies through Research on their Symbionts and Pathogens, Vienna, Austria, from 26 to 30 March 2012.

Niassy S., Subramanian S., Ekesi S., Gitonga L.M., Mburu D.M., Masiga D. and Maniania N.K. 45th Annual Meeting of the SIP and 2012 International Congress on Invertebrate Pathology and Microbial Control, Buenos Aires, Argentina, from 5 to 9 August 2012.

Ekesi S., Mohamed S., Khamis M.F. and Maniania K. Nguya Compatibility of fruit fly attractants with *Metarhizium anisopliae* for the management of *Bactrocera invadens*, an invasive pest of horticulture in Africa. Paper presented at the 45th Annual Meeting of the SIP and 2012 International Congress on Invertebrate Pathology and Microbial Control, Buenos Aires, Argentina, from 5 to 9 August 2012.

Ekesi S., Mohamed S., Fathiya M.F. and Maniania N.K. Management strategies for the invasive fruit fly, *Bactrocera invadens* in Africa. Paper presented at the XXIV International Congress of Entomology, Daegu, South Korea, from 19 to 25 August 2012.

Niassy S., Maniania N.K., Ayuka F.T., Torto B., Subramanian S. and Ekesi S. Use of *Tithonia diversifolia* and *Metarhizuim anisopliae* in a lure-and-kill approach for thrips management. Paper presented at the XXIV International Congress of Entomology, Daegu, South Korea, from 19 to 25 August 2012.

Akutse K.S., Maniania N.K., Fiaboe K., Van den Berg J. and Ekesi S. Effects of entomopathogenic fungal endophytes on mortality, oviposition, emergence and longevity of *Liriomyza huidobrensis* (Diptera: Agromyzidae). Paper presented at the XXIV International Congress of Entomology, Daegu, South Korea, from 19 to 25 August 2012.

Maniania N.K. and Ekesi S. The use of entomopathogenic fungi in the control of tsetse flies. Paper presented at the XXIV International Congress of Entomology, Daegu, South Korea, from 19 to 25 August 2012.

Ekesi S., Mohamed S., Khamis F.M. and Maniania N.K. Management strategies for the invasive fruit fly, *Bactrocera invadens* in Africa. Paper presented at the Regional Planning Workshop on the Activities of the National Centre of Specialization on Fruits and Vegetables (CNS/FL), Bobo Dioulasso, Burkina Faso, from 2 to 9 September 2012.

Maniania N.K. Lutte biologique à l'aide des champignons entomopathogènes: Expérience de l'*icipe*. Invited lecture at the Université Pédagogique National (UPN), Kinshasa, Democratic Republic of Congo, on 26 October 2012.

TECHNOLOGY TRANSFER

2007

Nyambo B. Strengthening phytosanitary services for the export-oriented horticultural sector in Zambia: Pest monitoring and management. Paper presented at the Training Seminar for NZTT/PQS/ZEGA, from November to December 2007.

2008

Nyambo B. Cropping system-based IPM training for smallholder horticultural producers in East Africa. Paper presented at the AGSF-FAO/Horticultural Promotion of Uganda Workshop, held at the Africana Hotel, Kampala, Uganda, from 14 to 17 May 2008.

Nyambo B. Strengthening phytosanitary services for the export-oriented horticultural sector in Zambia: Pest monitoring and management. Paper presented at the Training of Farm Crop Scouts and Plant Health Inspectors, from 15 to 22 June 2008.

Nyambo B., Gatama G., Obiero J., Löhr B. and Njumwa G.M. Re-distribution of ex-South African strain of *Cotesia plutellae* Kurdjumov (Hymenoptera: Braconidae) in Africa for control of diamondback moth: Lessons from East Africa. Paper presented at the XXIII International Congress of Entomology, held at the International Convention Centre, Durban, South Africa, from 6 to 12 July 2008.

Nyambo B. Can Africa achieve food safety and security with minimum use of synthetic pesticides? Paper presented at the 1st African Congress on Pesticides and Toxicology Science, held in Neshishieba, Wad Medani, Gezira, Sudan, from 8 to 11 November 2008.

2009

Nyambo B. Enhancing food safety and market access for smallholder export vegetable producers in East Africa. Prepared and submitted to the CTA/ATPS/AGRA/FARA/RUFORUM Women in Science Competition 2008 finals, Addis Ababa, Ethiopia, on 21 April 2009.

Nyambo B., Sevgan S., Chabi-Olaye A. and Ekesi E. Management of alien invasive insect pest species and diseases of fruits and vegetables: Experiences from East Africa. Paper presented to the All Africa Horticulture Congress (AAHC2009), held at the Safari Park Hotel, Nairobi, Kenya, from 31 August to 3 September 2009.

2010

Nyambo B. Integrated management of emergency plant pests: Red locust in Central and Southern Africa. Paper presented at the Sub-Regional Contingency Planning and Transboundary Emergency Plant Pest (EPP) Preparedness Workshop, Lusaka, Zambia, from 18 to 22 October 2010.

Nyambo B. Status of Horticultural pest management in Africa: Challenges and opportunities in a changing global environment. Keynote address presented at the 3rd International Scientific Research Conference on "Enhancing Food & Nutrition Security and Integrated Pest Management in Developing Countries", held at the National University of Rwanda, Huye-Butare, Rwanda, from 2 to 4 November 2010.

2011

Nyambo B. FAO Somalia EU Food Facility Project "Integrated Support to Rural Livelihoods" IPPM Training, at the Sheraton Hotel, Djibouti, Republic of Djibouti, from 28 to 31 May 2011.

Nyambo B. and Tale K. S. Sudan Productive Capacity Recovery Programme (SPCRP) OSRO/SUD/623/MUL: South Sudan ToT course for Agricultural Extension Officers on Integrated Plant and Pest Management (IPPM), held at Pan Door, Rumbek South Sudan, from 26 September to 12 October 2011.

SOCIO-ECONOMICS

2009

Affognon H. Do social networks influence livestock keepers' knowledge on animal trypanosomosis and its control? Paper presented at the 30th Meeting of the International Scientific Council for Trypanosomosis Research and Control (ISCTRC), Kampala, Uganda, September 2009.

Affognon H. African animal trypanosomosis in West Africa: What makes livestock keepers not use other means of control in a drug resistance context? Paper presented at the 12th International Symposium of Veterinary Epidemiology and Economics, Durban, South Africa, from 10 to 14 August 2009.

Affognon H. Disseminating research results on trypanocide resistance in West Africa: A method for identifying effective pathways. Paper presented at the 12th International Symposium of Veterinary Epidemiology and Economics, Durban, South Africa, from 10 to 14 August 2009.

2011

Affognon H. Difference in knowledge of trypanosomosis and its control between two main ethnic groups in Northern Benin: Case of Fulani and Batonou. Paper presented at the 31st Meeting of the International Scientific Council for Trypanosomiasis Research and Control on "Refocusing Research and Control of Tsetse and Trypanosomiasis: A Development Agenda", Bamako, Mali, from 12 to 16 September 2011.

ANNEX 8: *icipe* staff participation in journal reviews and editorial boards

Journal Title	No. of *icipe* Staff	Cluster/Unit
Acta Tropica	1	IPM Cluster
African Journal of Agricultural Research	3	IPM Cluster (2) and BCE Unit (1)
African Journal of Biotechnology	2	IPM Cluster
African Journal of Plant Sciences	3	IPM Cluster
American Journal of Tropical Medicine and Hygiene	1	IPM Cluster
Annales de la Société Entomologique de France	2	IPM Cluster
Annals of Applied Biology	1	IPM Cluster
Bio-organic and Medicinal Chemistry	1	BCE Unit
BioControl	1	IPM Cluster
Biocontrol Science and Technology	1	IPM Cluster
Biological Control	2	IPM Cluster
BMC Computational Biology	1	MBB Unit
Bulletin of Entomological Research	4	IPM Cluster (3) and BCE Unit (1)
Computers and Electronics in Agriculture	1	BCE Unit
Crop Protection	2	IPM Cluster
Current Zoology	1	BCE Unit
Entomologia Experimentalis et Applicata	3	IPM Cluster
European Journal of Entomology	2	IPM Cluster
Experimental and Applied Acarology	1	IPM Cluster
Experimental Parasitology	1	MBB Unit
Florida Entomologist	3	IPM Cluster (2) and BCE Unit (1)
Food Chain Journal	1	IPM Cluster
Genetica	1	IPM Cluster
Industrial Crops and Products	1	BCE Unit
International Journal of Pest Management	1	IPM Cluster
International Journal of Tropical Insect Science	7	IPM Cluster (5); BCE Unit (1) and MBB Unit (1)
Journal for Agriculture and Food Security	1	IPM Cluster
Journal of Agriculture and Biological Science	2	IPM Cluster
Journal of Agriculture and Food Chemistry	3	IPM Cluster (2) and BCE Unit (1)
Journal of Applied Entomology	5	IPM Cluster
Journal of Chemical Ecology	1	BCE Unit
Journal of Economic Entomology	1	IPM Cluster
Journal of Food Safety	1	BCE Unit

Journal Title	**No. of *icipe* Staff**	**Cluster/Unit**
Journal of Insect Behaviour	2	IPM Cluster
Journal of Insect Physiology	1	BCE Unit
Journal of Insect Science	2	IPM Cluster
Journal of Orthopteran Research	1	BCE Unit
Journal of Pest Science	1	IPM Cluster
Microbial Pathogenesis	1	IPM Cluster
Molecular Ecology Resources	1	MBB Unit
Mycopathologia	1	IPM Cluster
Naturwissenschaften	1	BCE Unit
Neotropical Entomology	1	IPM Cluster
Parasites and Vectors	1	MBB Unit
Pest Management Science	1	IPM Cluster
Pest Science	1	IPM Cluster
Physiological Entomology	2	IPM Cluster
Phytoparasitica	3	IPM Cluster
PLoS ONE	1	MBB Unit
PLoS Neglected Tropical Diseases	1	MBB Unit
Psyche	1	BCE Unit
Scientia Agricola	1	IPM Cluster
Scientia Horticulturae	1	IPM Cluster
Veterinary Parasitology	1	IPM Cluster

ANNEX 9: List of training materials produced by *icipe*

IPM cluster

PUSH-PULL
Flyers (in Kiswahili and English):

- Use Push-pull strategy and produce more maize by controlling stemborers and striga weed
- Farmers guide on planting a push–pull field
- Farmers' guide on planting a push–pull field using desmodium vines
- Use the climate-smart push–pull technology and produce more maize and sorghum by controlling stemborers and striga weed
- Mwongozo wa wakulima wa upandaji wa shamba la sukuma–vuta kwa kutumia marando ya desmodium
- Tumia mbinu ya sukuma–vuta ili upate mavuno mengi ya mahindi kwa kuzuia mabuu (funza) wa mabua pamoja na kiduha
- Tumia mbinu mpya ya sukuma-vuta yenye uwezo wa kupambana na mabadiliko ya hali ya hewa ili uzalishe mahindi na mtama zaidi kwa kudhibiti nondo na kiduha
- Tumia mbinu ya sukuma–vuta ili upate mavuno mengi ya mahindi kwa kuzuia mabuu (funza) wa mabua pamoja na kiduha

Booklets (in Kiswahili and English):

- A primer on planting and managing 'push-pull' fields for stemborer and striga control in maize—A step-by-step guide for farmers and extension staff
- Push-pull step-by-step primer - Swahili
- Planting for prosperity: Push–pull—a model for Africa's green revolution
- Impact assessment of push–pull technology developed and promoted by *icipe* and partners in eastern Africa

Books (in Kiswahili and English):

- Push-pull curriculum for farmer field schools
- Mtalaa wa sukuma-vuta kwa mafunzo ya wakulima shambani

Informational Comic Strips (in Kiswahili and English):

- Push-pull improving livelihoods
- Mfumo wa kilimo wa sukuma-vuta waimarisha hali ya maisha

Videos: A number of videos were also produced and are being used as technology dissemination tools. One of them has been broadcast on Swiss Television http://www.youtube.com/watch?feature=player_embedded&v=kBkawz0nq4Q

FRUIT FLIES, APHIDS AND PODBORERS
Manual:

- A field guide to the management of economically important tephritid fruit flies in Africa. Second edition.

Flyers:

- Fruit fly population monitoring
- Fruit fly control by field sanitation
- Fruit fly biological control with parasitoids
- Fruit fly biological control with biopesticides
- Fruit fly control with protein bait
- Fruit fly male annihilation

Teaching posters:
- Fruit fly – Life cycle and damage
- Fruit fly control – Simple as A, B, C, D…
- Fruit fly homemade trap – Make it yourself!

THRIPS PROJECT
Posters:
- Management of thrips and tospoviruses in vegetables in eastern Africa (English & Kiswahili)
- Diagnostic protocol for major vegetable *Liriomyza* leafminers in eastern Africa
- Field identification and management of *Liriomyza* leafminers in eastern Africa (English, Kiswahili, French and Somali)
- Major insect pests and diseases of tomato in East Africa and their management (French and Somali)

Identification and information tools:
- Identification and information tools for thrips of East Africa, CD-ROM, published by Centre for Biological Information Technology, University of Queensland, Australia.

Teaching material:
- Short course for the ARPPIS students on "Principles of Insect Pest Management".

LEAFMINER PROJECT
PowerPoint training material for plant inspectors:
- Management of leafminer flies
- Diagnostic protocol for invasive leafminer species

Factsheet:
- Development and implementation of an IPM programme for invasive leafminer flies in East Africa

Poster in English, Kiswahili and French:
- Field identification and management of *Liriomyza* leafminers in eastern Africa

Leaflet:
- Management of major vegetable leafminers in Kenya.

TECHNOLOGY TRANSFER
Posters:
- Management of thrips and tospoviruses in vegetables in eastern Africa (English and Kiswahili)
- Diagnostic protocol for major vegetable *Liriomyza* leafminers in eastern Africa
- Field identification and management of *Liriomyza* leafminers in eastern Africa (English, Kiswahili, French and Somali)
- Major insect pests and diseases of tomato in East Africa and their management (French and Somali)

Training curriculum:
- ToT IPM curriculum developed for the Sudan Productive Capacity Recovery Programme (SP-CRP) OSRO/SUD/623/MUL in October 2011
- Training manual for plant health inspectors and NZTT in Zambia in 2008

IVDM Cluster

ANIMAL HEALTH
- WHO book chapter
- Tsetse repellent control brochure

ACCES cluster

COMMERCIAL INSECTS PROGRAMME

- Brochures in vernacular languages on commercial insects
- Training manuals on organic certification and ICS training for Kenya, Ethiopia and Uganda
- Training manual on queen rearing and bee management
- Training manual on wild silk
- Training manual on mulberry silk

CHIESA

- Economic valuation of ecosystem services and goods manual
- Soil and water assessment tools (SWAT) model
- Introduction to geographic information systems manual
- R software course manual

BIOSYSTEMATICS

- African Insect Taxonomy Toolkit: a webportal for insect taxonomy in Africa, containing citations and links to websites relevant for the identification of insects and other arthropods. http://taxonomy.icipe.org
- BSU Basic Entomolgy course for ARPPIS and DRIP students at *icipe*
- A series of PPT files on various topics of entomology and information management

ANNEX 10: List of all products derived from *icipe* projects

IPM Cluster

- *Metarhizium anisopliae* isolate ICIPE 69, commercialised by Real IPM as Campaign™ biopesticide.
- *Metarhizium anisopliae* isolate commercialised as ICIPE 78, commercialised by Real IPM as Achieve™ biopesticide.
- Identification and information tools for thrips of East Africa, CD-ROM, published **by** Centre for Biological Information Technology, University of Queensland, Australia
- Dudulure (fruit flies protein bait yet to be commercialised).
- *icipe* yellow traps for fruit flies monitoring and suppression.

ACCES Cluster

- Silk (Mulberry and wild silk yarn and cloth)
- Honey based products (Honeybees and stingless bees)
- Royal jelly from honeybees
- Supply of queen bees
- Supply of mulberry silkworm eggs from three *icipe* races.
- Wax candles
- Bee venom
- Propolis
- Pollen
- Langstroth hives and newly developed *icipe* stingless bee hives
- Mozigone® – A mosquito repellent product
- Naturub® Balm (4, 7 and 25 gram products) – medicinal and insect bite relief product
- Naturub® ointment (15 and 30 gram products) – medicinal product
- Mondia Tonic® (15 and 50 gram products) – neutraceutical product.

ANNEX 11: Acronyms and abbreviations

4Hs	The 4 'healths'—human, plant, animal and environmental
AAT	African animal trypanosomosis
AAU	Association of African Universities
ACCES	Adaptation to Climate Change & Ecosystem Services
ACTS	African Centre for Technology Studies
ADOPT	Adaptation and Dissemination of the 'Push-Pull' Technology to Climate Change
AFAAS	African Forum for Agricultural Advisory Services
AGORA	Access to Global Online Research in Agriculture
AGRIS	International Information System for the Agricultural Sciences and Technology
ANAFE	The African Network for Agriculture, Agroforestry and Natural Resources Education
ARPPIS	African Regional Postgraduate Programme in Insect Science
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
AU-IBAR	African Union-InterAfrican Bureau for Animal Resources
BecA	Biosciences Eastern and Central Africa hub
BMGF	Bill and Melinda Gates Foundation
BMZ	Federal Ministry for Economic Cooperation and Development
BRICS	Brazil, Russia, India, China and South Africa (association of emerging national economies)
Bti	*Bacillus thuringiensis israelensis*
BvAT	Biovision Africa Trust
CAADP	Comprehensive Africa Agriculture Development Programme—a programme of the New Partnership for Africa's Development (NEPAD)
CABI	Commonwealth Agricultural Bureaux International (UK)
CBB	coffee berry borer
CB&ID	Capacity Building and Institutional Development programme
CGIAR	Consultative Group on International Agricultural Research
CHIESA	Climate Change Impacts on Ecosystem Services and Food Security in Eastern Africa
CIAT-TSBF	International Centre for Tropical Agriculutre-Tropical Soil Biology and Fertility Institute
CIP	Commercial Insects Programme

CIRAD	Centre de coopération internationale en recherche agronomique pour le développement (France)
CRL	Central Research Laboratory
CRP	CGIAR Research Programme
CORAF / WECARD	Conseil ouest et centre africain pour la recherche et le développement agricoles/West and Central African Council for Agricultural Research and Development
DAAD	German Academic Exchange Service
DALY	disability adjusted lives years
DBM	diamondback moth
DFID	Department for International Development (UK)
DLPO	District Livestock Production Officer
DRC	Democratic Republic of the Congo
DRIP	Dissertation Research Internship Programme
EID	Emerging Infectious Disease
EIARD WG	European Initiative for Agricultural Research and Development Working Group
EOA	Ecological Organic Agriculture
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
FARA	Forum for Agricultural Research in Africa
FCP	Farmer Communication Programme
GC	Governing Council
GIS	Geographic information system
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GTZ	Gesellschaft für Technische Zusammenarbeit (Germany)
HAT	human African trypanosomosis
HERD	higher education spending on R&D
HINARI	Health InterNetwork Access to Research Initiative
HORTI	Horticultural Research and Training Institute-Tengeru (Tanzania)
IAEA	International Atomic Energy Agency
IAASTD	International Assessment of Agricultural Science and Technology for Development
ICRAF	World Agroforestry Centre (Kenya)
IGAD	Intergovernmental Authority on Development

IITA	International Institute of Tropical Agriculture
ILRI	International Livestock Research Institute (Kenya)
IOBC/WPRS	International Organisation for Biological Control/West Palaearctic Region Section
IPER	*icipe* Periodic External Review
IPM	Integrated pest management
IRC	icipe Resource Centre
ISA	*icipe* Staff Association
ISS	Institute for Security Studies
IT	information technology
ITOC	*icipe* Thomas Odhiambo campus, Mbita Point
IVDM	Integrated Vector and Disease Management
JKUAT	Jomo Kenyatta University of Agriculture & Technology (Kenya)
KARI-TRC	Kenya Agricultural Research Institute-Trypanosomiasis Research Centre
KEBS	Kenya Bureau of Standards
KEMRI	Kenya Medical Research Institute
KEPHIS	Kenya Plant Health Inspectorate Service
KOAN	Kenya Organic Agriculture Network
KWS	Kenya Wildlife Service
LPNF	livestock protective net fence
LZARDI	Lake Zone Agricultural Research and Development Institute (Tanzania)
MDG	millennium development goal
MIT	Massachusetts Institute of Technology
MLND	maize lethal necrosis disease
MoU	memorandum of understanding
NARS	National agricultural research system
NEMA	National Environment Management Authority (Kenya)
NEPAD	New Partnership for Africa's Development
OARE	Online Access to Research in the Environment
OCD	Organisational Capacity Development project
OECD	Organisation of Economic Co-operation and Development
PANVAC	Panafrican Veterinary Vaccine Centre
PATTEC	Pan African Tsetse and Trypanosomosis Eradication Campaign

PP	Push–Pull
PPP	public–private–partnership
R&D	Research and development
RIU	Research-into-Use
RUFORUM	Regional Universities Forum for Capacity Building in Agriculture
RVF	Rift Valley fever
SGI	Sponsoring Group of *icipe*
SIDA	Swedish International Development Agency
SIT	sterile insect technique
SLU	Sveriges lantbruksuniversitet (Swedish University of Agricultural Sciences)
SSA	Sub-Saharan Africa
SSNC	Swedish Society for Nature Conservation
STEPS	Social, Technological and Environmental Pathways to Sustainability
STVS	Sheikh Technical Veterinary School (Somaliland)
TAHA	Tanzania Horticultural Association
THRiVE	Training of Health Researchers into Vocational Excellence in East Africa
TWAS	The World Academy of Sciences for the Advancement of Science in Developing Countries
UNEP GEO	United Nations Environment Programme (UNEP)–Global Environmental Outlook
UNSDSN	United Nations Sustainable Development Solutions Network
USAID	United States Agency for International Development
WBA	World Bioenergy Association
WHO	World Health Organisation

***icipe* – Working in Africa for Africa…**

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

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

Cover photos

Top left: EcoHoney, a product of participatory forest conservation in Tolay, Ethiopia.
Top right: Climate adapted push–pull field planted with sorghum.
Botton left: Farmers viewing the fruit fly augmentorium at Visiga, Tanzania.
Botton right: Cow with innovative tsetse repellent collar.

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