

December 2007 volume 23 no.4

# LEISA

Magazine on Low External Input and Sustainable Agriculture



## Ecological pest management

# Enhancing the Push-Pull strategy

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Millions of rural people in Eastern Africa depend on maize and sorghum for food security and cash income. Despite this, production of these crops is seriously affected by constraints such as stemborers, the parasitic weed *Striga hermonthica*, low and declining soil fertility, lack of knowledge on how to manage these pests and weaknesses in the extension system. Stemborers lead to yield losses of 30 - 40 percent, while *Striga* infestation causes a loss of 30 - 50 percent to Africa's agricultural economy on 40 percent of its arable land. Although chemical control is usually recommended, it is uneconomical and impractical for many small-scale farmers, and has negative impacts on the environment and human health. On the other hand, the commonly used cultural method of uprooting *Striga* is labour-intensive and less effective. Adoption of effective control methods is limited due to lack of labour, little knowledge about the pest problems, and lack of other resources needed to make the necessary investments.

Affordable alternative strategies are needed to combat the growing threats to the smallholders' livelihoods. One such method is the "Push-Pull" strategy. This combines knowledge of the chemical ecology and agro-biodiversity of the stemborer, with *Striga* management. This strategy was developed by scientists at the International Centre of Insect Physiology and Ecology (ICIPE) in Kenya and Rothamsted Research in the United Kingdom, in collaboration with other research organisations in Eastern Africa. A first article about Push-Pull in *LEISA Magazine* (Vol.17 No.4, December 2001) presents it as a viable "organic" alternative to genetically modified maize (Bt maize). This article explains how the Push-Pull strategy has been adopted by farmers in Kenya since then.

## How does the Push-Pull strategy work?

Push-Pull uses a combination of legume repellent plants to deter the pest from the main crop ("push") and trap crops to attract the repelled pest ("pull"). Molasses grass (*Melinis minutiflora*) and *Desmodium* (*Desmodium uncinatum*) are the common repellents, whereas Napier grass (*Pennisetum purpureum*) and Sudan grass (*Sorghum vulgare* var. *sudanense*) are the common trap plants. Research has shown that the repellent plants produce chemical compounds, some of which repel the stemborer pests. On the other hand, during dusk Napier grass produces other chemical substances that evaporate easily, some of which are good attractants for stemborers to lay eggs. Fortunately, Napier grass produces a gummy substance which traps the resulting stemborer larvae, and only few survive to adulthood, thus reducing their population.

Push-Pull also suppresses and eliminates the *Striga* weed through several mechanisms, including nitrogen fixation, soil shading and allelopathy. Allelopathy is where one plant harms another with chemical substances: *Desmodium* roots produce such chemical compounds. Some of these compounds stimulate *Striga* seeds to germinate but others inhibit lateral growth and the attachment of the *Striga* roots on to maize roots. The *Striga* dies, and eventually the number of *Striga* seeds in the soil decreases. As *Desmodium* is a perennial crop, it controls *Striga* even when the host crop is out of season, making it a better repellent than other legumes.

## Opportunities for diversifying livelihoods

The Push-Pull strategy is a good case of how basic research can contribute to the enhancement of agricultural productivity

and improvement in the sustainable use of natural resources. The strategy provides several benefits, directly or indirectly contributing to the livelihoods of rural families. Such opportunities include:

### Improving food security

Push-Pull has increased maize yields of farmers in Kenya by an average of 20 - 30 percent in areas with only stemborers (Trans Nzoia district), and by more than 100 percent in areas with both stemborers and *Striga* (e.g. Vihiga, Siaya, Suba and Migori districts). This has been a key incentive for its increased adoption.

### Reduced soil erosion and increased soil fertility

By providing a good ground cover, the strategy improves soil conservation. Through nitrogen fixation, the strategy reduces the required amount of nitrogen fertilizers, which are unaffordable by most smallholder farmers. A long-term study at ICIPE's on-station fields in Mbita, western Kenya, has shown a significant increase in total nitrogen on field plots under maize-*Desmodium* intercropping for three years, especially when compared to maize fields intercropped with other legumes.

### Enhanced biodiversity

The Push-Pull strategy promotes and conserves biodiversity by maintaining species diversity. This, in turn, improves natural and agricultural ecosystems by contributing to ecosystem services such as nutrient cycling and decomposition. This helps in developing sustainable crop protection systems which rely less on pesticides. A study conducted in Lambwe Valley (Suba district, Kenya) shows that the strategy is associated with an overall enhancement of beneficial predators, which is important in agricultural systems.

### Livestock production and human health

Unstable availability and seasonality of livestock feed have been major constraints to improving dairy livestock in Eastern Africa. Push-Pull provides quality fodder for livestock. On small farms where land pressure is high, this is likely to improve the health of farming families, especially children. Improved dairy cows and goats are emerging as important income alternatives for smallholder farmers.

### Protecting fragile environments

Higher crop yields and improved livestock production, resulting from habitat management strategies, have the potential to support rural households under existing circumstances. This can slow the migration of rural populations to areas designated for protection. Moreover, farmers using such strategies have less reason to use pesticides that could affect flora and fauna in the agro-ecosystem.

### Income generation and gender empowerment

Push-Pull has shown promising impacts of not only enhancing farm incomes but also empowering rural women. It provides alternative income sources, as surplus grain, fodder and *Desmodium* seed can be sold. It also has potential for improving the quality of rural life as more partners interact with farmers to disseminate it to other farmers.

## Push-Pull dissemination to smallholder farmers

The Push-Pull strategy has been adopted by more than 10 000 households in 19 districts in Kenya, five districts in Uganda,



Photo: Jimmy Pitchar / ICIPE

Consolata enjoys talking about the success of her Push-Pull fields, and sharing her knowledge with others as an FFS facilitator.

and two districts in Tanzania. It is being promoted by the public extension system, non-governmental organisations, the private sector, and by regional partners in these three countries. Previously, the strategy has been disseminated through mass media (a radio programme called *Tembea na Majira*), printed material (newspapers, brochures, information bulletins and posters), farmer field days comparing Push-Pull and conventional cropping systems, agricultural shows, farmer-to-farmer extension (farmer teachers), on-station demonstrations, and public meetings (*barazas*). These methods have produced variable achievements.

The Farmer Field School (FFS) approach is now being used to disseminate this strategy as it is knowledge-intensive, and the FFS approach is likely to increase economies of scale by reaching out to many thousands or millions of farmers. The FFS approach uses a curriculum developed by stakeholders involving farmers, government extension staff, researchers, FFS and curriculum specialists, ICIPE scientists, and staff from NGOs and community-based organisations. The curriculum includes weekly sessions during two cropping seasons, largely based on the life cycle of maize, namely: (a) pre-season weekly sessions of five weeks covering activities that prepare the ground for FFS formation and implementation, (b) a first season of 21 weeks corresponding with the first maize cropping season activities, (c) first off-season sessions of two weeks involving relevant economic activities, and (d) a second season of 23 weeks corresponding with the second maize cropping season. The programme follows two seasons because during

the first season, the companion crops (Desmodium and Napier grass) are not fully established for farmers to learn how to manage them. Additionally, given the emphasis on learning by observation and discovery, learning how to conserve and utilise Push-Pull products is made easier during the second season. During this season farmers also learn how to establish Push-Pull plots using Desmodium vines and Desmodium seed multiplication plots. The curriculum also involves collecting relevant information for assessing the effectiveness of the Push-Pull strategy.

Following the successful launch of the Push-Pull curriculum in Bungoma district in western Kenya, in March 2007, ICIPE organised a first training workshop for FFS facilitators the following month. The objective was to train facilitators on the strategy, learn how to implement it in a field school, and develop facilitation and group management skills. The workshop was attended by experienced FFS facilitators from Bungoma and Busia districts and potential facilitators from Suba and Homa Bay districts, all in western Kenya. After the training, the facilitators from Bungoma and Busia started implementing the curriculum in the existing FFSs. Now there are 22 and 12 FFSs in Bungoma and Busia respectively. One such school in Bungoma, the Ngwelo FFS, started in 2005 initially to learn about conservation agriculture in growing groundnut and water melon. Its members had some prior knowledge about Push-Pull through the Push-Pull radio programme. Some of the FFS members were among a group of farmers who took a study tour to the ICIPE-Mbita station to see

the Push-Pull demonstration site. They were encouraged by the superior performance of Push-Pull compared to other legume intercrops. The school then approached the Bungoma district Umbrella FFS Network to provide an experienced facilitator whom they pay weekly stipends. Ngwelo FFS has provided useful lessons for establishing FFSs in other areas in western Kenya.

ICIPE organised a second workshop in June 2007 at the ICIPE-Mbita station to train FFS facilitators from the Suba and Homa Bay districts. First, interested farmer groups were identified through focus group discussions with experienced Push-Pull farmer teachers and non-practising Push-Pull farmers. These discussions were used to find out about the groups' profiles, members' access to information, and experience with Striga and stemborer control. They also provided entry points for raising awareness among farmers about the strategy and role of FFS in providing opportunities to learn new or improved strategies. Each group then selected one farmer to attend the

support provided by the ICIPE field staff, Consolata and the other farmers planted Push-Pull fields. Currently, Consolata is the facilitator of an FFS in Ebukhaya village in Vihiga district.

Consolata used to harvest about 45 kgs of maize per season from a 0.25 acre plot. During the 2002 long rainy season she started using the Push-Pull strategy and harvested about 270 kgs. This motivated her to increase her Push-Pull acreage to half an acre in 2006. Since then she has been selling some of her Napier grass to neighbours. She has also acquired a dairy goat, which she feeds on her own fodder. She has increased her livestock herd and her milk production has increased dramatically.

Consolata has disseminated the Push-Pull strategy to several other farmers in her neighbourhood. She has been an example to others, with over 30 visitors to her farm from outside the district. Consolata is gradually expanding her Push-Pull fields, leaving a small portion of her farm for planting maize and beans. Asked to sum up what she enjoyed most about the strategy, she said: "I don't have to buy a lot of maize from the market to feed my family. Push-Pull has also enabled me to have more livestock".

#### Future outlook

Push-Pull is not a universal remedy for solving smallholder farmers' problems, but it can provide opportunities for diversifying livelihoods. The major constraint to its dissemination to thousands or millions of farmers has been the non-availability of Desmodium seed. Several opportunities have emerged, including involvement of a private seed company, community-based seed production and vegetative multiplication. The relative merits of these in stimulating the diffusion of the strategy are being investigated. In addition, the effectiveness of different dissemination pathways, such as mass media, print media, farmer-to-farmer advisory and Farmer Field Schools are being evaluated to provide lessons for improving the dissemination of Push-Pull.

Work is underway to develop tools for ensuring the performance of new Push-Pull components, as well as to improve our understanding of soil nutrient dynamics. Research is also ongoing into the emerging problems of a previously unrecognised pest (a pollen beetle attacking Desmodium) and a disease of the companion crops (phytoplasma disease in Napier grass). Questions relating to the potential integration of new production and protection strategies (e.g. Bt maize) or their complementarities have been raised. This has stimulated the need to evaluate crop productivity and protection strategies in continued collaboration with other centres. The Push-Pull strategy thus lays the foundation for wider scientific work and serves as a model for the management of other pests in Africa and beyond.

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#### References

- Cook, S.M., Z. R. Khan, and J.A. Pickett, 2007. **The use of 'Push-Pull' strategies in integrated pest management.** *Annual Review of Entomology* 52: 375-400.
- ICIPE, 2007. **Push-Pull curriculum for Farmer Field Schools.** International Centre of Insect Physiology and Ecology, Nairobi, Kenya.
- Nielsen, F., 2001. **The Push-Pull system – a viable alternative to Bt maize.** *LEISA Magazine* Vol.17 No.4: 17-18.



Photo: Philimon Orondo / ICIPE

**An FFS Farmer facilitator demonstrates how to plant Napier grass around a maize field; Lambwe Valley, Suba.**

facilitators training workshop. As in the first training, this was also supported by experienced FFS facilitators from established FFSs in Bungoma district. The trainees visited ICIPE's on-station Push-Pull fields at Mbita and several Push-Pull farmers in Suba. Later, the Suba and Homa Bay facilitators visited Farmer Field Schools in Bungoma district, where they observed how a typical FFS is organised. They engaged in observational learning, asked questions and sought clarifications. They also visited Desmodium seed bulking plots. Using this strategy of training, ICIPE has trained more FFS facilitators in about ten districts in Western Kenya. It has also organised training for farmers from Uganda, who will eventually be trained as FFS farmer facilitators.

#### Success story

Consolata James is a mother of four children, living in Ebuchie, a village in the Luanda division in Vihiga district (western Kenya) with 3.5 acres of land. She was among the first 12 farmers from Vihiga who visited the ICIPE-Mbita station and the farmers in Suba in 2001 to learn about Push-Pull. Following this field experience and with technical