

# Intensifying push-pull with high-value vegetables





## Background

### The need for intensification

The population of sub-Saharan Africa is increasing at over 2.6% per year. With an estimated population of 1.14 billion inhabitants, that is an extra 30 million mouths to feed every year. About 40% of the population lives below the poverty line (US\$1.90 per day) - the World Bank estimated that 433 million Africans were living in poverty in 2018. Meanwhile, in 2019, an estimated 234 million experienced chronic undernourishment, indicating that demand for food is already far beyond supply.

Rural poverty is exacerbated by low crop yields and over-worked, eroded soils, to the extent that poor people produce insufficient food and have minimal or zero income to buy to make up the shortfall. Poverty is rightly referred to as a 'trap' and is all-too-frequently a self-perpetuating and vicious spiral. Families with zero income have no resources to send their children to school - the one route that could offer them a better future.

### Cereal and vegetable farming in sub-Saharan Africa

Food production in sub-Saharan Africa (SSA), even of staples, is failing to meet demand. Since all parts of SSA have a tropical, equatorial or subtropical climate, they are not only ideal for plant growth, but also for pests, weeds and diseases. The most prevalent pests of cereals in SSA are: stemborers, fall armyworm and parasitic striga weed.

Vegetables are mostly produced, handled and marketed by women. Vegetables are highly profitable (margins per unit area five times those of maize). Moreover, vegetables are important sources of micronutrients, vitamins and minerals - essential components of balanced and healthy diets. Thus, vegetables are a 'win-win-win' (favouring women, increased income, improved nutrition) for rural farming communities.

However, vegetables are also attacked by a large number of pests: aphids, cabbage looper, diamondback moth, tomato leaf miner and others. Weeds and various bacterial, fungal and viral diseases are also prevalent in crop fields. Meanwhile, in an already drought-prone region, climate change is increasing the length and severity of dry spells, including during the wet growing seasons, and rising temperatures are also hampering crop production. All of these combine to make farming in Africa increasingly difficult and increasingly risky.

Increasing food crop production is therefore essential for sub-Saharan Africa. This can be achieved by increasing individual crop yields, but also by intensifying land use to produce more food from the same land.

Besides nutrition (people consuming diets traditionally heavy in starchy staples), food safety is another issue. Encouraged by big multinational businesses, many farmers see no solution to the problems of pests and diseases other than spraying (sometimes highly) toxic pesticides on their crops to achieve at least a minimum yield. Illiterate people (who make up about 35% of SSA adults, including smallholder farmers) are unlikely to follow safety instructions on pesticide labels, risking severe contamination of the soil, water resources and the wider environment, in addition to the health risks of pesticide drift during application and residues on crops if they are not handled properly after harvest before consumption.



Aphids on black nightshade.



Diamondback moth caterpillar damage on kale.



# Push-pull as a solution

In 1994, the International Centre of Insect Physiology and Ecology (*icipe*) in Kenya and Rothamsted Research in the UK, with initial funding from Gatsby Charitable Foundation, began the research that would ultimately lead to the development of push-pull, the first iteration of which was released to farmers in 1997. Since then, push-pull has been upgraded to a climate-smart version (replacing Napier grass with brachiaria and replacing silverleaf desmodium with drought-tolerant greenleaf desmodium) in 2012 and then a 'third generation' (introducing more drought-tolerant brachiaria variety 'Xaraes' and an African desmodium, *Desmodium incanum*) in 2019. *icipe* began a new research in 2020 on intensification of push-pull by integration of vegetables and started rolling out the new technology to farmers.

Push-pull combines the cereal pest attracting properties of a grass (Napier grass or brachiaria) with the pest-repelling, weed-smothering and striga-suppressing properties of desmodium. Napier grass and brachiaria both emit chemicals that are strongly attractive to cereal stemborers, but the insects' egg-laying is in vain - Napier grass produces a sticky gum that traps the borer and prevents it developing, while brachiaria emits further chemicals that attract stemborer-parasitic wasps that kill the larvae. Meanwhile, desmodiums are the most successful legumes identified to date for several purposes: first, they emit chemicals that repel cereal and vegetable insect pests and attract their natural enemies; second, they cause striga seed to germinate, but striga cannot parasitize the desmodium the way it does cereal crops, so the seeds die (suicidal germination of striga seed); and third, ground cover by growing desmodium suppresses weed growth and conserves moisture as a live mulch.

Studies of long-term push-pull fields have demonstrated that the presence of desmodium increases soil organic matter, fixes atmospheric nitrogen in the soil, and improves phosphorous availability and carbon sequestration (especially after two successive cropping seasons).



Pure vegetable push-pull: vegetable intercropped with desmodium with a field border of brachiaria.

## Intensification of the push-pull system with vegetables

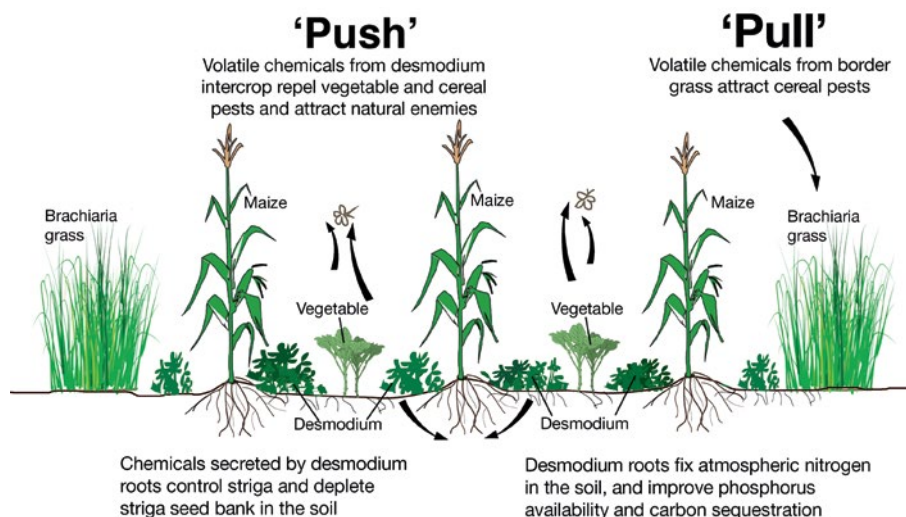
In 2019, reflecting on the need for sustainable intensification, *icipe* researchers asked an obvious question: will push-pull work for vegetables? Could vegetables be integrated with cereals in a push-pull system or planted between rows of desmodium during a fallow period after cereal harvest when the fields are typically left without any crop? It was quickly shown that desmodium does repel vegetable pests and does attract beneficial arthropods (predators and parasitoids); however, brachiaria and Napier grass do not attract vegetable pests, their sole but vital role being to attract female cereal stemborer moths to lay their eggs on them rather than on the cereal.

Armed with this information, *icipe* drafted a proposal for farmer-participatory research on vegetable integration into cereal push-pull in 2019, which was funded by Biovision Foundation for Ecological Development in 2020. At the earliest opportunity, and fortuitously just before the advent of the COVID-19 pandemic, *icipe* called together experienced push-pull farmers representing both genders, the whole spectrum of ages and western Kenya's different climatic zones - to suggest how a field might be laid out with vegetables and to identify their preferred vegetables.

The result is a base scheme that has vegetables replacing alternate lines of cereal (see diagram) and a list of farmer-preferred vegetables, headed by kale and black nightshade, followed by tomato and onion, but also including cabbage and cowpea. Like the researchers before them, the farmers also proposed planting vegetables after cereal harvest to benefit from soil moisture retained as a result of desmodium ground cover, thereby providing off-season food and income from the field.



Maize push-pull integrated with kale.





## Planting vegetable-integrated push-pull

1. Clear land during dry season and prepare the soil to make it fine. Demarcate the push-pull field and plant three rows of Napier grass or brachiaria around the border of the field, as shown in the diagram.
2. Mark out rows 37 cm apart.
3. Sow alternate rows with desmodium: the first and last rows of the field must be desmodium. You need 1 kg of desmodium seed for 1 acre (0.4 ha) of land. Plant desmodium with the rains for maximum germination.
4. Plant remaining rows alternately with cereal and vegetable per the diagram. Keep to recommended between-plant spacing (within rows) specific for each crop.
5. For off-season vegetables, plant the vegetables in the lines from which the cereal plants have been removed, and replace existing vegetables.
6. **Important:** Routinely monitor vegetables for weeds, pests and diseases during the establishment period of the push-pull field, especially while the desmodium is becoming established and has yet to fill the spaces between crops.
7. Trim desmodium after three and six weeks so it does not grow into crop rows.
8. Early weeding is very important for establishing a push-pull field. Weed once when the crop is three weeks old and once when the crop is five weeks old.



## Farmers' benefits

The case studies that follow are testimonies of clear benefits for farmers who have integrated vegetables into push-pull. The first benefit is healthier crops: the cereals and vegetables are, for the most part, free from pests, and the fields are, for the most part, free from weeds, including striga. Second is improved nutrition and nutritional security: by bringing vegetables into the family diet, farmers are improving their nutritional status and are therefore healthier and stronger. Third is having surplus crop to sell, be it vegetables, cereals or fodder, all contributing to household income and improving family well-being.

Fourth is health and safety: push-pull is essentially organic farming - no more pesticides on the farm, which reduces the risk of ill-health from toxic chemicals to a negligible level. Fifth, but by no means last, is that the design of the push-pull field provides everything the farmer needs: staple and vegetables for food, animal fodder from the grass (Napier grass or brachiaria) and desmodium, and the income from the sale of surpluses from all three. Other benefits are highlighted by the individual farmers interviewed for this brochure.



## NOW THE FAMILY IS WELL FED

Leonida Andewa of Esalwa village, Vihiga county, western Kenya, has a large family – seven children aged 28 to 43 years, and seven grandchildren. She has about an acre (0.4 ha) of farmland on which she grows maize, beans, banana, vegetables, Napier grass and push-pull with the help of her children and two occasional hired labourers.

After receiving information from *icipe* staff at a public farmers' meeting, she adopted both conventional and climate-smart push-pull in 2019 on a quarter of an acre (0.1 ha). In February 2020, *icipe* staff came to talk to the Blessed Dairy Farmers' Group about vegetable integration into push-pull. Learning that push-pull integrated vegetable farming could be profitable, she immediately adopted it for that long rainy season (March-April). She says that the earlier push-pull had made the soil soft, so it was easy to establish the vegetable integration. She has almost three quarters of an acre (0.3 ha) under push-pull.

In separate fields, Leonida has integrated kale, cowpea and black nightshade into maize push-pull. After maize harvest, she feeds some of the desmodium to her livestock (two local cows and a goat), remanures the field with local farmyard manure, and plants additional cowpea in what were the maize rows.



On the parts of her farm that are not under push-pull, she experiences striga, fall armyworm on maize, and beetles and aphids on vegetables. In the push-pull, however, the desmodium "traps" the insects and there are almost no pests. She harvests two sacks of vegetables, compared with very little yield outside of push-pull, some of which she sells.

Asked about the impact of vegetable push-pull on her life, she said: "it made me improve so much on various things – things I was unable to get now I can get out of that small income and buy them. Sometimes, because I had a large family, I was unable to feed them properly, but when we started this project now the family's coming up well."

Leonida plans to continue with vegetables, and even create several new vegetable push-pull fields so that she "will get much income."

While she has told her family, friends and neighbours about the push-pull, she says that most of them have small-scale farms, so only a few are adopting. She talks to them in various groups and adds "those who are interested, they practise."



Leonida Andewa of Vihiga county with her vegetable-integrated push-pull fields: cowpeas (bottom) and black nightshade (top).



## NUTRITIONAL SECURITY IN A DIFFICULT ENVIRONMENT, WITH A LITTLE TO SPARE



Ruth Tulli of Namanjalala village in Trans-Nzoia county showing off one of her chickens bought from the proceeds of her vegetables.

Trans-Nzoia county, western Kenya, is the 'cereal bank' of Kenya, with little space for anything other than cereals. Consequently, it has a vegetable deficit and has to import from other parts of the country.

Ruth Tulli has half an acre (0.2 ha) of land, which includes her home, in Amani village, which she farms with her husband and three children (aged 8-16 years). She first came across push-pull at a farmers' meeting attended by *icipe* staff in 2019. She then adopted conventional maize push-pull in 2020. At a further farmers' meeting in 2020, she learned about vegetable integration into push-pull and adopted it on 240 m<sup>2</sup> in 2021.

Before push-pull, she grew few vegetables. Her motivation for adopting was to have vegetables to eat, sell and give to family and friends. She found no difficulty

in establishing the field because it is very much like maize-bean intercropping, which she had done before.

She has observed no pests in the push-pull field, and also notes that the field does not dry out, because the desmodium ground cover minimizes soil moisture evaporation.

Trans-Nzoia has a long nine-month crop season and the farmers typically grow long-cycle maize that takes the whole season to mature. The vegetables are already finished by the time the maize is harvested. Ruth then plants more vegetables and beans for the off-season, which she occasionally has to irrigate.

Ruth is harvesting vegetables every two to three weeks. When she first had a surplus to sell, she made 1,000 shillings (about US\$9), with which she bought some chickens and a celebratory bottle of soda.

In the future, Ruth would like to expand her vegetable production under push-pull, but there is little land and she needs to consider her livestock. She says her neighbours have seen the vegetables and would like to adopt the intensified push-pull, but most are smallholders who also have small parcels of land and are yet to understand the viability and benefits of intensification. Ruth has seen the benefits and advantages of the intensified push-pull and encourages them to adopt it so they can get vegetables for a more nutritious and healthier diet. She says that smallholders who have no livestock could consider the benefit of selling forage (brachiaria and desmodium) to neighbours who do. For her, however, there is the big advantage of feeding desmodium to her chickens.

## PUSH-PULL WITH VEGETABLES INCREASES STANDARD OF LIVING

Tom Abok first adopted climate-smart push-pull on a quarter of an acre (0.1 ha) of his farm in Ndiru village, Homa Bay county, western Kenya in 2019. Then in 2020 a farming friend told him about the importance of vegetables and convinced him to try vegetable push-pull. Consequently, when he replanted the push-pull field, he did so with maize and kale - two lines of each separated by desmodium, replicated across the field. The good yields encouraged him to also integrate green leafy onions (a popular commercial vegetable

locally) on a second parcel of farm. He says it was very easy and straightforward to adopt.

"I used to grow vegetables," he says, "but I faced challenges - lots of pests and disease. It was a big problem and production was minimal." Now, however, "because we are using desmodium, pests and diseases: they are not there. ... In my garden, the production was very high and I got good income from it."

Some of the vegetables are eaten at home (he has a wife and seven-year-old child) and some sold. He is able to sell two half-sacks a year, and the proceeds go towards his siblings' fees and for personal use.

Overall, "it has increased the living standard for ourselves because of the production we get," he says. "We don't buy vegetables nowadays from the market, we just go straight to the farm and we have vegetables and we get something to eat."

"My plan for the future is to expand the farm, so that I'm growing onions, tomatoes and other vegetables."

He has told "so many people" about vegetable-intensified push-pull, including his mother and neighbours, and many of them have adopted it. To them, he says "continue doing the vegetable technology



Tom Abok of Homa Bay county (right) supplying kales and spring onions harvested from his push-pull integrated vegetables to a trader at the local Rodi Kopany market.

because it has a lot of impact in their lives and increases standard of living." To others, he says "adopt it [vegetable push-pull] and you will get something from it."

## VEGETABLES IN PUSH-PULL EARN PARENTAL FAVOUR OF MORE LAND

Single mum Irene Lwamba practises maize-and-vegetable push-pull on a small field on her father's 2 acre (0.8 ha) farm in Ebukolo village, Vihiga county, western Kenya.

Irene learned about push-pull from a friend who was growing many vegetables, from which she was gaining an income. Her friend was also feeding dairy cattle from push-pull, which were giving good milk yields with surplus for sale. Irene was convinced to try the integration, and a neighbour provided the manure to start her field. She began with a 9 m x 9 m field in the second (short) rainy season of 2020. In 2021, in light of the benefits, her father allowed her to increase her field to 25 m x 30 m.



Irene Lwamba of Vihiga county harvesting her vegetable-integrated push-pull.



Selling the vegetables at the local market in Luanda.

She says that the field was "not difficult" to establish and that even someone unschooled would be able to do it from an explanation.

Before push-pull, Irene's vegetables were heavily infested with pests, which caused losses. With push-pull, however, she is seeing vigorous plants and high yield, faster growth and regrowth, increased soil fertility, and fewer pests.

After the maize harvest, Irene plants cowpea in the maize rows. Cowpea has a short one-month growth cycle, so is ideal for the short off-season farming.

Irene's push-pull vegetables (kale and cowpea) are either eaten at home or sold. The income she makes from the vegetables is accumulated and then used for school fees for her two primary school-aged children.

She says that push-pull has improved the soil fertility and also made the soil "lighter", and so easier to work on; there are no more maize pests; there is increased milk yield because of the quality of the fodder (brachiaria hay mixed with desmodium); and she now has income. She wants to expand the push-pull further.

Irene has shared her experience with friends and neighbours, three of whom have also adopted vegetable-integrated push-pull. With some of her neighbours, she has formed a vegetable farming interest group.

Her message to other farmers is that they should "come and see the benefits of push-pull": milk, food, vegetables, income.



## FROM ENVY TO REGULAR INCOME

Everline Ouma is a young woman with four children in primary school or baby-class and half an acre (0.2 ha) of land, which she farms with her husband in Kosio village, West Kanyadwera location, Kisumu county, western Kenya.

A neighbour called Jacinta is an *icipi* lead push-pull farmer and became self-sufficient in vegetables under push-pull, selling her surplus to neighbours such as Everline.

Everline was envious and jealous of Jacinta - "in a positive way," she stresses - and admired the field arrangement with maize and how vigorous the vegetables looked. Then in 2020, Everline met *icipi* field staff at a training event on Jacinta's farm and learned how to establish her own vegetable push-pull. Consequently, in the 2020 short rains, she established a field of 28 m x 16 m with maize, kale and black nightshade. She decided to grow them all together with two rows of one vegetable separated by greenleaf desmodium from two rows of the other vegetable in one direction and maize in the other. At the end of the maize season, Everline follows the maize rows, but replaces the vegetable plants with younger ones.

Before adopting push-pull, Everline grew black nightshade and cowpea. In push-pull she understands "proper" agronomic practice and control of pests, and has increased her income. For example, her first vegetable harvest from the push-pull earned her US\$ 8-9 at the local market, which is a "short" 30-minute walk away. Subsequently, she's been making \$1-2 a day from local sales, which she says assures her of a basic income.

Everline has shared her experience with some of her neighbours, one of whom has adopted climate-smart vegetable push-pull. Her message to other farmers is simple: "push-pull can transform your livelihood." Just as she was jealous of Jacinta and acted on it, so others should do the same - adopt push-pull and become food self-sufficient and have surplus to sell for cash income.

While Everline says she could sell her vegetables in the city, she thinks it is better to be self-sufficient. With some of the proceeds from her farm she bought some chickens. She is thinking of increasing the size of her push-pull field and adding other vegetables such as onion.



Everline Ouma (left) selling black nightshade and kale from her push-pull in Kisumu county to one of her neighbours.





John Ngatia and Docia Njenga of Trans-Nzoia county, flanking their son (10), daughter (14) and grandchild, showing off some of their 'sweet' kale.

## HIGH DEMAND, PREDICTABLE INCOME

John Ngatia and his wife Docia Wanjiku Njenga live in Trans-Nzoia county, western Kenya, with its single long growing season. The region is a major maize-growing zone and has a vegetable deficit. They farm 1.5 acres (0.6 ha) with maize and beans, and keep a pure-breed dairy cow, three sheep and chickens.

They learned about push-pull at a government-run public farmers' meeting in 2018, and adopted the conventional version on a 30 m x 30 m field that same year. They then switched to climate-smart push-pull. In early 2021, during a farmers' meeting held in their home, visiting *icip*e research officer George Genga introduced the intensification of push-pull with vegetable integration. Given how well the maize push-pull had done, they integrated vegetables into a 30 m x 30 m field for the 2021 season.

"The soil was soft because of the desmodium," says John, "and we planted with farmyard manure rather than fertilizer - establishment was easy."

"Kale, black nightshade and cowpea grown before push-pull had had lots of pests, but the push-pull field has been pest-free," says John. "We are harvesting one bag [90 kg] of kale and half a bag of black nightshade three times a season." And those are in addition to what

they consume at home. "The vegetables we sell are bringing us 300 shillings [about US\$2.70] twice a week for three months." John and Docia are using their new income for school fees and to "buy other things." With its three-month economic life, they replace the kale once or twice during the maize-growing period to maintain vegetable production. They then grow cowpea in the off-season.

The couple say that the impact on their lives has been great - they have increased income, the vegetables are sweet, they are spending less on health and less on other food, they are experiencing good nutrition.

They plan to expand their fields to produce even more vegetables and maize, and to continue to sell surplus produce at their farm gate. They say that those who come to buy are interested in adopting vegetable-integrated push-pull and want to enter the project: four of their neighbours have adopted it already.

"Maize takes a long time to reach harvest," John says. "Vegetables have a shorter cycle and are easier to manage. We are gaining a lot of income from vegetables. While maize price fluctuates, vegetables are in high demand and provide us with a predictable income."



## VEGETABLES, MAIZE, FODDER AND INCOME ALL FROM ONE INTENSIVE PUSH-PULL PLOT

Florence Nyabaro and her husband own 3 acres (1.2 ha) of land in Chisaro village, Kisii county, western Kenya, which comprises their homestead and their farm. Florence attended an end-of-season field day run by agricultural extension staff at a local demonstration site in 2020, where she learned about vegetable-integrated push-pull. Impressed by the pest-control message, she decided to adopt it. A number of local farmers came together to form an '*icip*e group', of which she is a member.

After testing the method in a 20 m x 25 m field in 2020, in 2021 Florence grew black nightshade, kale and spider plant in push-pull with maize. The maize and vegetables are for home consumption (she has seven children aged between 9 and 24 years), the Napier grass and desmodium are fed to her cow, and surplus vegetables and fodder are sold.

She says that establishing the push-pull field as a newcomer to the technology was "moderate" (i.e. neither hard nor overly easy). Compared with vegetables that she had grown in the past, Florence said that the primary differences with push-pull were that she had no need to use pesticides and that she could take multiple harvests - vegetables, maize and fodder. With the income, she can buy household items, and contribute to school and college fees - the vegetable profit is complementing household income.

In the future, Florence plans to grow multiple push-pull fields and stagger them - mainly as a way of making money to contribute further to her children's school and college fees.

Family and neighbours whom she has told about push-pull have appreciated the information and some have adopted it in 2021.

To the wider farming community, Florence says: "push-pull integrated with vegetables is very useful, because you get vegetables, maize and fodder, and income. The entire field is used intensively."



Florence in her black nightshade and maize push-pull field.



Florence with her three youngest children show off healthy kale leaves.





Vitalis Njaga weeding his kale plants in his vegetable-integrated push-pull field in Kisumu West sub-county.

## AN EASY LIFE

Vitalis Njaga is an experienced push-pull advocate, successful farmer, strong opinion leader and farmer-trainer. His 3 acre (1.2 ha) farm in Yenga village, Kisumu county, western Kenya is used for maize, vegetables, bananas, sweet potato, beans and livestock-raising.

Vitalis first adopted conventional push-pull in 2007 on a small 15 m x 20 m field, later upgrading to the climate-smart version and expanding to several fields making up over half an acre (>0.2 ha). In January 2020, he was selected by *icipe* to field-test vegetable integration. They visited his farm and explained the advantages, especially in vegetable pest control. Since Vitalis's vegetables had been attacked by fall armyworm and aphids to the point where he had all-but abandoned vegetable farming, he decided to test the vegetable integration on a new 15 m x 20 m field. He says the field was very easy to establish.

He has identified a number of advantages to growing vegetables in push-pull. Overall, he says it is very easy farming and highly profitable. While waiting for the maize, which takes three months, he can harvest and sell vegetables for quick income. The maize provides food and cash for seeds and more. He says the land

under push-pull is "good - everything we need is there: maize and vegetables, fodder for animals, and it is easy to cultivate." There are no pests and therefore no need for chemicals.

"Formerly, I used chemical [pesticide] for vegetables, but not now. I also used a lot of fertilizer, but not now because of desmodium. I make quick income - it is a very easy life," he says.

He plans to keep expanding his vegetable area across most of his farm, because "growing maize alone leads to poverty" - it has a three-month growth cycle, while vegetable harvest starts after one month and is continuous. The market is conveniently nearby. Vitalis also plans to supply vegetables to the school, primarily to feed boarders.

Vitalis has trained many of his friends, neighbours and others, even helping them to implement push-pull on their farms. "People are coming to adopt in large numbers," he says, "which is leading to reduced poverty. It is very easy to convince others," because they see what Vitalis has and compare it with their own farms. "Local farms are full of striga, especially in among the maize, which is the staple crop."





Beryl in her cowpea-integrated push-pull field.

## PROVING HER WORTH - "DISABLED PEOPLE JUST NEED A CHANCE"

Beryl Munika is a 32-year-old single mother with a disability - she needs a crutch to help her walk. It took over two years to persuade her father to let her have her own farm on the family smallholding. Now almost a decade on, she has taught her parents and other local farmers a few things about boosting production and income through vegetable-integrated push-pull: it is she who provides the family with fresh vegetables, her fodder crops feed her parents' livestock, and she harvests upwards of two sacks of maize (180 kg) from her quarter-acre (0.1 ha) push-pull farm while her neighbours typically harvest just 2-10 kg from their entire mono-cropped maize area.

"A friend introduced me to the push-pull physically challenged group, which I attended for about a year without doing anything," says Beryl. Eventually, "in December 2012, my father gave me the poorest part of the land," she recalls - the soil was spent and the maize yields were minimal. Her parents expected her to ask for resources, especially cash for laborers. But Beryl had something to prove. Her first push-pull was planted in 2013. Today, 'Beryl's farm' is well known locally for its Napier grass border and neat crop rows. In 2020, she immediately adopted vegetable integration when she learnt about it from *icipe*. When *icipe* staff told her that vegetables in push-pull could provide quick income while the maize was growing, she integrated

vegetables into her whole push-pull field. "I get two or three vegetable harvests while the maize is growing," she says.

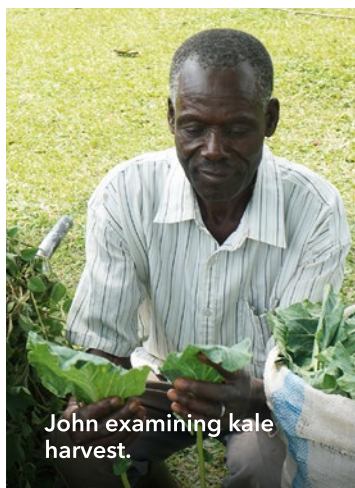
After the maize harvest, Beryl grows cowpea in the push-pull, which she can harvest in as little as two weeks. She also retains the longer-lived kale, replacing it every three months. While the vegetables are also eaten by the family, the majority are sold. The income she makes covers the fees and transportation for her three-year-old son to attend private school over 4 km away (combined about 4,000 shillings a month, or US\$35), toys and other food.

Nineteen-year old Sylvia has just finished her 'O' levels and wants to study agricultural engineering. In a country where most youth are turning their backs on farming as a dead-end job, Sylvia sees her big sister as a role model who has brought a lot of success from agriculture. Even their parents admire Beryl's success and are adopting push-pull.

To her fellow Kenyans, Beryl says: "We disabled people, we just need a chance!" With just a little help, she has shown that her disability is no barrier to success.

Biovision is making a film about Beryl and her life with push-pull technology.





John examining kale harvest.

## COME AND SEE!

John Otiep lives in Wawaga village, Migori county, western Kenya, where he has an 8 acre (3.24 ha) farm. He grows cereals and vegetables, raises chickens and dairy cows, and nine people get their livelihoods from the farm. John adopted conventional push-pull in

2008; and by the time he adopted climate-smart push-pull in 2010 he was earning enough from farming to pay high-school fees for the eldest of his 12 children.

In 2020, John was one of the pioneer experienced push-pull farmers invited to *icip*e Mbita Point to advise on field layout with vegetables and viable preferred vegetables for integration. John tested the vegetable push-pull on a 25 m x 25 m field. In 2021, he expanded the field to quarter of an acre (0.1 ha). The vegetables are kale, black nightshade, cowpea and green bunching onion (onion that looks a bit like leek).

"Most of the pests were controlled," says John. "And I get vegetables, maize and fodder from one field." His records show that the same field that used to produce two sacks (180 kg) of maize produced one sack of

maize and five or six sacks of vegetables under the new intensified push-pull. Some of the vegetables are eaten at home, thereby improving the family's nutritional status, some are sold and some are given to the high school in lieu of fees. The cash earned from the vegetables pays for other school fees, for health management and for clothing (including school uniforms).

Maize is killed by the all-too-frequent droughts, but the vegetables survive. John says he intends to expand the push-pull to supply the school with vegetables during drought, and that he also plans to establish a water supply to the home and farm from his profits. This will enable him to irrigate his crops during drought, thereby saving the maize and increasing vegetable yields for increased income.

John is also a long-standing peer farmer trainer who uses his farm as a training ground for many other farmers in Awendo sub-county. He was also featured in an agricultural TV programme, *Shamba Shape-up*, which created a lot of publicity and interest in the integrated push-pull vegetable technology. His message to other farmers is simple: "Come back and see how to practise push-pull for food self-sufficiency. With the vegetable push-pull, I have all the food I need for my family and my animals!"



John Otiep talking to *Shamba Shape-up* crew about vegetable-integrated push-pull at his homestead, in preparation for a feature for Citizen TV, a national network with over 5 million viewers.





Young school children enjoying a meal of fresh kale from Molly's farm.

## PUSH-PULL IS GOD-SENT

For 66-year-old Mama Molly Osita, farming has been a means of feeding, clothing and educating 'her' children - the children she has responsibility for as orphans and pupils at 'her' school. Three quarters of her 2 acres (0.8 ha) of land are occupied by the school that she helped establish in the mid-2000s. Since she adopted climate-smart push-pull in 2015, the farm has provided food and income to pay for the children's needs and 12 full-time teachers.

In 2020, after attending an *icipe* Mbita Point seminar for experienced push-pull farmers about the vegetable intensification design and options, Molly planted a

vegetable push-pull test field with kale, which proved very productive. She now has a second, bigger field with onions and black nightshade. With her previous push-pull experience, Molly says that the integrated vegetable field was very easy to establish. After the maize harvest, she plants more vegetables and the field is productive through the off-season.

The vegetables in her push-pull give better yields and are healthier than the ones she used to grow, which were attacked by cabbage looper, aphids, diamondback moth and fall armyworm. They are also much healthier as food for Molly herself, as she has severe allergies especially to the pesticides used on the vegetables typically sold on the local market. She rarely finds pests in her vegetables in push-pull and the interactions of the various components mean she has no need to spray them.

"Most of the vegetables are eaten by the children and me," says Molly, "and what's left over is sold. We are all very happy ... very healthy. There's more money and more food for the children. ... The children eat well and we no longer buy vegetables."

Historically, farmers in her community have not sold their vegetables, so having surplus to sell is a new thing for them. She says: "Continue to grow vegetables: they will change your life, raise your income; you can eat vegetables, market them and sell them to friends." In short, Molly says, "push-pull is God-sent!"



Molly with some of the kale from her push-pull. Note the novel arrangement of kale either side of the maize, with desmodium outside the lines of kale, showing that farmers feel free to experiment with the basic design - deeper in the field, she has rows of desmodium between the kale and the maize.



## WE NEED POLITICAL LEADERSHIP, COMMUNITY EMPOWERMENT AND RESOURCES FOR DEVELOPMENT



Paskalia Shikuku of Siaya county delivering her vegetables to the local market vendors who buy them.

By any measure and especially in her neighbourhood, Paskalia Shikuku is a successful farmer. She has six push-pull fields on her 3.5-acre (1.4 ha) farm in Indor village, Siaya county, western Kenya. Three of those include vegetables planted at the start of the 2021 long rains - two with kale and one with onion.

insects from attacking them. She does not need to apply insecticides to the push-pull fields, but had to spray mono-cropped vegetables every three weeks in the previous dry season. The only management the vegetables need is occasional weeding.

"I have seen lots of changes," she says. "I have a little income every day, which was not the case before. I am selling frequently, assured of income. This means I can buy medication when needed" for herself or her youngest daughter (24) who works on the farm. With the extra income, she plans to finish her house and also dig a borehole so she can irrigate the vegetables during the dry spells that are increasing with climate change. She will also expand her vegetable push-pull area.

Her motivations for adopting vegetable push-pull are diverse and much the same as those that led her to adopt and spread the message about earlier forms (conventional in 2011, climate-smart in 2014 and third-generation in 2019) - fodder production, nitrogen fixing, striga control, soil erosion prevention, income, being climate-smart, and insect control. Paskalia says the soil in the push-pull fields is easy to cultivate, the fields are clean (i.e. weed-free) and they require less labour than her other fields.

Her vegetables are soft and sweet, and her neighbours and customers like that. The vegetables are also clean rather than damaged, as push-pull prevents many

But Paskalia has much bigger dreams: "People can do things together," she says, "but we need resources. We need support for small community development - empowerment and resources." She is not talking about gifts, either. She recognizes that she has the means, but needs to know which resources to buy to continue to develop. "If the Mijikumi [the lowest administrative unit of government, common interest-cum-policy committee that oversees security, health and social well-being] were to mobilize all the local villages for vegetable push-pull for food security, then everyone would be better off and have income.



Paskalia Shikuku on her cowpea-integrated push-pull farm in Indor village, Siaya county.





## About *icipe*

The International Centre of Insect Physiology and Ecology (*icipe*) is an intergovernmental organisation established in Kenya in 1970 by renowned Kenyan entomologist Thomas Risley 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.

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 which are affordable to resource-limited rural and urban communities.

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## About Biovision

Biovision Foundation for Ecological Development is a charitable organization in Switzerland. Since its establishment in 1998, Biovision Foundation has been promoting development, dissemination and application of sustainable ecological agricultural practices allowing people in the developing world to help themselves. The Foundation advocates for an agroecological transformation of the food system and makes significant contributions to the Sustainable Development Goals (SDGs) in the implementation of Agenda 2030 at local, national and international levels for eliminating extreme poverty, reducing inequality, and protecting the planet.

Biovision Foundation has been supporting *icipe*'s Push-Pull Programme since 2002.

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