



icipe

African Insect Science for Food and Health

Stories of our Success:

positive outcomes from push-pull farming systems



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Karen Brock of Green Ink, under the direction of Dr Zeyaur Khan, carried out the fieldwork for ‘Stories of our Success’ and wrote the report. She was guided and supported in every way by *icipe* field technicians Aloice Ndiege and Dickens Nyagol. Editing, design and layout were completed by other members of the Green Ink team.

We would like to thank all the farmers who gave up their valuable time to be interviewed for this report.

Dedication

This publication is dedicated to the founding Director General of *icipe*, the late Professor Thomas R. Odhiambo, and to the many farmers across East Africa who are using push–pull to make positive changes in their lives.

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Foreword

The year 2015 will be a watershed year for international development. The Millennium Development Goals (MDGs) will expire and be replaced with a new agenda. This is a time both for reflection on what has been achieved in the struggle to eradicate poverty and hunger and to strategize about the challenges that lie ahead.

This report, which examines the positive outcomes from push–pull farming systems in East Africa, has much to offer current debates. It tells the story of how scientists at *icipe*, the International Centre of Insect Physiology and Ecology, have worked with farmers, NGOs and extensionists to develop and implement a platform technology that addresses some of the main constraints to cereal production in smallholder mixed farming systems in East Africa and beyond. To date, push–pull has been adopted by more than 68,000 farmers in Kenya, Ethiopia, Tanzania and Uganda.

The success stories that farmers tell about their experiences with push–pull reveal not only the direct benefits of the technology – substantial yield increases, improvements in soil fertility and control of stemborers and the parasitic striga weed – but also how these benefits translate into a wide-ranging set of positive development outcomes. These include improved food security and reduced income poverty, which contribute directly to meeting MDG 1: eradicating extreme poverty and hunger. Other benefits include significant contributions to universal primary education, promoting gender equality and ensuring environmental sustainability, thus addressing MDGs 2, 3 and 7 respectively.

Looking ahead and beyond the MDGs, work has already begun to develop a set of Sustainable Development Goals (SDGs). The post-2015 approach is likely to be framed by the necessity of integrating the economic, social and environmental aspects of sustainability. The need for development pathways that respect ecological limits and restore ecosystem health whilst maintaining productivity has never been greater; neither has the need for adaptive agricultural practices that can cope with increasingly variable climatic conditions and still produce food for people and livestock.

Our experiences with push–pull offer important lessons about developing and implementing the kinds of technologies that are needed to meet these challenging goals. Through narrating the evolution and spread of an integrated, adaptable cropping practice – that fits in well with farmers and addresses their problems – and that has transformed livelihoods and agricultural sustainability, this report highlights the paramount importance of strong partnerships between farmers, scientists and international development organizations. Above all, it demonstrates that the possibility of improving the lives of subsistence farmers and, at the same time, reducing damage to ecosystems is both real and attainable.



Professor Christian Borgemeister
Director General, International Centre of Insect Physiology and Ecology
July 2013

From food poverty to food security



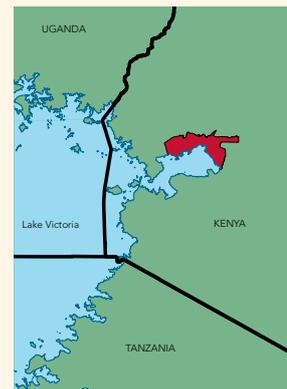
Name: Vitalis Ayara

Location: Kisumu West, Kenya

Age: 51

Farm: Two acres of maize, sorghum, sweet potato, cassava, beans and cowpeas

Household size: 11 – Vitalis, his wife and nine children, including three orphans



Ten years ago, producing maize on Vitalis Ayara's small farm in the densely populated, hilly landscape of Kisumu West was an uphill struggle in every way imaginable. Despite investing many days in weeding every season, the invasive, parasitic weed striga always robbed the growing crop of nutrients. At the other end of the plant, stemborer larvae chewed out the heart of the stems, weakening it further. In the end, says Vitalis, "the maize could not grow and give good production".

With barely enough maize to feed his family and none left over to sell, Vitalis had no alternative but to search for casual labour on other farms. Several of his children could not go to school because there was no money to pay for the books and uniforms they needed. The family often went hungry.

In 2006, Vitalis learned of push-pull, an innovative technology in which maize is grown with two fodder species, silverleaf desmodium as an intercrop and Napier grass as a border crop, in a way that raises yields by tackling striga, stemborer and soil fertility.

In 2007, he planted a 15 x 20 metre push-pull plot on his farm and has continued cultivating maize and

beans on it ever since. At the end of the first season, he harvested twice the usual amount of maize from the plot; by the end of the second season, his harvest had gone up again.

Three years after planting the first plot, Vitalis had saved enough money to buy a local breed cow. She is tethered and fed on desmodium and Napier, and has provided the family with a modest amount of milk to consume and sell, as well as two heifer calves. Her manure is used to fertilize the farm's soil.

At the start of the long rainy season in 2013, Vitalis planted a second, larger push-pull plot, using two new drought-resistant companion plants, greenleaf desmodium and Brachiaria grass. "Maize from the push-pull plots," he says, "is very clean and neat, and there is no insect or disease."

This family has carefully walked a tightrope between hunger and a decent harvest for many years. Today, the outputs from their push-pull plots – reliable, adequate crops of maize, beans and fodder – make the difference between food poverty and food security. "In the past," says Vitalis, "I was dull and I had to beg. But nowadays, I can get what I need from my farm."

Vitalis and his wife proudly showing off their two push-pull plots



Introduction to push-pull: “One stone to kill many birds”

Across the eastern half of Africa’s Lake Victoria region, thousands of farmers like Vitalis Ayara have found that using push-pull technology to deal with the triple menace of striga, stemborer and poor soil fertility is making a big difference to their lives. For them, the opportunity to reverse many years of declining maize yields is triggering an interlinked set of changes that has helped many to break out of the downward spiral of poverty and hunger.

For the millions of women, men and children in this region who rely on farming to give them everything they need, life is often hard. Many have very small farms, often made up of a patchwork of fragmented plots, where they grow a mixture of cereals and roots, vegetables and fruit. Most also keep livestock, ranging from a few free-range local chickens to hybrid dairy animals in small zero-grazing units. Growing enough to eat, and generating enough of a surplus to pay for education, healthcare and clothing, is a constant balancing act.

In the last two decades, widespread contextual changes have had a profound impact on farmers, their families and the natural resources that sustain their livelihoods. High HIV prevalence means many more labour-poor households, often headed by widows or grandparents. Increasingly variable rainfall demands constant vigilance to timely planting of a crop mix chosen to maximize chances of a good harvest. Changing patterns of crop and livestock



The parasitic weed Striga hermonthica attaches itself to the roots of the maize plant, robbing it of nourishment.



The larvae of several species of stemborer moth feed first on the leaves of the maize plant, before going on to bore into the stem.

pests and diseases, combined with soil fertility loss and erosion, make it hard to get even a basically reliable yield without spending precious money on costly inputs.

Push-pull is an established intercrop technology for dealing with striga and stemborer that results in increased cereal yields. The technology now has a firm foothold in western Kenya, where uptake continues to rise, and is steadily widening its spread in neighbouring regions of Ethiopia, Tanzania and Uganda. It has succeeded because it reliably solves two problems, at the same time as bringing with it a range of related benefits. It is “one stone to kill many birds”. In different places, for different people, push-pull has:

- helped farmers to adapt to climate change and supported better use of natural resources
- improved nutrition for people and livestock, contributing to better health
- supported the education and enhanced the knowledge of both children and adults
- improved food security and strengthened social safety nets
- alleviated income poverty.

Push-pull has changed many lives. By learning what is behind the success stories of some of the farmers who have adopted it, this report aims to pave the way for the future adaptation and spread of this innovative technology.

What is push-pull?

Push-pull is a novel technology developed by *icipe* and partners for the integrated management of insect pests, weeds and soil fertility in cereal-based farming systems. It involves attracting cereal stemborers with trap plants like Napier grass (the 'pull') while, at the same time, driving them away from the main crop using a repellent intercrop like desmodium (the 'push'). Chemicals released by the desmodium roots control parasitic striga weeds by inducing 'suicidal germination' – preventing the emerging striga from attaching to the cereal roots.

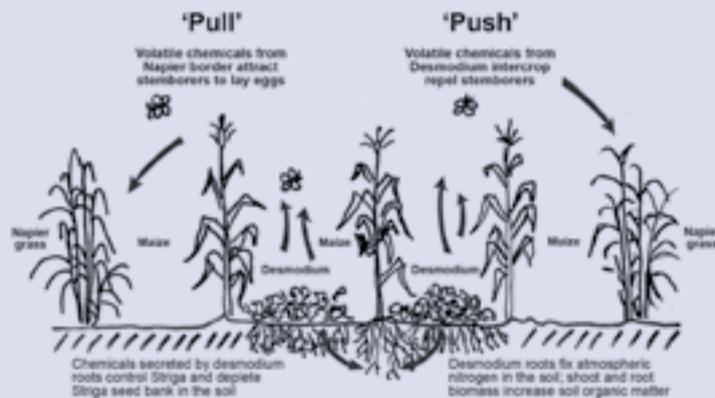
Both Napier grass and desmodium provide high-value animal fodder, boosting milk production when fed to dairy animals. Furthermore, desmodium enhances soil fertility by fixing nitrogen and it acts as a cover crop to retain soil moisture. The technology improves gender equity, diversifies farmers' income sources and is appropriate

and economic as it is based on locally available plants. As such, it fits well with the traditional mixed cropping systems practised in Africa.

Rising uncertainties in Africa's rain-fed agriculture due to its vulnerability to climate change prompted the *icipe* team to adapt the technology to hotter and drier conditions. They have identified and incorporated a drought-tolerant trap plant – *Brachiaria* grass – and a repellent intercrop – greenleaf desmodium.

The new companion plants have the same beneficial chemistry, and environmental and economic benefits, as those in the conventional push-pull system. Known as 'climate-smart' push-pull, the technology thus ensures that the novel push-pull approach will continue to perform effectively over the longer term.

See www.push-pull.net for more information.



Conventional push-pull uses silverleaf desmodium (*Desmodium uncinatum*) as the 'push' plant and Napier grass (*Pennisetum purpureum*) as the 'pull' plant.



Climate-smart push-pull was developed in 2011 and uses two drought-tolerant species. Greenleaf desmodium (*Desmodium intortum*) is the 'push' plant and *Brachiaria* grass (*Brachiaria cv Mulato II*), also known as 'Mulato', is the 'pull' plant.

1. Push–pull: an adaptive technology evolves

From insect science to habitat management

In 1993, Dr Zeyaur Khan, an experienced agricultural entomologist, arrived in Kenya to take up his new appointment at Mbita Point, at the Thomas Odhiambo Campus of the International Centre of Insect Physiology and Ecology (*icipe*). “In my very first meeting with then Director General Professor Odhiambo,” he recalls, “he asked me to develop a funding proposal on a subject that was very different from my training in plant resistance to insect pests”.

Professor Odhiambo, deeply committed to providing African solutions to African problems, asked Khan to find out where the stemborers go when the maize is harvested, and how they come back when the new crop is planted. This simple question set Khan on a path that eventually led to many thousands of farmers incorporating push–pull, a sustainable habitat management strategy for pest control, into their farming systems.

Having successfully secured funding from the UK’s Gatsby Charitable Foundation, and established a partnership with scientists at Rothamsted Research which still remains strong two decades later, Khan began to examine the relationships between wild and cultivated grasses and stemborers. More than 500 grasses all over East Africa were surveyed and those that were more attractive to stemborers were selected to bring to the grass nursery at Mbita Point. “This was the time,” says Khan, “when I found out that some of the grasses – including Napier – were highly attractive for stemborer egg-laying, but that most of the larvae did not mature. That was a very big achievement, because finding a grass that is highly attractive to the insect but doesn’t support its development is what makes a good trap plant to help farmers reduce their pest population”.

The idea of using trap plants in pest management – the ‘pull’ element of push–pull – was not new. But the challenge that faced Khan and his team was how to translate his discovery into a practice that farmers would be prepared to use. “At this point,” he reflects, “I did not have much experience of engaging directly with farmers. But I thought, if I am going forward with something, I must have feedback.” Khan’s first discussions with farmers about which of the stemborer trap grasses would be most useful to them laid the foundations for nearly two decades of farmer involvement in the development and adaptation of push–pull.

The discovery and selection of Napier grass as a suitable stemborer trap plant was followed by more scientific research to identify a suitable repellent plant. This resulted in the first version of a push–pull system, which used stemborer-repellent Molasses grass as the intercrop. This pioneering push–pull



Still listening to farmers after 20 years: Zeyaur Khan and *icipe* technician Dickens Nyagol listen to farmer Remjius Bwana’s push–pull success story.



Joseph Omolo's crossbreed goat thrives on its desmodium diet.

system became quite popular in Trans Nzoia district, where there was no striga. "But," Khan recalls, "when we brought the technology to farmers in Mbita district, they planted maize, and although we were able to control the stemborer, the striga had already killed the plant".

From the research into stemborer-repellent plants, Khan already knew that some legumes produced the right chemicals to push the moths away. In the back of his mind he was also aware that, in some places, legume-cereal rotations had been able to reduce striga. By chance, in a Nairobi seed shop, Khan saw desmodium on the shelf. "I didn't know it," he recalls, "and I asked the shopkeeper what it was. He said it was a fodder legume which farmers keep on cutting to give to their animals in a zero-grazing system. So I bought a kilo of seed, just for curiosity, brought it to Mbita Point, and planted it between the maize rows. While taking observations on the stemborer populations in different plots, we found that, not only was the stemborer population reduced where the desmodium was planted, but also there was no striga. I said maybe it is a coincidence, so we planted again. And we came up with the same results."

Realising at once the importance of this discovery, Khan reported it to the Gatsby Foundation, who immediately provided funds to further develop the technology and extend it to farmers as an effective way of controlling striga and stemborer. In 1998, the push-pull garden at Mbita Point was

planted, the first of many demonstration plots, and work began in earnest to share push-pull technology with farmers and learn about how it functioned in practice at a larger scale.

Benefits for soil and livestock

The discovery of the striga and stemborer control qualities of desmodium and Napier grass had immediate implications for the technology's attractiveness for farmers. But the positive contribution that the push-pull plants make to soil fertility and livestock nutrition also render the technology particularly useful for those who, like the majority of the region's farmers, raise crops and livestock together.

Desmodium has a positive impact on soil fertility. As a legume, it 'fixes' part of the nitrogen it needs from the atmosphere, making this available to other plants. Its trailing habit conserves soil moisture and helps prevent erosion, and its leaves contribute organic matter to the soil.

As well as the positive impact it has on soil fertility, desmodium is palatable to many livestock, including poultry, and it contains protein, which is particularly beneficial for milk-producing animals. Growing desmodium alongside a fodder grass in a push-pull system means that farmers can use the same plot to grow cereals for their household and feed for their livestock. Using cut-and-carry fodder, rather than taking animals out to graze on common land, is conducive to collecting and using farmyard manure as fertilizer. Rather than exporting vital nutrients from the cropping system, this practice



Most push-pull farmers notice an improvement in their soil within a very short time.

encourages the nutrient cycling that is a feature of stable and resilient agro-ecosystems.

As the implications of the technology for integrated crop–livestock systems became clearer, a zero-grazing dairy unit was added to the push–pull garden at Mbita to demonstrate good practices in fodder processing and use, milk production, and farmyard manure and composting techniques. Push–pull’s compatibility with integrated crop–livestock systems was to prove a vital aspect in extending the technology to farmers and establishing partnerships with other implementing organizations.

Sharing the discovery – knowledge, seeds and farmers

In Kenya’s Homa Bay district, *icipe* field worker Patroba Obonyo works with 25 groups of farmers. At the start of every season, he carries out a push–pull planting demonstration for each group. “Every farmer is welcome,” he says, going on to explain that mobilization for the demonstrations is all done by the group members themselves. Patroba continues visiting groups and individuals throughout the season, providing seeds when plots have been correctly prepared, and advice and further training on different aspects of the technology. He and many others like him are at the front line of an interconnected set of social and institutional networks that link farmers



Field worker Philip Andanje, travelling by bicycle, visits about 300 farmers in Kenya’s Butere district every season.

and their families to extension workers, development partners and scientists in the effective dissemination of push–pull.

Push–pull is a knowledge-intensive technology. It functions most effectively when farmers understand clearly why it works, and what each component in the system contributes to its overall success. “Push–pull is not built upon seed technology,” observes Khan, “it is built on knowledge and management.” As well as being knowledge-intensive, push–pull is also farmer-centred. Jimmy Pittchar, *icipe*’s senior social scientist, explains that “the biggest resource in the system is the farmers: what they do, how they do it, and what their aspirations are”.

Extending push–pull therefore required a farmer-centred approach to knowledge sharing. This has involved creating a widespread demand for the technology, and then fulfilling it with training and seed distribution. Extension efforts began with two groups of ten farmers in Suba and Trans Nzoia districts in 1997. By mid-2013, over 68,000 farmers in three countries had adopted push–pull. Case Study 1 traces these efforts through the story of a family in Kenya’s Suba district.

From the outset, demonstration plots have been used as a basic tool for both education and inclusion. They offer a place to share with farmers all the information needed to plant and maintain a push–pull plot throughout its seasonal cycle, and a space to include the farmers in the development and wider spread of the technology. Providing tangible evidence of the success of push–pull, a mobilization point for interested farmers and an open-air classroom for those who want to learn more, demonstration plots now exist not only on individual farms but also on collectively cultivated group plots, and in the gardens of churches and schools. As well as being used by extension field workers and farmer-teachers, they have also become a focal point for public events like field days that promote push–pull and raise its profile in different localities.

Many farmers have taken it upon themselves to ensure that their own push–pull plots have a visible presence at the community level. Many are deliberately sited next to roads, where their unusual appearance and noticeably healthier crops provoke comment and discussion. Other locations include a busy short-cut between two roads, a shady sitting-place adjacent to a large well where neighbours come to collect water and beside the toilet hut near a busy bus stop.

Keeping push-pull in the family



Name: Rispa Ouso

Location: Suba, Kenya

Age: 55

Farm: Six acres of maize, millet, beans, groundnuts and vegetables

Household size: 11 – Rispa, seven children and three grandchildren



“Two farmers from Rispa’s village were in the very first group of ten farmers to get push-pull in Suba district,” recalls Aloice Ndiege, an *icipi* field technician who has been disseminating the technology for 15 years. “When those farmers were given a chance to explain their experiences at a chief’s meeting, Rispa was convinced, and in 1998 I helped her plant her first push-pull plot.” After working the plot of conventional push-pull with maize for four seasons and seeing a steadily increasing yield and a reduced need for labour, Rispa planted a second plot, this time with sorghum. Two more push-pull maize plots followed, in 2003 and 2006.

During these years, she was closely watched and assisted by her fourth-born child, Frank, whose interest in what she was doing led him to study for a Certificate in General Agriculture when he left school. Surplus maize from the push-pull plots helped to pay for his higher education.

In 2005, Rispa was elected by other push-pull farmers to become a farmer-teacher, organizing field days and

advising other farmers. “Rispa is a natural mobilizer,” says Aloice, “and a woman for the people. She accepts everybody, irrespective of social status – and that is why people selected her. Whether you are young, old, rich, poor – she will take you to be the same.”

In the same year that Rispa became a farmer-teacher, Frank, having completed his studies, joined *icipi* as a field worker. Eventually posted to Nyando district, where he now works with about 250 push-pull farmers, Frank is very clear about what motivates his work. “We need to eradicate striga,” he says, “so there’ll be an increase in food production. I am part of getting rid of striga. The best part of my job is meeting new groups, because we are inspiring them to change the way they do their farming.”

Rispa, meanwhile, now has less time to participate formally in push-pull dissemination. Her activities as a farmer-teacher gave her the confidence to train as a community health worker. But, she says, “a community needs health and wealth,” and so she has not stopped spreading the word about push-pull.

“I enjoy meeting farmers,” says Frank Ouso, “and I have many friends.” Here, he and farmer Melenia Otieno discuss drought stress in her maize crop.



Beyond the community level, establishing a regional and national media presence for push-pull, particularly in Kenya, has been an important part of sharing information about the technology and creating demand for it. A push-pull storyline featured in a farming-based soap opera on national radio, 'Tembea na majira', a Swahili term meaning 'keep up with current trends'. Push-pull farmers, field workers and technicians have made several appearances on 'Shamba Shape-Up', a national TV programme broadcast in English and Swahili every weekend. Frequent appearances in the print media have been boosted by push-pull's association with high-profile 'ambassadors', like Mama Sarah Obama, grandmother to the President of the USA.

Over time, these diverse efforts at raising awareness have created an increasing demand for training, seed distribution and support. Technicians and field workers from *icipe* have given countless introductory training sessions to farmer groups. They often carry out training that includes local farmer-teachers, who go on to give trainees encouragement and technical assistance in establishing push-pull plots. The uptake of the technology is rooted in farmer-to-farmer peer support relationships.

Training sessions have also been provided to the staff of other organizations. A hallmark of the successful spread of push-pull has been *icipe*'s capacity to identify and work in harmony with the groups and organizations it meets on the ground – whether local self-help groups, research institutes, government departments, development organizations or large international non-governmental organizations (NGOs). Exploiting



Joshua Owino, an *icipe* field technician, demonstrates push-pull practices to the Nyota Farmers' Group in Awendo district as part of their training in organic agriculture.



Godfrey Sagwe points to the sign in front of his push-pull plot in Roria district, Tanzania. He explains that the toilet hut behind him means the path sees a lot of traffic, and many passers-by have asked about push-pull.

synergies with other organizations already active in the region has created new channels for sharing knowledge about push-pull.

In Kenya's Bungoma district, for example, push-pull extension has become entwined with an existing network of farmer field schools, the first four of which were established in 1997 by government extension officials. In 2005, *icipe* trained several participating groups of farmers in push-pull, and 20 of them went on to become farmer-teachers. In 2007, *icipe* worked with farmers, extension education experts, farmer field school experts, government extension staff and scientists to develop a curriculum for farmer field schools, which every student now follows. There are now farmer groups in the network, and more than 7000 field school graduates; of these, most have adopted the technology.

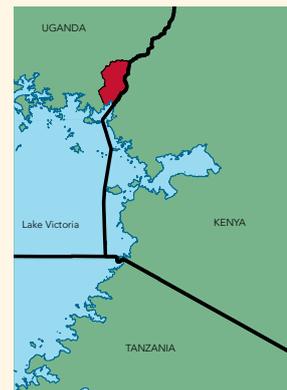
During the early years of disseminating push-pull, first in Kenya and then in Uganda, evolving partnerships with existing development organizations provided *icipe* with crucial opportunities to ensure wide uptake of the technology. Particularly important in Kenya and Tanzania has been the partnership with Heifer International, an NGO whose work distributing livestock and building capacity for livestock management has proved to be a good fit with push-pull. Many other partners on the ground have been important too. In Uganda, as Case Study 2 illustrates, building partnerships with government initiatives has been pivotal in spreading push-pull to farmers.

As well as building partnerships with other institutions, *icipe* has worked hard to engage with the farmers themselves and with the grassroots system of local groups that is a characteristic of the social life

Collaborating with government initiatives in Uganda



Name: Annette Taaka
Location: Busia, Uganda
Age: 43
Farm: Three acres of maize, millet, groundnuts, beans and sesame
Household size: 10 – Annette and nine children, including four orphans



“The unique challenge of disseminating push-pull in Uganda,” says *icipe* technician Romanus Odhiambo, “is the lack of awareness of the technology. A lot of education work is needed.” In this decentralized republic, working with existing agricultural development initiatives to reach farmers means collaborating with government structures, from the village council to various ministries in the capital city.

Five years ago, visitors from Kampala came to Annette Taaka’s local government headquarters to talk to local groups. As a member of the Busitema Culture group, Annette went to meet them, and heard about push-pull for the first time.

The visitors had come from the Poverty Alleviation Department (PAD) of the Office of the President of Uganda, which selected Syanyonia parish, Busia district, to become part of their national programme of 27 model parishes. The programme provides resources – including tools, improved seeds and purebred livestock – to groups in each parish, to demonstrate how a high concentration of projects can be used to tackle poverty and speed up rural transformation.

PAD field officer Rose Nasirumbi says that she became aware of *icipe* technical staff “when our paths crossed in the field. We got interested in each other and began to coordinate. Now there is a formal agreement, signed in Kampala.”

The results of that crossing of paths can be seen on Annette’s farm. The black-and-white dairy cow tethered in a stall eating Napier grass came from PAD in 2009, the same year that Annette sowed her first push-pull plot with maize. “They saw I was doing well with my goats,” says Annette, “and that I was already managing to keep local cows – so I was selected for this dairy cow too.”

The following year, Annette planted a second, larger push-pull plot on a part of her farm where the soil was better. Higher fodder yields meant the cow could eat more desmodium and Napier, and the amount of milk she gave nearly doubled.

Annette has been a widow for nearly 20 years. “I have struggled,” she says, “but push-pull has improved my life. I sell maize, I sell milk, I pay school fees – and even after that I have enough for the family to eat.”



Annette chops large quantities of Napier grass for her animals every day.



Nowadays, Annette’s cow gives nearly 20 litres of milk a day. Annette keeps three litres for the children and sells the rest.

of this region. Groups provide an indigenous way of organizing for mutual support and self-help, and are a well-established medium for delivering agricultural extension and other development interventions.

“Social cohesion,” points out Jimmy Pittchar, “is a very important aspect of *icipe*’s work.” Adapting to existing organizational structures and building strong partnerships based on mutual trust and the exchange of knowledge and information was a key element in the successful initial spread of push-pull. It was also to be integral in the successful development and extension of the next iteration of the technology.

Adapting to change

As the steady spread of push-pull began to gain momentum, farmers implementing the technology encountered several problems. Strong communication linkages between farmers and scientists meant that these challenges could be used to define and shape further research. It is this feedback loop that has given the technology its notably adaptive quality. As Jimmy Pittchar says, “We need to be nimble-footed in the field – the economic realities and the climatic conditions are changing fast.”

The first challenge was a limitation of the original silverleaf desmodium intercrop and Napier border crop, which could not tolerate the long seasonal dry spells that farmers reported were becoming more frequent. For some early push-pull adopters, this meant losing their intercrop and border crops to seasonal drought. It also meant that *icipe* could not extend push-pull to areas with lower average rainfall.

Supported by funding from the European Union, the search began for drought-tolerant intercrop and border crop components for the system. In partnership with the national agricultural institutes of Ethiopia, Kenya and Tanzania, *icipe* began to collect and screen a new set of potential ‘push’ and ‘pull’ species, which were grown in greenhouses under controlled conditions simulating extreme drought. Those that survived best went on to be tested by farmers and their cattle, and this led to identification of the ‘climate-smart’ push-pull package, comprising greenleaf desmodium (*Desmodium intortum*) and Brachiaria grass (*Brachiaria* cv Mulato II). Dissemination of climate-smart push-pull began in 2012 and farmers soon reported satisfaction with the quick-growing greenleaf, which, because it is fast to mature, deals effectively with striga in just one



Kennedy Anyango, *icipe* technician, screening push-pull companion plants for drought tolerance in one of the glasshouses at Mbita Point.

season. Brachiaria, easy to harvest and palatable for animals, also proved to be a popular choice.

The development of climate-smart push-pull meant scaling out the dissemination of the technology to different agro-ecosystems, regions and countries at the same time as maintaining and extending its spread in Kenya. While continuing to carry out its successful farmer-centred, knowledge-sharing extension activities, *icipe* also formalized its existing relationship with Heifer International, which became one of the dissemination partners for climate-smart push-pull. This means that push-pull is introduced to all Heifer International farmer groups in the areas where the climate-smart technology



Remjius Bwana’s farm is one of the sites of the Napier stunt disease resistance trial. The resistant Ouma 2 variety came from a farm in western Kenya.



Desmodium seed on Peter Waboya's farm in Bungoma, grown under contract for the Kenya Seed Company.

is being extended. The smooth functioning of this partnership in Tanzania is illustrated in Case Study 3.

A second challenge that emerged for farmers during the early years of dissemination was Napier stunt disease, which caused plants to become yellow and shrivelled. In research funded by the McKnight Foundation and carried out in partnership with long-term collaborators Rothamsted Research and the Kenya Agricultural Research Institute, the *icipe* scientists traced the cause of the disease to a phytoplasma bacteria transmitted by a leaf hopper. Tracing the cause meant they could screen varieties of Napier for disease resistance. In 2012, three resistant varieties were tested by farmers in a multi-location trial and, by 2013, two of these had been selected and specimen plants were being split and distributed by farmer-teachers and field workers to gradually replenish affected border crops.

A third and on-going challenge touches on the steady demand for seed to get new farmers started with push-pull and support early adopters in expanding and diversifying their push-pull plots. Initially, the rapid spread of push-pull in Kenya led to a shortage of desmodium seed. A seed multiplication project tested the agronomic conditions and management practices needed to plant desmodium bulking plots and process and harvest the seed. For the last ten years, some farmers – particularly farmer-teachers – have grown seed this way for their own use and for sharing with neighbours. But in order to be sold on the open market, seed must be certified, and grown in a single stand rather than as an intercrop.

To address this challenge, Dr Khan began working with Kitale-based Western Seed Company in 2003, and more recently with the Kenya Seed

Company. As a result, Kenya Seed Company now contracts farmers to grow seed for sale, especially in Bungoma, dealing with the necessary certification processes on the farmers' behalf. It also supplies *icipe* with much of the desmodium seed it distributes to farmers, the majority of which is imported, but some of which is grown by Kenyan farmers.

Producing seed for Kenya Seed Company demands a particular set of management practices, but for those who can afford the necessary inputs, it can be a lucrative business. Peter Waboya, who planted a 5 x 50 m desmodium bulking plot under contract to the company in August 2012, says that he harvested 8 kg of seed from it in the first season. Kenya Seed pays farmers KSh1000 (US\$11.50) for each kilogram, and regularly come to a group buying centre with a weighing machine to purchase seed.

Brachiaria seed for climate-smart push-pull was initially imported by *icipe* from the USA, but it is now being imported from Thailand. Learning from earlier experience with Western Seed and Kenya Seed, *icipe* has invited seed producers to visit Kenya to discuss the possibility of giving distribution rights to local companies.

Lessons from the Kenyan experience have been learned in Tanzania, where *icipe* and Heifer International have, from the outset, included the official government certification body in training farmers in the use of seed bulking practices. It is hoped that this will encourage a positive partnership and allow some Tanzanian farmers to produce seed commercially.

As well as being sown from seed, desmodium can also be propagated using rooted cuttings from



Under the right conditions, desmodium roots easily, meaning it can be multiplied without the need for new seed.

A pyramid of civil society partnerships in Tanzania



Name: Joshua Muruta

Location: Musoma, Tanzania

Age: 48

Farm: One and a half acres of maize, cassava, groundnuts, beans, potatoes, bananas and papaya

Household size: 8 – Joshua, his wife, five children and one grandchild



The front yard of Joshua Muruta's home is a hive of activity, containing two small kitchen gardens, a fishpond in the process of being dug and a zero-grazing unit with a pair of dairy goats. At the bottom of a gentle slope beyond the compound lies his first season climate-smart push-pull plot, where the neat rows of maize, desmodium and Brachiaria look healthy and green.

Joshua and his wife Lois are both members of the Usumboma group, hosted by local NGO the Bukemba Agricultural Centre (BAC). Membership of Usumboma links farmers like Joshua and Lois with the pyramid of partnerships through which climate-smart push-pull is being disseminated in Tanzania. At the base of the pyramid are farmers, and at the apex is Heifer International.

Heifer International carries out all its work, in many different countries, through local groups. In Tanzania, it also works with local NGOs to deliver training on a range of sustainable agricultural practices. BAC, funded by the Anglican Church of Tanzania and running its day-to-day activities from a small field centre, is Heifer International's partner in Butiama.

"Livestock are our core business," says Heifer International's Tanzania's Livestock Officer, Dr Godfrey

Magoma. Building livestock management capacity with farmer groups and placing livestock with selected families, on the condition that each family gives one or more of their animals' offspring to another member, are Heifer International's core activities. The training offered now includes push-pull which, says Magoma, "works wonders for livestock."

BAC is the bridge between Heifer International and farmers like Joshua. BAC supervisors such as Paul Melia support the formation of farmer groups and slowly build their capacity to increase farm productivity and tackle food insecurity. Paul was trained in push-pull by Heifer International staff and, in early 2013, he in turn trained Usumboma group members, including Joshua and Lois.

Joshua reflects that the main benefits gained from his membership of Usumboma are the goats, which the family received from Heifer International in 2012. But he looks forward to the day he will be able to begin harvesting fodder from his push-pull plot. At the moment, the work of cutting and carrying the grass needed to feed animals from around the house and down in the valley is laborious. "Life will be easier for the whole family," says Joshua, "once this work is no longer needed."

As a beneficiary of the Heifer International buck-share scheme, Joshua is keeping a dairy buck, which is helping him and his neighbours to breed improved goats that yield more milk.



existing plants. Similarly, Napier and Brachiaria grass roots can be split to produce new stock. The spread of rooting and splitting practices means that, although fresh seed will still be needed for new farmers for some time to come, farmers can extend and adapt their existing push-pull plots sustainably without wholly relying on new inputs.

Second generation push-pull

Some farmers have now been using push-pull for 15 years, and many more for at least ten. Some of their farms include plots that make use of both generations of push-pull technology – conventional and climate-smart push-pull – and link to a range of other enterprises and sustainable resource management practices.

This cohort of farmers has spawned many leaders, who have become effective spokespeople for push-pull and catalysts for sharing knowledge about the technology, supporting implementers and encouraging uptake. Often they were identified and themselves supported by field workers and technicians, and often they are men and women who have already gained the respect of their communities. As Tarime district field worker Martin Ogola puts it, the spread of push-pull depends in part on motivators, and as a field worker, “You have to pick a farmer with the heart to do it”.

Martin also points out that his mandate, when he is teaching push-pull to a group of farmers, is “to train the farmers to teach their neighbours”. Because this philosophy has underpinned the spread of conventional push-pull, there was an existing pool of knowledge and experience to draw on when the time came to start extending climate-smart push-pull in 2011. While farmer-leaders and farmer-teachers continue to build the capacity of other farmers, a ripple effect can be sustained.

As well as moving from village to village, push-pull is also spreading down generations of the same family. There are many stories like that of Frank Ouso in Case Study 2, who learned push-pull from his mother. In Kenya’s Kuria district, Petronella Wankio learned the technology from her father, who came to help her plant a plot using desmodium vines from his farm and locally purchased Napier cuttings. In

Kisumu West, Alan Metho, who was an early adopter and is one of push-pull’s most eloquent farmer advocates, proudly explains that his 23-year-old son has chosen to be a farmer, rather than go for employment elsewhere. “We are,” he laughs, “a push-pull family.”

The success story of push-pull is rooted in the horizontal and vertical social networks that have sustained its spread. These networks link farmers to the scientists who maintain the effectiveness of the technology and ensure that it adapts to contextual changes. The linkages take the form of functional partnerships with institutions and organizations across a spectrum that ranges from families to local community-based organizations to international philanthropic foundations. They represent a unique and valuable stock of social capital for continued and future efforts to sustainably increase cereal production through the effective control of striga and stem borers in East Africa.



Farmer-teacher Eunice Atieno, who planted her first push-pull plot in 1995, also participated in a farmer evaluation of the whole push-pull programme. She is one of the farmer leaders who are sustaining the second generation of push-pull practice.

2. A good fit for farming systems

The region where push-pull was developed and has spread lies on the east side of Lake Victoria. An area with relatively high agricultural potential, it experiences two rainy seasons a year. Most smallholders practise integrated crop-livestock production for a mixture of consumption and sale and the majority suffer from stemborer or striga or both. But there the similarities end; no two farms are exactly the same.

Amongst the farmers interviewed for this report, farm size ranged from less than a single acre in Kenya's densely-populated Vihiga district, to 60 acres on a large commercial farm in Tororo district, Uganda. Rainfall varied between a narrow semi-arid lake-shore strip in Suba and Rachuonyo districts, which sees about 700 mm a year, and the sub-humid, higher-altitude districts of Bungoma and Kuria in Kenya and Tarime in Tanzania, which can receive up to 1600 mm.

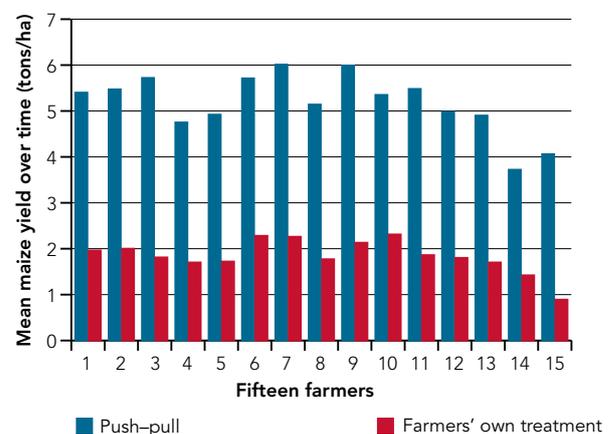
All farmers interviewed cultivate several crops, including more than one staple from a range comprising grains, roots and legumes and including maize, sorghum, rice, millet, cassava, sweet potato, peas and beans. Almost all keep livestock; some herd their animals to common land for grazing, while others cut and carry fodder to dairy cows and goats kept in zero-grazing units.

A key to understanding the success story of push-pull is the way it fits with most of the region's farming systems. At the same time as dealing with striga and stemborer and increasing food production, it also produces nutritious fodder and helps maintain the sustainability of ecosystem functions that are the foundation of every farm, by improving nutrient cycling and soil fertility, increasing biodiversity and using available water efficiently. Most farmers – as long as they have their own land, access to enough labour for the first season and the right knowledge – can give push-pull a try, safe in the knowledge that one or more of its many benefits is likely to prove worth the investment. Indeed, for many, the results have been transformative.

Increasing grain output

Before she adopted push-pull, the striga weed on Miriam Sureri's farm in Kuria district, Kenya was so bad that she rarely planted maize, opting instead to grow sweet potato. On Helen Ndede's farm in Rachuonyo, "That field used to be full of purple flowers, and the maize could not get over two feet tall. If I had gone without breakfast and tried to pull the striga weed, it was so strong I would fall over." For Jane Ooko in Suba, stemborer infestation was so bad that "before, all this maize would be fallen down."

For the vast majority of adopters, the fact that push-pull deals with striga and stemborer leads to increased cereal yields when compared to conventional cropping practices. Monitoring of early adopters also shows that these yield gains can be maintained over time. The chart below shows mean annual maize yields on plots with and without push-pull on 15 farms in Butere, Kisumu, Siaya and Vihiga districts of Kenya. The data have been collected from farmers for between six and ten years. It reveals not only the impact of push-pull on yield, but also shows that the improved yield is consistent over time.



Mean annual maize yields with and without push-pull

By dealing effectively with striga and stemborer, push-pull overcomes two of the main constraints to increased cereal production. But producing more grain is more than just a matter of producing a healthy cereal crop free from damage by pests and diseases. It is also increasingly a question of gambling with the weather as climatic patterns become more unpredictable.

Farmers have for many years habitually diversified the crops they plant as an insurance strategy against climate uncertainty – many, for example, will not plant maize, a thirsty crop, without also planting a plot of drought-tolerant sorghum or cassava in case the rains fail. Push-pull reinforces this strategy, because it can equally usefully be applied to maize, sorghum, millet and rice. That it can also accommodate an intercrop of beans only adds to its good fit with existing practices.

Push-pull widens the range of plant material that farmers can use to tailor their cereal cropping patterns to local climatic conditions. For many, planting both a conventional and a climate-smart push-pull plot adds a further dimension to planting both a maize crop and a sorghum crop. Some farmers with more than one push-pull plot also vary their use of local and improved cereal seeds with different combinations of intercrop and border crop plants.



“The size of the maize was so big – the biggest I had ever seen,” says Jetu Wasike, describing the crop she got in her second season with conventional push-pull.



“I am local, born and brought up here,” says Simeon Arioba, “and I know this is a superior technology for this place.”

The technology also gives farmers a variety of options for producing grain according to different conditions on their own farms. This is exemplified perfectly by Simeon Arioba, a young farmer from Kuria district in Kenya, whose sloping land has a swampy patch at the bottom. In 2011, he planted a 50 x 50 m conventional push-pull plot with maize, but the desmodium was wiped out when “the rains disappeared for nearly half a year”. He planted cassava where the plot had been, to take advantage of the increased soil fertility, and carefully transplanted what remained of the Napier into a single stand at the bottom of the slope, hoping it would be protected if another drought came. Despite this setback, Simeon believed in push-pull, and wanted to try again. In 2013, he planted a climate-smart plot with sorghum at the very top of his land. Although he has not yet harvested his first crop, he has decided not to cut the *Brachiaria* grass, instead saving it so that he can extend his push-pull plot further as soon as he can.

Simeon’s story illustrates not only the flexibility of the technology, but also how it can effectively occupy several ecological niches on the same farm.

Protecting the soil

Although striga and stemborer have undoubtedly inhibited cereal productivity, soil erosion and loss of soil fertility play an equally important part in farmers’ stories. Indeed, it is no surprise to find that striga thrives on poor soil.



Samuel Ochien'g Ong'ou empties the slurry pit from his zero-grazing goat unit. He will add it to the soil as liquid fertilizer.

Farmers described improvements in soil fertility after adopting push-pull in every district in Kenya, Uganda and Tanzania where interviews were carried out for this report. The words of Nactical Kutayi in Vihiga district sum up the comments of many. "Since push-pull, there has been a big difference in the soil: it is soft, moist, dark and fertile. I no longer use any inputs except farmyard manure."

Desmodium is the key to this positive impact on soil fertility. As well as fixing nitrogen, conserving moisture and preventing erosion, its leaves contribute to soil organic matter. As Alan Metho says, "The soil in my push-pull plots is ever soft and it is as if it is full of farmyard manure. This is because of the leaves of the desmodium."

Although push-pull can improve the soil of those who do not own livestock, when incorporated into an integrated crop-livestock system its positive effects on soil fertility are manifested fully, as shown in Case Study 5. Feeding desmodium, Napier and Brachiaria to livestock and returning some of their manure to the soil recycles some of the nutrients taken from the soil by cultivation.

Keeping livestock healthy and productive

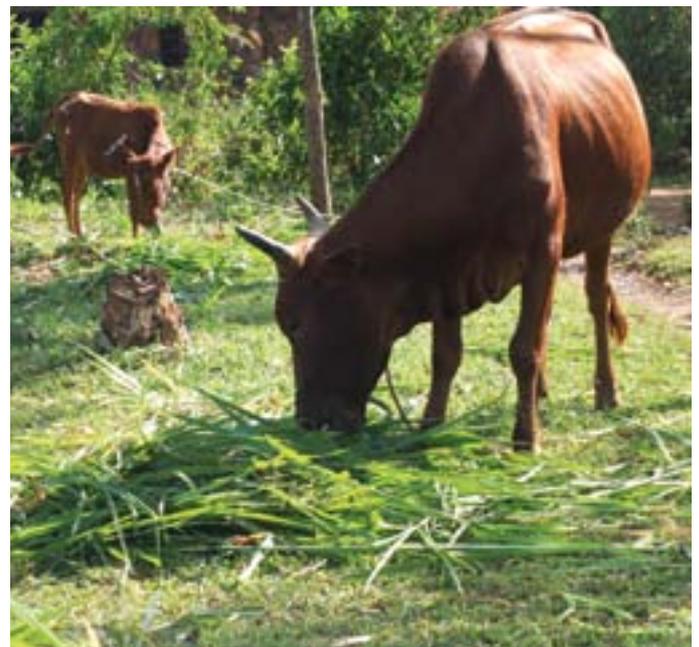
Livestock fulfil many purposes in the livelihood systems of farming households. They provide milk, meat, manure and draught power. Their outputs become goods for sale and exchange, and the animals themselves represent a form of savings. Keeping animals well fed and healthy is often pivotal in main-

taining soil fertility, paying school fees and eating a nutritious, balanced diet.

Farmers choose which livestock they keep according to the resources they have available to acquire and manage them. For example, improved cattle and goats are sought after for producing large quantities of milk, but their purchase and management can be expensive and they tend to be susceptible to diseases. Local breeds give less milk, but they are cheaper to buy and keep and more resilient.

Push-pull farmers use their fodder crops to feed goats, sheep, cattle, pigs and poultry – there is even one farmer, whose story is told in Case Study 6, who raises desmodium-fed rabbits. The farmers report positive changes in the health and productivity of their animals, particularly thanks to the nutritious qualities of desmodium. There are many accounts of goats kidding more frequently and producing twins more often, and of desmodium-fattened birds getting a good price at market.

Samuel Ong'ou from Rachuonyo district sums up the relationship between his push-pull plot and his animals. "With push-pull, there is a certain circulation. The fodder is eaten by the cows, the waste is collected for compost, and this goes back to the fields. Some of it is eaten by the goats, which are penned at night, and the slurry from their pen goes to the vegetables. Cow and poultry manure go in the fishpond – there is no waste. And there is more production – of maize, of milk and of vegetables."



Eunice Atieno's crossbreed cow eats Napier grass from her push-pull plot.

Closing resource cycles for sustainable intensification



Name: Roseline Ngoye

Location: Siaya, Kenya

Age: 32

Farm: Two acres of maize, sorghum, cassava, sweet potatoes, vegetables and bananas

Household size: 8 – Roseline, her adult sister, their mother and five children



Roseline Ngoye's farm is a carefully designed network of interconnected, intensive crop and livestock production sub-systems. Each has a distinct role in a system of nutrient cycling that aims to protect and enhance the soil and avoid wasting resources at the same time as producing enough food.



This compost heap is turned every two weeks during the growing season, and takes a second season to completely mature.

Roseline has three different 20x20 push-pull plots, one growing sorghum with conventional push-pull and two growing maize with the climate-smart plants, within walking distance from her house. In

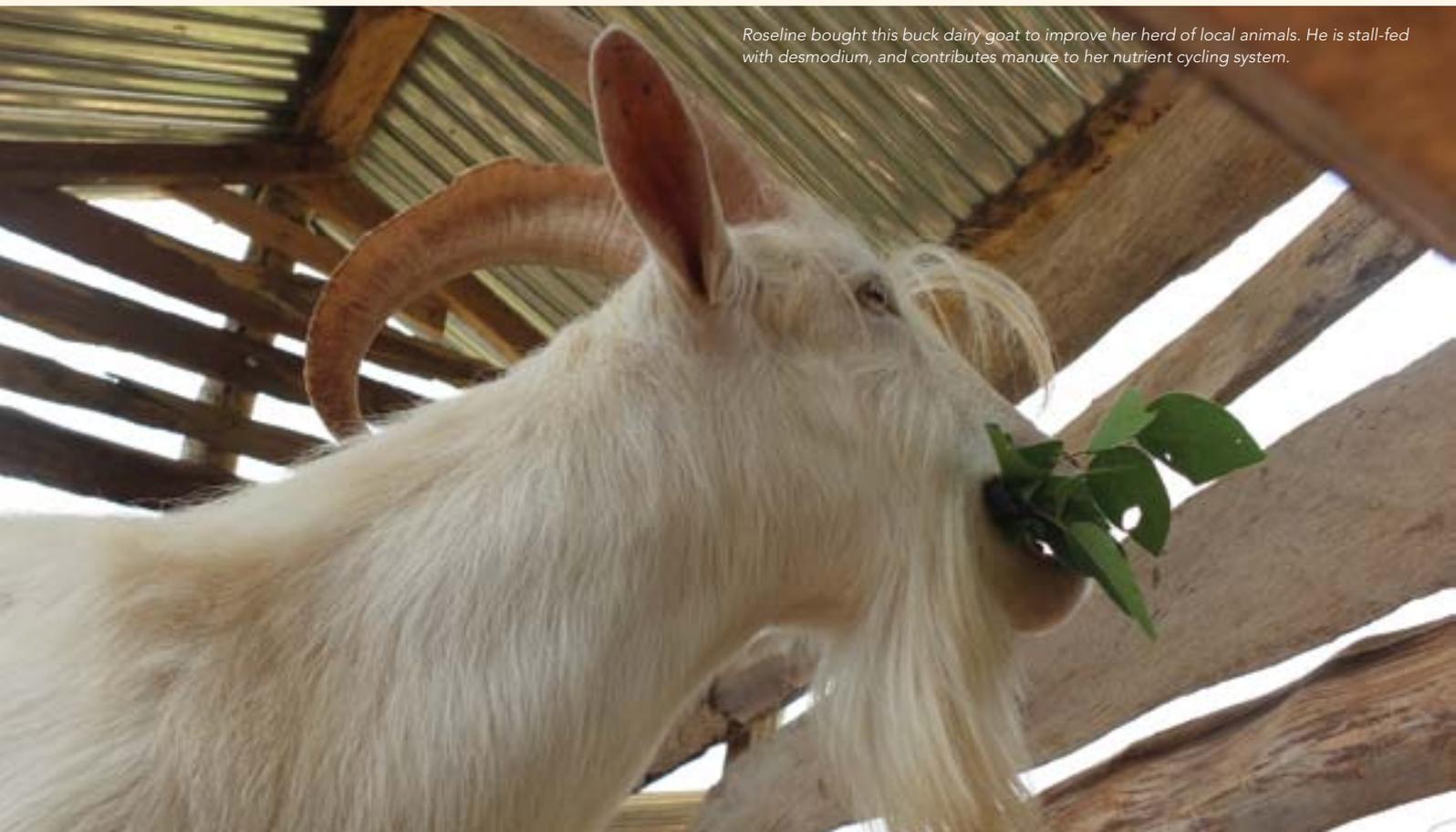
the front yard, there is an enclosure full of poultry, an improved breed buck goat and a local cow and calf in a zero-grazing unit. She also has several local-breed goats. She has started a Brachiaria grass bulking plot to provide

border trap plants for further expansion of her push-pull activities.

Keeping crops and livestock in such close proximity means working hard to keep the two apart. "Bit by bit," Roseline explains, "we are fencing the land. We work on a small area at a time, trying to make it more productive."

Beside each push-pull plot is a compost heap, to which Roseline adds weeds and farmyard manure from her animal and poultry enclosures throughout the growing season. Making compost close to the plot saves having to carry it from elsewhere next season. If there is excess desmodium, this is also added to the compost heap. Roseline observes that, after four years of cultivation on her oldest push-pull plot, "The soil is fine and moist and free of weeds, and it takes less work."

The fodder from the plots goes to feed the enclosed animals, as well as supplementing the diet of the local goats, which are grazed outside the farm. The poultry too are fond of desmodium, and maintaining their health and weight is important because Roseline earmarks money she earns from the hens to pay the children's school fees.



Roseline bought this buck dairy goat to improve her herd of local animals. He is stall-fed with desmodium, and contributes manure to her nutrient cycling system.

Small animals, significant benefits



Name: Jairus Ounza
Location: Vihiga, Kenya
Age: 42
Farm: One acre of maize, sorghum and vegetables
Household size: 6 – Jairus, his mother and his four children



Since being paralyzed in an accident, Jairus Ounza has faced life from the seat of his tricycle wheelchair. "When I became paralyzed, I thought it was the end of the journey," he says. "But now I am proud to show that disabled people are not only beggars who sit by the side of the road." Instead, Jairus is a familiar figure on the road to Maseno, cycling his poultry and rabbits to market.

He learned about push-pull through his membership of Maseno Depot Disabled Group, when an *icipe* field worker addressed one of their meetings. The idea of a system that would produce a high yield from a small area was very appealing. With help from his family, Jairus established his first conventional push-pull plot with maize in 2011 and a second in 2012, before adding a climate-smart plot in 2013.

Although the family keeps a cow, which he says was starving before he started growing Napier and desmodium, Jairus finds it difficult to manage large animals. Instead, he keeps rabbit hutches and chicken coops in his compound; low structures that he can reach

from his chair. He has had the rabbits for only nine months, but has used the carefully collected manure from the hutches on his newest push-pull plot.

He got the idea of keeping rabbits from a friend. Apart from selling a few to local high schools for teaching biology, Jairus keeps the animals mainly for meat. He says they fetch a high price at market – up to KSh1000 (US\$11.50) each.

Jairus also rears chickens for meat. He has two coops, the second of which was built for him by the TV crew from 'Shamba Shape-Up', who visited his farm to film his push-pull plots. Publicity has been good for Jairus, who says that when people see his maize crop, they come to talk to him and ask him about it, and perhaps buy a chicken or a rabbit while they are there.

Jairus is keen to point out that the different activities on his farm rotate around push-pull. Before using the technology, he says, "There was not enough food to satisfy my family. Now I rely on my maize and my animals for food and the vegetables from horticulture satisfy our other needs."



The chickens Jairus raises are fed on desmodium to fatten them before sale.



Jairus says that rabbit is popular with customers, especially those trying to avoid red meat.

Nutritious fodder: a versatile resource

For some farmers, particularly those in the less densely populated areas of the region, push-pull is their first experience of growing fodder crops alongside their food crops. The training delivered by Ministry of Livestock and *icipi* field staff to farmers includes practices for processing and storing fodder grasses and desmodium. For some, this means they can be self-sufficient in fodder throughout the year.

Because desmodium is rich in protein, push-pull fodder has a widely reported positive effect on milk yields, frequently doubling or even tripling whatever the animal was producing on its previous diet. Miriam Sureri in Kuria District, Kenya, who has a local-breed cow that she keeps for milk, points out that greenleaf desmodium is even better for milk production than silverleaf. Before push-pull, she got two litres a day from her cow. With conventional push-pull fodder, this went up to three litres, but with fodder from her climate-smart plot, it doubled to six.

Many push-pull farmers point out that there is always a demand for milk, which is sold at markets or to neighbours, small local tea vendors or larger-scale dairies. But nearly all of them keep some for domestic consumption, where it makes a vital contribution of essential nutrients to children's diets. Milk from desmodium-fed animals is widely praised for being thick and creamy.

For many, the sale of milk makes an essential contribution to the cash needed to meet the costs of education. Several farmers also reported paying school fees in kind. In Vihiga district, Maureen Ambubi remembers regularly sending her smallest child to school with two litres of milk. "I have three children," she says, "and they have now gone through high school and college. All their fees were paid by milk."

Although the relationship between milk and fodder is an important one, many push-pull farmers do not keep dairy animals, and some do not have animals at all. There is a demand for fodder – particularly Napier grass, which people are widely familiar with – on the open market. Some push-pull farmers without livestock reported reaching agreements with neighbours to sell them regular quantities of Napier, *Brachiaria* or desmodium throughout the season. Others have agreed terms for an exchange in kind. In Tanzania's Tarime district, for example, Rosalia Robi gives her desmodium crop to a neighbour, who ploughs her fields with his oxen in exchange. In Kenya's Nyando district, Mary Okoth does the same, but she also receives milk in exchange for the fodder.

These examples illustrate the versatility of fodder as a resource, with a diversity of viable options for its use. Through producing this versatile resource from the same plot that produces grain, push-pull can support the sustainable intensification of crop-livestock production.



Evelyn Otungo's children cut Napier grass to feed to their purebred dairy cow in Rachuonyo district, Kenya.



In Kenya's Suba district, Johnson Ngige processes and stores fodder to help feed his 11 cows throughout the dry season.

3. A good fit for farmers

Farming systems cannot be regarded as separate from farmers, their communities or the social contexts in which they live. So if a technology is to work, it must not only be a good fit for farming systems, but also for farmers themselves and the human resources they have available to invest in their farms. One reason that push-pull works so well is that, because farmers participated in its development and adaptation from very early on, it closely reflects both African multi-cropping farming systems and African social structures and norms.

As already discussed, one of the main ways that push-pull fits with farmers is through its widespread use of groups for technology dissemination. But equally important is that it has been extended in a deliberately inclusive way, allowing it to be adopted and used successfully by many different kinds of farmers, regardless of gender and age.

Women are, and have been from the outset, an integral part of push-pull's target audience for dissemination. Many farmer-teachers, for example, are women, and their experiences with push-pull have raised their profile and standing as valuable members of their communities.

This is important in a context where women have had fewer opportunities to access the same agricultural resources as men, particularly when those resources are knowledge-based technologies. Ensuring that push-pull has been positively extended to women acknowledges the importance of raising agricultural output on the substantial quantity of land they farm.

Household structure and gender relations

In this region, husbands are the traditional breadwinners of the household, and women and children are the collective responsibility of the entire kin group. But these conventional patterns, which

have governed both farm labour and strategies for coping with food insecurity for hundreds of years, have altered under the dual impact of male out-migration in search of work and HIV-AIDS.

In particular, AIDS mortality rates in this region have been higher among men than women, with the result that there are now many more female-headed households than once was the case. This has forced the role of women as primary breadwinners to become more socially acceptable.

There are also many grandparent-headed households and countless examples of families who have included the orphaned children of their kin into their own households. The traditional kinship

Rita Ochwo, pictured with her son and some of the chicks from their poultry unit, is a farmer-teacher in Uganda's Tororo district. "Now I am known," she says, "and they respect me very much."



Raising the children alone



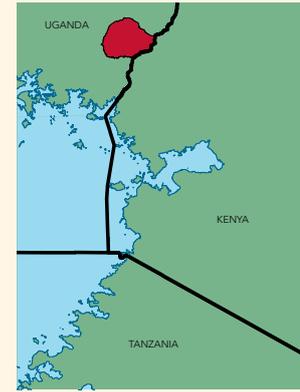
Name: Janet Oyo

Location: Tororo, Uganda

Age: 47

Farm: One acre of maize, bananas and sweet potatoes; two acres of groundnut and millet on rented land

Household size: 7 – Janet (a widow), her two children and four orphans



“Five years ago, I saw a field in another parish,” says Janet Oyo, a widow who is raising six children alone. “I noticed the way it was made, the planting between the lines. I admired it and the farmer explained it to me. He said, ‘The next time Mr Romanus comes to our farmers’ group, why don’t you come?’ So I did, and after that Romanus came to a meeting of our group.”

The group that *icipe* technician Romanus Odhiambo went on to visit is a Post-Test Club, all of whose members have tested positive for HIV. It was founded with 65 members in 2003; ten years later, only 13 remain. For Janet and the children she was left to care for when her husband died, hearing about push-pull at the club that day was a stepping stone on the road away from a life of relentless, lonely labour.

In 2009, Janet was the beneficiary of a pair of oxen, which she received on the condition that she would plough the land of club members for free at the beginning of each season. These large, powerful animals, says Janet “need to be strong and healthy to do their work.” Despite planting a small plot of Napier as fodder, it was a struggle for Janet and the children to find adequate feed for the oxen and their other animals. The children spent many hours herding

cattle and goats in search of grass. In 2010, Janet decided to try to increase her fodder production by planting a conventional push-pull plot with maize.

Since then, the oxen have thrived on their new diet and they have been much in demand for their work. Each season, after they have met their ploughing obligations on the fields of fellow club-members, they are hired out to neighbouring farmers. The money they earn from ploughing during these weeks, twice a year, pays the children’s school fees.

But this is not the only benefit of push-pull for Janet and her family. “Now,” she says, “there is little labour needed with the animals, and my land can produce something better. Before, we used to labour without resting – now we can rest for some time, which is good for our health. Now, what we eat is enough for us.”

Janet would like to expand her push-pull plot but will only consider doing this on land that she owns. She also needs to continue cultivating a mix of crops as insurance against one crop failing completely. So she is currently searching for land to rent to plant her crop of sweet potatoes, so that she can start a new push-pull cereal plot on a field within walking distance of the house.

Janet with her oxen. Keeping them well fed and healthy enough to work has been very important in helping her bring up her children alone.



obligations of supporting vulnerable relatives have been stretched thin, sometimes to breaking point.

These patterns of change in household composition have profoundly affected labour for farming, and many households are labour-poor, with one adult responsible for feeding many dependent children. This often means that children have to work, frequently to the detriment of their education; it also means that people are more likely to go hungry. The impact of push-pull on a household like this is shown in Case Study 7.

Although the availability of anti-retroviral (ARV) drugs to suppress the HIV virus means that being HIV-positive is no longer a death sentence, it is nonetheless the case that the disease continues to cause widespread day-to-day illness and it reduces the capacity of sufferers to do the heavy labour demanded by farming activities.

Push-pull is an appealing technology for labour-poor households, because once established, it demands relatively little labour to produce cereals. Weeding and digging, two of the most labour-intensive tasks in the seasonal cycle of agricultural work, are substantially reduced. It also minimizes labour demand by providing cut-and-carry fodder for animals that previously had to be herded in search of grass – a job frequently done by children.

The challenges of youth

In common with young people in agricultural communities all over the world, the youth of this region face a particular set of challenges. Youth unemployment is high, even for those with a secondary education. In the more densely populated parts of the region, land is scarce, with farms already fragmented to tiny sizes by inheritance. Many young people, particularly men, migrate to urban areas to search for work. For young women, unemployment rates are higher even than those among young men, and alternatives to early pregnancy and domestic work are few.

In some cases, such as the situation described in Case Study 8, young people are able to access push-pull through groups and make use of the technology as part of a portfolio of communal activities through which they hope to access high-growth value chains, particularly in poultry production and horticulture.



Making ghee from the milk of push-pull cows is one of the skills that mentor Jane Ooko has shared with the young women of Lower Kachola Women's Group.

For youth groups like these, as elsewhere in push-pull dissemination, *icipe* has learned the importance of mentors in contributing knowledge and stability. For example, in Kenya's Suba district, 52-year-old Jane Ooko is part of a group of much younger women that was originally founded by the international Value Girl initiative, which trained them in poultry production. The group was introduced to push-pull when the Value Girl training ended. Their poultry unit and push-pull plot are on Jane's land, and she takes a share of the profits. She is on hand to train and mentor the other members in all aspects of developing their enterprises, including push-pull.

Working along similar lines, *icipe* field workers in Uganda have recently started a network of 'youth implementers' who target the spread of the technology to younger people. Eunice Aroba, recently elected youth implementer in Uganda's Bugiri district, has recruited and trained eight young people in this isolated rural area, two men and six women. She notes that an important part of her role has been helping them to be taken seriously by their parents when they ask for small parcels of land on which to establish their plots.

In these cases, it is the technology's capacity to produce a good output from a very small area, and to be part of a wider portfolio of communal activities, that enables push-pull to help younger people to deal with the particular set of problems they face.

Troubled youth – making your own way in the world



Name: Waondo Youth Group
Location: Suba, Kenya
Age: Group founded in 2007
Farm: Half an acre of horticulture and a 20 x 30 m push-pull plot, both on borrowed land
Group size: 11 active members



Caught between unemployment and land fragmentation, many of Kenya's young people struggle to make their way in the world. But for some, working together to make good economic use of scarce resources is presenting new possibilities for the future.

Nine of the 11 active members of Waondo Youth group are young, unemployed men and the other two are high school students. The group formed after its members "caught the opportunity to start horticulture," thanks to the donation of a water pump and a small plot of land. "Agriculture is the backbone of our economy so we thought it wise to venture into it," the group's chairman explains. "We want to combine agriculture and business."

Any profit made by the group is saved as capital for investing in new enterprises. The horticulture profits were reinvested in equipment and stock for a small poultry unit. This season, after the generous offer of

some further land from a relative of one of the members, the group sowed climate-smart push-pull with maize on their first plot. They worked hard together to provide the intensive labour demanded to establish the plot.

The group hopes that the push-pull plot will help them reduce the cost of feeding their poultry – either through feeding the maize directly to the birds, or by selling it to buy other feed. They also aim to generate income by selling surplus fodder, which is in high demand thanks to wide distribution of dairy goats in the area by Heifer International.

They are encouraged by the results so far. The striga and stemborer are low and the maize crop looks visibly different from a neighbouring one planted at the same time without push-pull. Much rides on their success this season. Their patron is ready to give them a bigger area to cultivate, "if I see they have done very good work, if they are serious and this is going to benefit them."



"Here in our group," says the chairman, "we are unemployed, all of us. The backbone of our survival depends on our group. We are not idle."

4. Translating a beautiful technology into good development

Push–pull is without doubt an elegant technology that is highly effective in dealing with striga and stemborer. As discussed in the previous sections, it has spread successfully because it provides solutions to the weed, pest and soil fertility problems faced by farmers.

Most farmers who have adopted the technology incorporate it into an existing portfolio of strategies for gaining a livelihood for themselves and their families. When it becomes part of these livelihood systems, push–pull often triggers a set of interlinked, positive outcomes that are fundamental to sustainable development. Here, we outline five key sets of outcomes, before presenting a case study that illustrates each of them.

Climate-smart, sustainable agriculture

Developing adaptable agricultural systems that are resilient to the risks and shocks of long-term climate variability is essential to maintaining food production into the future. Climate-smart agriculture also needs to protect and enhance natural resources and ecosystem services in ways that mitigate future climate change.

Push–pull contributes towards this outcome in several ways. It makes efficient use of land, labour, water and other agricultural inputs. As part of an integrated crop–livestock system, it fosters local nutrient cycling. Because it contains a legume, it adds nitrogen to the soil; because it reduces digging and adds organic matter to the soil, it enhances the capacity of the soil to sequester carbon. Finally, it improves the health of both crops and livestock, making them better able to withstand climate shocks and stresses.

Furthermore, push–pull has a positive effect on plant and insect biodiversity, and has been shown to result in soil rich in beneficial micro-organisms.



“Formerly, when I was a young man, rain fell in a regular way,” says 69-year-old Sospeter Mwita, from Kuria district in Kenya. “Now, you do not know when it will come, and you do not know how much it will be.”

Maintaining biodiversity is crucial to the health of stable and sustainable agro-ecosystems. The identification of drought-tolerant intercrop plants and the development of climate-smart push–pull have strengthened the already formidable climate-smart characteristics of the technology.

Better nutrition, better health

Despite progress in health service delivery, nutrition-related diseases and health problems remain common in this region. Malnutrition is still widespread; for example, vitamin A deficiency weakens human immune response to infectious diseases like measles, while protein deficiency causes kwashiorkor and impaired development. In many cases, push–pull farmers say that their health and that of their families has improved since adopting the technology, because it has resulted in an improved diet. This is achieved in three principal ways.

Firstly, increased cereal yields mean that there is enough to eat. In the words of Eunice Omondi, farmer-teacher and community health worker in Kenya’s Siaya district, “Having enough food helps in healing.”

Sustainable intensification and diversification



Name: John Otiep

Location: Rongo, Kenya

Age: 60

Farm: Seven acres of maize, sorghum, rice, cassava, bananas and vegetables

Household size: 15 – John, his wife and three other adult family members; ten children and grandchildren



John Otiep's seven-acre farm is a verdant patchwork of thriving plots. At the centre of the family's compound is a mulched spiral-shaped bed thick with dark-green kale plants. Behind the tidy house with its shiny tin roof is a greenhouse showing the harvested remains of last season's tomato vines. Alongside are two wooden zero-grazing units, home to cows and goats, and beside them is a large heap of slowly composting farmyard manure.

Beyond this compound lie several acres of diverse cereal, fruit and vegetable plots. An apiary nestles in a thick row of leguminous trees. All this, says John, is a long way from the day he was identified as a poor, food-insecure farmer, targeted to benefit from a Heifer International dairy goat programme. "Much of this change is thanks to push-pull technology," he says. He explains that before he adopted push-pull, he was "working in a large area, using lots of energy, and not producing enough for consumption."

In 2008, Heifer International put John's group in touch with *icip*. Once he had learned the technology, John established a push-pull plot. Each season, he has added at least a quarter of an acre, as much as possible given the available plant material and labour. When his silverleaf desmodium became thin from drought, he was able to replant it using vines from another part of the farm. He saves desmodium seed for his own use and for distribution to other farmers.

The sandy soil on John's farm is particularly prone to drying out, and he especially values the mulching and moisture conservation properties of desmodium. "Mulching covers the soil and reduces tillage," he notes, "and the micro-organisms are not interfered with." He says that the soil on his push-pull plots has improved, "from sandy soil to dark soil that looks like bush soil." He now practises mulching outside his push-pull plots, particularly on the 20 round beds he uses for horticulture.

"This is my pure push-pull cow," says John. The improved dairy animal was bought with profits from the sale of surplus maize and fodder.



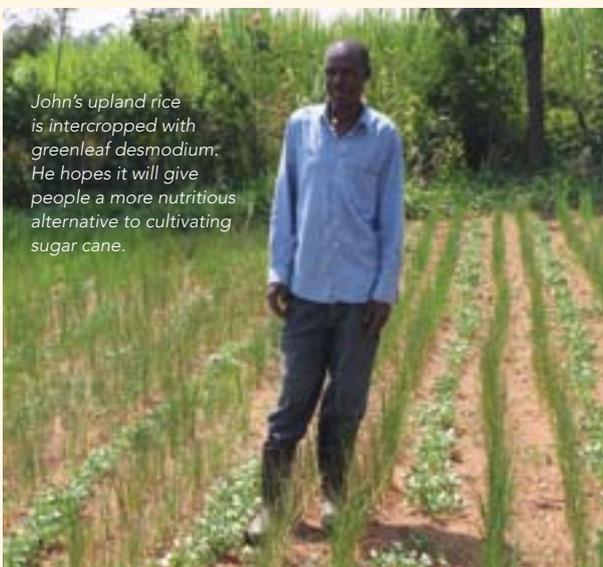
John says that since adopting push-pull, "money has come from many sources." He built this house with his savings.



The principle behind John's farm is the sustainable and intensive use of local resources. This means that he no longer buys chemical fertilizers, pesticides or herbicides, relying entirely on farmyard manure, nitrogen fixation and mulching to maintain and build the health of the soil, and intercropping to deal with insect pests and weeds. It also means that he produces a higher yield from a smaller area with no external inputs, "and there is enough, and surplus to sell."

All of John's push-pull plots differ slightly from one another. He uses the technology to cultivate sorghum, rice and maize and protects these crops with all four of the push-pull intercrop plants. This diversity is intentional and meets two needs. Firstly, John recognizes that diversification minimizes the impact of increasingly unpredictable rainfall. Secondly, it means that he has real-life examples of the range of push-pull options to show others. As a farmer-teacher, travelling the local area by bicycle, he invites other farmers to see his plots.

When John is asked about the benefits of push-pull for himself and his family, he spends ten minutes elaborating a long list of points that include eradicating striga, a new house, increased income, better health, a steady stream of visitors and exposure to new places and people. "Since I have started this technology," he says, "I am living as a human being, so I am not poor." There is little surprise when he adds, "I am out to spread the word."



John's upland rice is intercropped with greenleaf desmodium. He hopes it will give people a more nutritious alternative to cultivating sugar cane.

Secondly, for those push-pull farmers with dairy animals, increased milk yields from push-pull fodder mean more protein and vitamins in the household diet, particularly for children, who are often given priority in milk consumption.

Thirdly, thanks to increased income from the sale of push-pull products and by-products, many farmers report that they are in a better position to purchase the kinds of food they are not able to produce, with a resulting increase in the diversity of their diets.

As already discussed, these widely-reported improvements in nutrition and health take on particular importance for those who are HIV-positive and taking ARVs.



Five-year-old Alex and eight-year-old Wilfred both drink milk from their mother's desmodium-fed cow every day. "You can see that they are healthy," says their mother Petronella Wankio.

Supporting learning and education

When farmers are asked what they do with any additional income gained from their push-pull plots, the most common response by far is, "I pay school fees." This catch-all phrase covers the varied costs of providing education at the primary, secondary, college and university levels. In one case, a push-pull farmer even helped fund the construction of a school. In this very tangible sense, push-pull is supporting the education of children wherever it has been adopted.

But push-pull also supports adult learning. Dr Khan is adamant that one of the most important contributions that scientists can make

Your health is your first customer



Name: Alpheus and Emily Onyango
Location: Migori, Kenya
Age: Alpheus 47 and Emily 27
Farm: Three acres of maize, cassava, cowpeas, onions, vegetables, mango, papaya and sugar cane
Household size: 7 – Alpheus, Emily and five children



Alpheus and Emily Onyango are proud to tell their push-pull success story. Comfortably seated in his wheelbarrow, Alpheus describes how they heard about the technology through their membership in the Alpha Nyabisawa Group, and were trained by a field worker at a demonstration plot on a nearby farm.

Emily tells how they planted their first 25 x 25 m conventional push-pull plot with maize in a place with a lot of striga, and how the yield rose from 50 kg to 160 kg by the second season. She smiles at Alpheus as she recounts how they planted a second, identical plot the following year, so that husband and wife could compete to see who got a higher yield.

Emily and Alpheus say that the single biggest benefit of push-pull is that it means they have enough to eat. Although they consume all the milk from the dairy goat they received from Heifer International, they also have surplus maize and fodder to sell. Before, says Emily, "We had to go the extra mile to find money."

When their silverleaf desmodium suffered during a long dry spell in 2011, Alpheus discussed the problem with

icipe field worker Tom Otato, who was looking for places to plant new demonstration plots for climate-smart push-pull. One result of their conversation was the Onyango's third, climate-smart push-pull plot; the other was that Alpheus became a farmer-teacher in February 2012. He now travels the area on his *icipe* bicycle supporting other push-pull farmers. "I am proud to say that 62 farmers have learned from me and implemented push-pull," he says.

Rachel Owino, Project Advisor at Heifer International Kenya, has worked extensively with the Alpha Nyabisawa Group and knows the Onyangos well. "Today," she says, "Alpheus and Emily live in a serene home. But at the beginning, they were really down."

The Alpha Nyabisawa Group was founded under a programme of the international NGO Catholic Relief Services (CRS) which provides HIV testing and works to support those who are diagnosed positive. One of the challenges seen frequently by CRS was the disappointing way that people responded to anti-retroviral drugs when their nutrition was poor. To overcome this, CRS asked Rachel to help them come up with a plan for groups that



Behind the family is the zero-grazing unit housing their improved-breed goats.



Here, desmodium is mixed with foliage from the nitrogen-fixing tree Calliandra to feed the Onyango's goats.

would help them grow nutritious food with the minimum of labour. Gradually, Rachel introduced horticulture, zero-grazing dairy goats and push-pull to the Alpha Group.

"When I met the Alpha Nyabisawa Group for the first time," says Rachel, "Emily didn't have a home. She lived in a single room with mud walls, in a very bad state. Alpheus' wife had left him and their children because of the abject poverty created by his condition, which was going down by the day. In the Group, Alpheus and Emily met, so that is how they were married. But by the time Heifer International and Alpha Nyabisawa Group started working together, Emily herself was on the verge of running away. When I came in, I said 'How long are you going to live like this?'"

The Group's activities began with simple technologies for growing vegetables for consumption and sale. Heifer International's training emphasizes business skills as well as agricultural practices. "So that once you produce, whatever is in excess, you sell. But your health is your first customer," says Rachel. Through income saved from horticulture, Alpheus was eventually able to build the first room of the house where the family now live. As soon as he had done this, he established his first push-pull plot.

Alpheus and Emily's transformation from the unlucky individuals Rachel encountered four years ago to the cheerful and confident couple telling their push-pull success story today could not be more marked. It is a transformation that includes hope, capacity, assets and income; but, underpinning all these, it is a transformation to better food and better health.

Alpheus shows his drought-stressed silverleaf desmodium, which he is gradually replacing with drought-tolerant greenleaf vines from his climate-smart push-pull plot.



to development is in explaining how and why agricultural systems work. One of the reasons that push-pull has spread successfully, he says, is because "Each farmer who has planted it knows why he or she has planted it. Farmers understand the science of it very well." The more knowledge farmers have, Khan argues, the better they do with push-pull.

In this sense, push-pull has contributed to the building of substantial human capital in the agricultural sector. In doing so, it has also built the confidence of many ordinary farmers, farmer-teachers and farmer-leaders. In the words of Peter Waboya, farmer-teacher from Bungoma, "Before, I was just a farmer, but I have gained much. I am trained, computer-literate, a facilitator; and I am a push-pull expert."



Rachel Agola sets aside the profits from two of her three push-pull plots for paying for the education of her five children. Eric (right) is at Kenyatta University studying education, and Freddy (left) is in high school.

Improved food security, stronger safety nets

All the farmers who shared their stories for this report said that adopting push-pull had made them more food-secure at the household level. Many said that since starting push-pull cultivation, they usually had enough maize to last them from season to season, if there was adequate rainfall. For most, this represents a significant improvement.

Beyond the household, there were many examples of groups that are using push-pull as part of their collective efforts to ensure the food security of vulnerable people. Traditional kinship and group structures for mutual assistance have overlapped with a plethora of external interventions, and many have absorbed push-pull into their existing activities. By ensuring increased production, the technology is serving to strengthen the vital safety nets that these groups offer to people that may be too young, poor, ill or vulnerable to provide for themselves.

Building a school for vulnerable children



Name: Samuel Sana

Location: Suba, Kenya

Age: 39

Farm: Six and a half acres of maize, sorghum, sunflowers, beans, soybeans and cowpeas

Household size: 5 – Samuel, his wife and their three children



In Samuel Sana's front yard, where a chicken scratches happily through a carpet of drying desmodium, the sound of schoolchildren doing their lessons at the neighbouring Gikasa Academy can be heard on the quiet morning air.

Samuel's substantial farm surrounds the house, its fields bordered by hedges of trees. His six local cows graze outside on common land, while his poultry are kept in a brick-built shed in the compound.

When Samuel first heard about push-pull at a field day near his home, he was "really perplexed. I just didn't see how it could work." But when an *icipe* field technician visited the self-help group where he is a member, he saw how it was carried out and decided to give it a try, planting a 10 x 10 m plot of conventional push-pull with maize on a striga-infested field.

The immediate impact on his maize yield led Samuel to expand his plot as rapidly as he could. The new 30 x 30 m plot he cultivated the next season was followed by a larger 30 x 60 m plot the next year. For the first time, he found that he was producing surplus maize to sell.

The main problem on Samuel's farm, he says, is the adverse climatic conditions. "Either there is too much rain, or there is too much drought." The silverleaf desmodium in his conventional system began to have problems when the temperatures were very high in the dry season. So when he heard of climate-smart push-pull in 2011, Samuel was keen to diversify, and enthusiastically planted a 30 x 30 m plot, which he doubled the following year. He has also planted a *Brachiaria* grass bulking plot in anticipation of expanding his push-pull further.



Pupils at the Gikasa Academy, built from the profits of Samuel's push-pull plot.



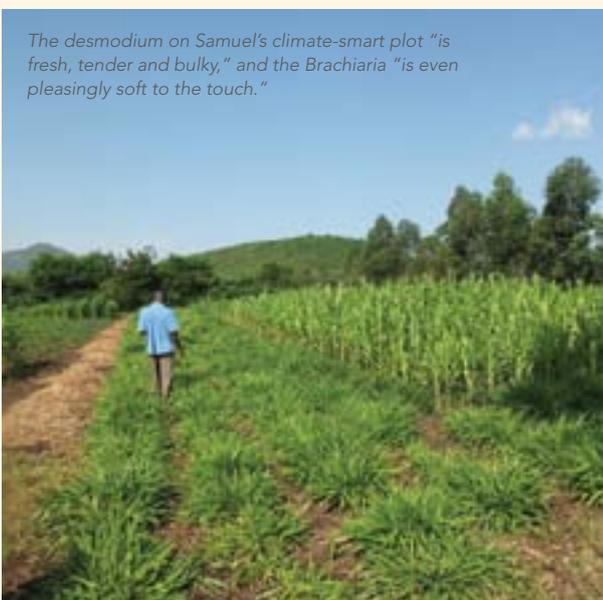
One of Samuel's chickens pecks happily at desmodium being dried for storage.

Samuel appreciates the extra cover given to the soil by the greenleaf desmodium in the climate-smart plots. He also reports that the yield from this 30 x 30 m plot, which jumped from 60 to 120 kg under conventional push-pull, increased again to 180 kg under climate-smart push-pull.

He also likes the quality of the fodder, which he sells locally. He and other push-pull farmers are in the process of starting a union of hay sellers, who will work together to improve supply and increase their bargaining power in the market. They have already identified several dry-season customers who have large zero-grazing dairy units.

This substantial increase in productivity has allowed Samuel and his family to prosper. "Formerly, I was using all my strength for working on my farm and I was getting nothing," he says, "but now I have a healthy diet and I can eat what I want."

More importantly for the pupils of the Gikasa Academy primary school, Samuel says that "Push-pull has helped me to help other vulnerable people." With some of the income earned from selling maize and fodder, Samuel constructed the Academy on his own land to give orphaned children a place to go to school. Under its tin roof, push-pull has given 230 children the chance of an education.



The desmodium on Samuel's climate-smart plot "is fresh, tender and bulky," and the Brachiaria "is even pleasingly soft to the touch."



In Uganda, members of the Muterere Catholic Church group weed the last of the striga from their first-season push-pull plot, the most recently planted of three. The maize they produce contributes to feeding and educating 100 orphans.

Savings, investments and financial stability

There are a number of ways in which push-pull generates cash income, including through the sale of cereals, milk and fodder. For some farmers, this has meant the chance to save and invest in assets and enterprises that have increased the financial security of their households.

The technology can also reduce income poverty through substitution. If a farmer can grow enough maize to last the season, the money they would have spent on buying food can be used for other things instead. Violet Otieno in Migori district explains that she still does casual labour for other farmers, but instead of spending her earnings on maize, she has now been able to buy a sheep.

For several farmers, the push-pull surplus has provided a springboard into the formal cash economy. Several have opened savings accounts at banks, and countless others use 'table banking' and other forms of community-based rotational savings systems to make the best of the money they earn. As Remjius Bwana comments, "The more surplus you have, the more settled your family is financially."



"Before push-pull I was very poor – a mere ordinary person," says Nactical Kutayi. "But now I have bought hybrid cows, I sell milk, I have money. I started a small business and I now have a shop. I have saved, and I am constructing a new house."

“Disability is not inability!”



Name: Maseno Depot Disabled Group
Location: Vihiga, Kenya
Age: Group officially registered in 2003
Farm: One acre of push-pull and horticulture rented from a supporter
Group size: 30 active members



The Maseno Depot Disabled Group exists to bring together people living with disabilities to share their various talents and skills, to show that “disability is not inability”. Farmer-teacher Josiah Nkonde, who introduced the group to *icipe* in 2009, says that in the last three years, three out of four active members have planted climate-smart push-pull at home.

One such member is Mary Atemo, who planted her first conventional push-pull plot with maize in 2011, and has since expanded it twice, the second time using climate-smart push-pull. Her first plot was planted on poor, stony soil heavily infested with striga and the most she remembers harvesting from it before was 4–5 kg. That first season, she took an incredible 135 kg from the plot. She has not looked back since.

Mary received a dairy goat from a World Bank poverty alleviation programme on the strength of being able to

produce fodder from her push-pull plot, but she still had a surplus. In 2012, a neighbour gave her a bull to care for. “The animal became so big and well,” Mary recalls, and the neighbour was so happy that when he sold the bull, he gave her enough cash to buy two small local cows.

Mary learned about push-pull at the Disabled Group’s communal garden. Every Wednesday, members gather to work together at the single-acre field, where the push-pull and horticulture plots sit side by side.

These plots represent the group’s strategic effort to enhance both food security and income. The horticulture crops are a mixture of early-maturing vegetables and medicinal and culinary herbs, intended to generate income in the hungry season, before the maize is ripe. When the push-pull crops are ready to harvest, some of the maize is stored, to be shared between members in times of need, and some is sold to add money to the group’s savings.



Mary’s small cows enjoy fodder from her push-pull plots.



Mary's first-born son helps to cut Brachiaria grass for their livestock.

Members take turns in having the push-pull fodder when it is cut.

Their tidy communal push-pull plot is neatly quartered to show off four different systems: conventional push-pull maize with beans, drought-tolerant climate-smart push-pull, rows of maize and beans with Molasses grass every ten rows, and a stand of maize with no intercrop.

Group member Raphael Namema confidently explains that people who come here to learn about push-pull need to understand how all the different parts of the system work. He also says that visitors come from different places with different kinds of land and levels of rainfall, and that the plot shows them all the possibilities on offer. "My legs

may be crooked," Raphael points out, "but my brain is not, it is functioning well."

Taking up push-pull has triggered many changes for members of the group. Those who can cultivate a push-pull plot at home are more food-secure than before, and all members contribute to a vital safety net of mutual support. These interlinked benefits are summed up by Mary Atemo: "I have changed my style of cultivating, and I have the technology to teach others. Through push-pull we have enough food for our good health, and when I get crops I can sell them. We can dress well. And I can even give a cup of porridge to a needy child."



The Maseno Depot Disabled Group unites its members to use their talents and overcome their disabilities.



Beans, maize and Molasses grass grow on a quarter of the Maseno Depot Disabled Group's push-pull plot.

Looking forward to a brighter future



Name: Jane Anyango

Location: Busia, Kenya

Age: 32

Farm: One acre of maize, sorghum, millet, cassava and sweet potatoes

Household size: 4 – Jane, her husband and their two children



To be young and starting a new family with a fragment of land and few other assets is a tremendous challenge for many people growing up in this region. For Jane Anyango, mother of a seven-year-old boy and a six-year-old girl, this challenge also includes the stony, infertile soil on her acre of land, and the lack of employment for her husband, a qualified school teacher.

For several years after their marriage, Jane and her husband continued to live with his parents. He found part-time teaching jobs and she did casual labour on other people's farms to get by.

In 2005, local self-help group Jiinue was searching for new members so that it could become formally registered. "I saw that the activities were good," says Jane, "so I joined." Later that year, the group members were trained in push-pull and dairy management by staff from *icipi* and Heifer International and, in 2006, Jane started a conventional push-pull plot with maize on a quarter of her land. "At that time," she says, "I had no animals and no knowledge," so when she harvested the desmodium, she initially returned it to the soil as a heavy mulch, and fed the Napier grass to her mother-in-law's cows.

For the next five years, Jane saw steady improvement in maize yields and soil fertility on the plot; she reports being able to harvest two 90-kg sacks from an area that formerly gave about 20 kg in total. This improved harvest signalled a change in fortunes for her small family, because

it allowed them to start saving money to build their own house, instead of spending all their income on food.

Their good fortune continued in 2011 with the arrival of Amina, a purebred Friesian dairy cow, a gift from Heifer International. On her diet of Napier, desmodium and crop residues, Amina gives nine litres of milk a day. After the family have taken what they need, the rest is sold for KSh50 per litre. "We are living a good life," says Jane, "We have enough to eat, a balanced diet and the children drink milk."



The house that Jane and her husband have built for themselves and their children symbolizes a new-found economic independence from their extended family.

Jane's next construction project is building a new dairy unit for the Friesian cow Amina and Kate, her calf.



Once Amina arrived, they were able to accumulate enough money to start building their house, and in September 2012 Jane, her husband and their children moved in. The new house is only a short walk away from their old home, but it makes a world of difference that they are standing on their own feet.

As well as Jane and her family, the Jiinue group is flourishing. The use of push-pull spreads quickest in densely populated areas like this, and the group is tightly knit and active. "Many are interested in joining our group," says Jane. "This will help us grow, and it will help the area become food secure."

5. Future directions

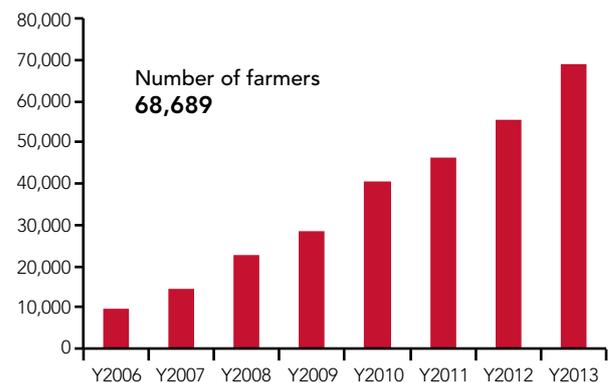
Push-pull is now practised by nearly 70,000 farmers in Kenya, Tanzania and Uganda. This steady spread represents a significant success and has had a substantial impact on the lives of many households.

Despite its overwhelmingly positive outcomes for the farmers featured in this report, push-pull is not a cure for every ill. Some farmers have faced challenges in adopting the technology, such as a lack of land and labour. Others do not have ready access to seed or planting material when they want to expand their plots. It can be hard to practise push-pull in areas where animals are traditionally free-grazed. Nonetheless, those who are able to adopt the technology tend to find themselves in a better position and become more resilient to economic and climatic shocks and stresses than they were before.

One of push-pull's strengths is the way the programme of work has been managed as a learning process. Because farmer participation is an integral part of push-pull dissemination, when farmers encounter problems in the field, these can be communicated, discussed and, if possible, solved. Achieving this level of reflexivity and responsiveness to change is thanks in no small part to the flexible approaches of the donor organizations that have funded push-pull, and it represents a substantial resource for the future.

A second important strength of the programme is its approach to partnership, which has ensured that dissemination has capitalized on synergies with existing organizations. On-going relationships with long-term partners Heifer International and Rothamsted Research are the result of many years of hard work and collaboration, and provide a strong foundation for the future development and spread of the technology.

The development of climate-smart push-pull has made it possible for the technology to travel to new areas with less rainfall, and to increase the potential number of farmers who might find it a useful and profitable addition to their livelihood strategies.



Number of farmers adopting push-pull 2006–2013

Work has begun to extend climate-smart push-pull in Ethiopia, trials are being carried out in Nigeria, and the technology has been adapted for use in South Africa. Slowly, the profile of push-pull is rising far beyond its home territory of western Kenya.

Push-pull has changed many lives and has the clear potential to change more. We end this report with the words of Ugandan farmer Peter Etiang, a grandfather and former civil servant who has returned to his farm in Busia in his retirement. His testimony is an eloquent plea for the further spread of push-pull.



Mary Atemo and members of the Maseno Depot Disabled Group share a joke with European Union Ambassador to Kenya, H.E. Lodewijk Briët, during his visit to their plot in July 2013. The EU funded the development of climate-smart push-pull.

Push-pull testimony – a salvation for farmers



Name: Peter Etiang

Location: Busia, Uganda

Age: 73, retired civil servant

Farm: 30 acres of maize, sorghum, millet, sweet potatoes, fruit and forestry

Household size: 12 – Peter, his wife, eight orphaned grandchildren and two farm labourers



“I can tell you that, having worked in the Ministry of Agriculture for 30 years, I have seen a lot. I have testimony about the issues of food security and the economic situation among the people. I think that I can talk from a position of strength.

“The production of cereals has never been very stable, never been consistent. Maize, for example, is an easy crop to grow, but it has constraints attached to it; mainly the pests: the stemborer and then the striga.

“I heard about push-pull. Because I had been working in agriculture I had curiosity to know more. I had a far-reaching interest, so I started doing it on my farm, and I found a high hope. The hope was that one day, this might work a miracle to save the people from famine, from poverty. You can do it on a small scale, you can do it on a big scale, and the returns are good.

“With this technology, I can see that the African Green Revolution may be forthcoming; and this is serious, because I don’t see what else you can do.

“It is not only yield. It is also sustainability. In some areas, the over-use of fertilizers has destroyed soil structure. So if you can avoid it by using desmodium, which will help you to improve your soil structure and fertility, and at the same time you can apply some organic material from your farm, your soil will live longer and do a better job. Good soil is a living thing.

“Sustainable production means safety for the soil; only then can you have assurance of food, and assurance of some economic benefits. If this push-pull can spread, and you can go to a greater scale, it will be a real salvation for farmers.”

Climate-smart push-pull planted with a crop of sorghum provides a resilient and sustainable farming option for the drier parts of sub-Saharan Africa.



The International Centre of Insect Physiology and Ecology (*icipe*) was established in Kenya in 1970, founded by renowned Kenyan entomologist Thomas Odhiambo. Its mission is to help alleviate poverty, ensure food security and improve the overall health status of people in the tropics by developing and extending management tools and strategies for harmful and useful insects, while preserving the natural resource base through research and capacity building.

Why work with insects? Because in the tropics, insects are a fact of life to be reckoned with. They pose a great risk to food production, often causing the loss of entire crops and destroying about half of all harvested food in storage. Livestock succumb in their millions to insect- and tick-borne diseases, resulting in loss of milk, meat and traction power.

The Centre's main objective is to research and develop alternative and environmentally friendly pest and vector management strategies that are effective, selective, non-polluting, non-resistance inducing, and that are affordable to resource-limited rural and urban communities.

Push-pull is one such strategy. It is an effective, low-cost and environmentally friendly technology for the control of stemborers and the suppression of striga weeds, the major pests of maize throughout Africa. For the farmers who successfully adopt 'climate-smart' push-pull, it can bring about an overall improvement in both farming systems and livelihoods.



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