Text Box 1: Tsetse repellent technology—A science-led innovation changing the livelihoods of poor livestock keepers in Africa

- Two potent repellents — synthetic and waterbuck repellent blend — identified
- Repellent collars developed which when fitted around the neck of cattle protect them from tsetse and other biting flies
- Impact of repellent technology includes:
  - ✓ Disease incidence reduced by >90%
  - ✓ Drug use reduced by >90%
  - ✓ Farmers able to graze their animals anywhere, including in tsetse infested areas
  - ✓ Significant increase in weight of animals
  - ✓ Protected bulls plough 2–3x more land daily
  - ✓ Animals are being sold at 2–3x of previous price
  - ✓ Milk yield has gone up 2x even though lactating cows are indigenous
  - ✓ High demand for the technology, as many farmers are demanding to be included in the trials.

These new data on chemosensory genes, and analysis of their functions, could lead to novel attractants and repellents, and improvements to existing tools that depend on sensory behaviour of tsetse flies.

Development of animal health packages

icipe scientists, together with partners in Europe, are developing site-specific animal health packages for improving the productivity of livestock. These packages aim to reduce vector and disease burden, and enhance milk production in Kenya. The impact of the packages for protecting cows in zero-grazing units is shown in text box 2.

Improving health of camels

Camels are the most sustainable agricultural resource for nomads and pastoralists in the arid and semiarid (ASALs) parts of Africa, where low agricultural productivity (often exacerbated by drought), is a major constraint to development. Although camels are well adapted to life in dry areas, a number of diseases affect their health and productivity, the most important being a vector-borne disease known as 'surra' (camel trypanosomosis) that is caused by a protozoan, *Trypanosoma evansi*, and is transmitted by biting flies (tabanids and *Stomoxys* flies). Surra is a debilitating disease and a major cause of morbidity and mortality in camels, and novel approaches to vector control and disease management need to be developed, because of its wide geographical range and massive

Text Box 2: Innovative animal health packages for zero-grazing dairy enterprises with Livestock Protective Fence (LPF) as an essential component

- A reduction in biting fly numbers by more than 90% annually
- A reduction in mastitis cases by >50% in LPF protected units, and by about 40% in waste protected units
- Reduction in mosquito catches by nearly 85% in LPF protected units and by >90% in waste protected units, as a result of which farmers are reporting reduction in malaria cases in households next to the protected units or waste pits
- Increase in milk production by 2–3x
- Cows are calmer, feed better, and are easier to milk in protected units due to reduction in biting fly numbers
- Within a year 20% farmers have invested in better breeds of animals.

impact on productivity of camels. *icipe,* with funding from the European Union, will investigate how biting flies interact with each other, their environment, and hosts and non-hosts, and use this knowledge to develop improved control strategies for these vectors of surra. The objective will be to develop an effective attract-and-repel management system for control and monitoring of the vectors of surra, along the lines developed by *icipe* for the vectors of trypanosomosis.

icipe's technologies impact the livelihoods of livestock keepers in Africa

Through its research on livestock disease vectors, *icipe* has been able to build capacity ranging from strategic and adaptive research, to technology development and transfer via strategic partnerships with government departments, research institutions and community-based organisations.

The Centre has also been able to develop expertise in quantitative vector ecology, behavioural and chemical ecology, and biocontrol, and integrate this knowledge in developing technologies that farmers can use.

In the process, *icipe* has gained considerable experience in mobilising communities, and in empowering and organising them for undertaking tsetse and trypanosomosis control in different agroecosystems and animal husbandry practices.

***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 that are effective, selective, non-polluting, non-resistance inducing, and which are affordable to resource-limited rural and urban communities. *icipe*'s mandate further extends to the conservation and utilisation of the rich insect biodiversity found in Africa.

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icipe's technologies have improved the livelihoods of communities from eastern to southern Africa wherever savanna tsetse are found.

COVER PHOTOS

Top left: A herdsboy with his healthy cattle protected by *icipe*'s anti-tsetse technology.

Top right: Protecting high-grade cows from biting flies increases their productivity and milk yields.

Bottom left: Improving the health of camels increases their productivity.

Bottom right: A NGU trap, one of the various technologies that *icipe* has developed for the control of savanna tsetse.

DONORS: EU, IFAD

COLLABORATORS: KIRDI, Kenya Agricultural and Livestock Research Institue (KALRO), FAO, WHO, PATTEC, AU-IBAR, EAFF, KWS, Yale School of Public Health, South African National Bioinformatics Institute.

Photos: icipe

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Healthy Livestock, Healthy People

Tackling Tsetse Disease Vectors in Africa

icipe
African Insect Science for Food and Health

In Africa, livestock are vital to food security, and over two-thirds of the population is dependent on them for their everyday survival. If livestock are lost, households can slip into chronic poverty traps. Most livestock are raised on small farms or herded by pastoralists. Improvement of livestock health and productivity, therefore, provides a significant opportunity to improve the livelihoods of these people and to help them escape the poverty cycle. It is also important to improve livestock productivity to meet the increased demand for livestock products, and to enhance traction power of oxen for improved agricultural productivity.

For over four decades, improving the health of African livestock has been one of *icipe*'s core activities. The Centre's research focuses on the development of integrated strategies and tools to control livestock disease vectors, especially blood-feeding insects that transmit debilitating or fatal diseases in livestock.

Evicting Africa's unwanted tenants

Tsetse flies, a true African menace found only on this continent, are deadly, bloodsucking flies that carry the trypanosome parasite that causes human African trypanosomiasis (HAT) (also known as sleeping sickness), and the livestock disease, nagana. An estimated 70 million people, distributed over a surface area of 1.55 million km^2, are at risk for contracting sleeping sickness in Africa every year. Recent trends, however, indicate a figure of less than 10,000 cases annually; and these numbers are declining.

Left: By improving the health and productivity of livestock through disease and vector control, the livelihoods of farming communities can be improved; consequently, improved food security will give these children a better future.

Top: Tsetse flies cause the dreaded human sleeping sickness, and *Glossina fuscipes fuscipes*, a riverine tsetse is one of the major vectors of the disease. Unfortunately, livestock are also reservoirs for human diseases such as sleeping sickness. (Photo courtesy of Georg Georgen, IITA).

Bottom: Nature has her own defences against pests and diseases, and tsetse flies avoid certain animals such as the waterbuck; however, *icipe* scientists have identified potent repellents from the waterbuck that reduce tsetse bites by >90%.

African animal trypanosomosis (AAT) continues to be a major problem with over 3 million deaths in cattle each year. The combined effects of tsetse and its transmitted diseases affect crop production and land use in Africa. The flies are one of the main reasons why 80% of the continent's land is still tilled by hand, as in the absence of draught power a farmer is obliged to plough the land manually. Few livestock also implies less availability of manure for organic fertiliser, leading to lower yields of crops and fodder plants. It is estimated that monetary losses resulting from trypanosomosis are US$ 5.0 billion a year for the African economy.

Fear of contracting sleeping sickness makes farmers avoid tsetse-infested areas, which range from the savannas to the dense, riverine forests. As a result, much of Africa's fertile landscape is lying uninhabited and unused, making it a 'green desert'.

Control of tsetse with synthetic insecticides over vast regions is impossible and re-invasion remains a major problem. Frequent application of drugs for the treatment of nagana is leading to ever-increasing problems with resistance in trypanosomes. *icipe*'s goal, therefore, is to develop integrated and environmentally friendly strategies that are based on a sound understanding of the flies' biology, behaviour, and ecology, as well as tsetse–trypanosome and tsetse–host relationships.

Top: Communities can be empowered to make and deploy *icipe*'s NGU trap to reduce savanna fly populations by 99%.

Bottom: A cow fitted with a repellent collar. *icipe* scientists have also identified potent synthetic repellents that are being used to develop collars to protect cattle. This mobile technology of *icipe* keeps both cattle and herdsmen safe from tsetse and other biting flies.

Left: Photo of tsetse fly courtesy of Geoff Attardo, Yale School of Public Health, USA.

Right: Bulls protected by repellent collars plough 2–3x more land daily, thus increasing land under cultivation and improving food security of smallholder livestock keepers.

Laying a trap...

Over the years, *icipe* has developed various technologies for tsetse control, including the NGU series of traps, named after Nguruman, an *icipe* field station in Kenya. The NGU traps are made of several pieces of coloured cloth: blue is used to visually attract the flies, after which they land on the black target and are then, while trying to escape, caught at the top of the trap into a plastic cage where the heat of the sun kills them. Use of volatile odour baits; for instance, cattle urine and acetone (the latter present in the breath of cattle) enhance the effectiveness of the traps, and attract the flies from far away. Many countries have used the NGU traps for control of savanna species of tsetse.

Tsetse flies collared

Despite their effectiveness, NGU traps are not ideal for pastoralists like the Maasai of eastern Africa. For them, a 'mobile' technology would better suit their way of life. Therefore, *icipe* discovered a ground-breaking tsetse control innovation based on repellent collars, which is not only tailored for pastoralist communities, but is also becoming popular with sedentary livestock keepers.

Repellents have been identified from odours of animals that tsetse avoid, such as the waterbuck, a big antelope species that is common in tsetse-infested areas of eastern Africa, which the flies rarely feed on. *icipe* scientists have also identified potent synthetic repellents through molecular

optimisation of natural repellents found in the urine of cattle.

Results...

Collars and traps can be used together in a 'push–pull' system. The repellent collars 'push' away the flies from the cattle, while the black and blue traps, with the aid of the odour baits, 'pull' them into the killing containers, and thus suppress fly populations. This combined 'push–pull' strategy can reduce fly numbers and disease prevalence levels, and is popular among the Maasai and coastal communities in Kenya. *icipe* is now working with the private sector to optimise the repellent technology, and ensure that it is readily available to other tsetse affected countries. Impact of the repellent technology is shown in text box 1.

Tsetse genome decoded

icipe scientists were part of the team composed of 146 scientists from 78 research institutes across 18 countries that sequenced the full genome of the tsetse fly (*Glossina morsitans morsitans*), which was recently published in *Science* (*Science* 344.6182; 2014). Since then, genome data for five other species have been obtained, providing resources for all three sub-genera of tsetse flies (Savannah, Forest and Riverine). These data provide us with a unique opportunity to transform tsetse research and disease control practices using new knowledge from genomics.

Our focus at *icipe* is on the chemosensory machinery that enables tsetse flies to sense their environment, and to respond to food sources, mates, resting sites, predators, and other sources of stimuli.

We now know that:

- Tsetse have fewer chemosensory genes than other dipteran disease vectors, such as mosquitoes. This is due to the obligate blood feeding, with a reduced need to respond to odours from plants.
- Tsetse flies have lost receptors for sensing sugars.
- There is an expansion of receptors for CO_2.
- There is an expansion of genes involved in detecting pheromones, hence increasing success in breeding, considering also that tsetse flies mate only once.