Push–pull technology

The **push–pull technology** is a strategy for controlling agricultural pests by using repellent "push" plants and trap "pull" plants. For example, cereal crops like maize or sorghum are often infested by stem borers. Grasses planted around the perimeter of the crop attract and trap the pests, whereas other plants, like *Desmodium*, planted between the rows of maize repel the pests and control the parasitic plant *Striga*. Push–pull technology was developed at the International Centre of Insect Physiology and Ecology (ICIPE) in Kenya in collaboration with Rothamsted Research, UK [1]and national partners.

Pests of cereal crops

Stemborers, parasitic striga weeds and poor soil fertility are the three main constraints to efficient production of cereals in sub-Saharan Africa. Losses caused by stemborers can reach as high as 80% in some areas and an average of about 15-40% in others. Losses attributed to striga weeds, on the other hand, range between 30% and 100% in most areas, and are often exacerbated by the low soil fertility prevalent in the region. The soils are highly degraded due to continuous cropping with limited or no external inputs to improve soil fertility. When the two pests occur together, farmers often lose their entire crops. Crop losses caused by stemborers and striga weeds amount to about US$ 7 billion annually, affecting mostly the resource-poor subsistence farmers.

Control of stemborers using pesticides is not only expensive and harmful to the environment, but also usually ineffective, as the chemicals cannot reach deep inside the plant stems where stemborer larvae reside. Similarly, the use of herbicides against striga is neither effective nor feasible among smallholders in the region for both biological and socioeconomic reasons. Preventing crop losses from stemborers and striga weeds, and improving soil fertility in eastern Africa alone could increase cereal harvests enough to feed an additional 27 million people in the region

The pull

The approach relies on a combination of companion crops to be planted around and among maize or sorghum. Both domestic and wild grasses can help to protect the crops by attracting and trapping the stemborers. The grasses are planted in the border around the maize and sorghum fields where invading adult moths become attracted to chemicals emitted by the grasses themselves. Instead of landing on the maize or sorghum plants, the insects head for what appears to be a tastier meal. These grasses provide the "pull" in the "push–pull" strategy. They also serve as a haven for the borers' natural enemies. Good trap crops include well-known grasses such as Napier grass (*Pennisetum purpureum*) and Sudan grass (*Sorghum vulgare sudanense*). Napier grass has a particularly effective way of defending itself against the pests: once attacked by a borer larva, it secretes a sticky substance which physically traps the pest and limits its damage.

The push

The "push" in the intercropping scheme is provided by the plants that emit chemicals (kairomones) which repel stemborer moths and drive them away from the main crop (maize or sorghum). The best candidates discovered so far with the repellent properties are species of leguminous genus *Desmodium*. *Desmodium* is planted in between the rows of maize or sorghum. Being a low-growing plant, it does not interfere with the crops' growth and, furthermore, has the advantage of maintaining soil stability, improving soil fertility through enhanced soil organic matter content and nitrogen fixation. It also serves as a highly nutritious animal feed and effectively suppresses striga weeds. Another plant showing good repellent properties is molasses grass (*Melinis minutiflora*), a nutritious animal feed with tick-repelling and stemborer larval parasitoid attractive properties.

How push–pull works

The push–pull technology involves use of behaviour-modifying stimuli to manipulate the distribution and abundance of stemborers and beneficial insects for management of stemborer pests. It is based on in-depth understanding of chemical ecology, agrobiodiversity, plant-plant and insect-plant interactions, and involves intercropping a cereal crop with a repellent intercrop such as *Desmodium* uncinatum (silverleaf)[2] (push), with an attractive trap plant such as Napier grass (pull) planted as a border crop around this intercrop. Gravid stemborer females are repelled from the main crop and are simultaneously attracted to the trap crop. Napier grass produces significantly higher levels of attractive volatile compounds (green leaf volatiles), cues used by gravid stemborer females to locate host plants, than maize or sorghum. There is also an increase of approximately 100-fold in the total amounts of these compounds produced in the first hour of nightfall by Napier grass (scotophase), the period at which stemborer moths seek host plants for laying eggs, causing the differential oviposition preference. However, many of the stemborer larvae, about 80%, do not survive, as Napier grass tissues produce sticky sap in response to feeding by the larvae, which traps them, causing their mortality. Legumes in the *Desmodium* genus (silverleaf, *D. uncinatum* and greenleaf, *D. intortum*), on the other hand, produce repellent volatile chemicals that push away the stemborer moths. These include (E)-ß-ocimene and (E)-4,8-dimethyl-1,3,7-nonatriene, semiochemicals produced during damage to plants by herbivorous insects and are responsible for the repellence of *Desmodium* to stemborers.

Desmodium also controls striga, resulting in significant yield increases of about 2 tonnes/hectare (0.9 short tons per acre) per cropping season. In the elucidation of the mechanisms of striga suppression by *D. uncinatum*, it was found that, in addition to benefits derived from increased availability of nitrogen and soil shading, an allelopathic effect of the root exudates of the legume, produced independently of the presence of striga, is responsible for this dramatic reduction in an intercrop with maize. Presence of blends of secondary metabolites with striga seed germination stimulatory, 4′′,5′′,-dihydro-5,2′,4′-trihydroxy-5′′,-isopropenylfurano-(2′′,3′′;7,6)-isoflavanone, and postgermination inhibitory, 4′′,5′′-dihydro-2′-methoxy-5,4′-dihydroxy-5′′-isopropenylfurano- (2′′,3′′;7,6)-isoflavanone, activities in the root exudates of D. uncinatum which directly interferes with parasitism was observed. This combination thus provides a novel means of *in situ* reduction of the striga seed bank in the soil through efficient suicidal germination even in the presence of grassy host plants in the proximity. Other *Desmodium* species have also been evaluated and have similar effects on stemborers and striga weed and are currently being used as intercrops in maize, sorghum and millets.[3]

References

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External links

- www.push-pull.net (http://www.push-pull.net)

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