CASE STUDY 1: Push-Pull

One of the most effective agronomic approaches of IPM is the "push-pull" system, built on the concept of polyculture (agriculture using multiple crops in the same space), that protects maize, millet and sorghum from two devastating pests: the stem borer insect and the *Striga* weed. Push-pull entails mixing plants that repel insect pests ("push") and planting diversionary trap plants around a crop perimeter that attracts the pests away from the crop ("pull"). In the case of maize, millet and sorghum, the main cereal crop is intercropped with the forage legume *Desmodium*. *Desmodium* emits volatile chemicals that repel stem borer moths ("push") and attracts a natural enemy of the moths, parasitic wasps ("pull").[1]

Farmer planting Napier grass in Kenya. Credit, ICIPE

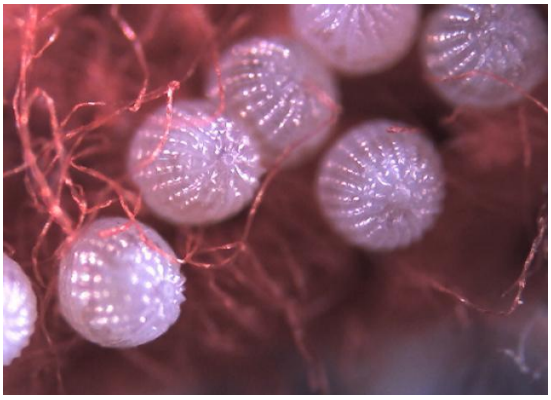
In addition, *Desmodium* secretes chemicals from its roots that cause "suicidal" germination of *Striga* seeds before they can attach to the maize roots. To ensure further protection, farmers can plant a "trap crop," such as *Pennisetum purpureum* (also known as Napier grass) around the edge of the field, which attracts the moths, pulling them away from the main crop. The system was developed in collaboration with the International Centre of Insect Physiology and Ecology (ICIPE) and the Kenyan Agricultural Research Institute (KARI) in Kenya, and Rothamsted Research in the United Kingdom. As of 2010, 25,000 smallholders in East Africa are using push-pull systems. Adopting a push-pull system allows them not only to control pests but also to increase soil fertility, protect against erosion, reduce pesticide use and gain income from marketing *Desmodium* for animal fodder.[2]

In 2014, Greenpeace researchers interviewed three sets of farmers in Kitale and Mbita, Kenya those practicing push-pull, those using pesticides, or those using neither approach. Although based on only a small number of interviews, average profitability per acre of maize per year was found to be 3 times higher for push-pull farmers than non-push-pull farmers, and this effect was even greater (up to 4 times more profitability) for women. Farmers also reported that maize yields often more than doubled compared to farmers that did not incorporate push-pull practices. In addition, push-pull farmers were also able to reduce their costs of labour and production. [3]

CASE STUDY 2: Cotton pest control

Pest management accounts for 25% to 45% of the costs of growing cotton in developing countries. Cotton accounts for nearly 25% of insecticide use worldwide.[4] Cotton pests such as bollworm (*Helicoverpa armigera*) however can be controlled by biological control, planting pest resistant varieties, cultural control such as deep ploughing and low density planting, the use of pheromones and bio-insecticides and even hand removal. A variety of crops can be intercropped with cotton to help recruit beneficial arthropods and natural enemies.

Moths of the African bollworm prefer to lay eggs on crops such as pigeon pea, chickpea, maize, sorghum and sunflower so these crops can be used as a distraction when planted in strips or around the field to reduce damage on cotton crops. In fact, flowering sunflower, sorghum and maize are more attractive to African bollworm moths, maize is often used as a 'trap crop.' The preference for maize in some cases is so strong, that cotton plots remained almost clear of eggs when surrounded by a few rows of maize.[5]



Bollworm eggs. Credit, Aneel Mohite

Some successful examples can also be found in Asia. On cotton farms in the Xinjiang province of Eastern China, alfalfa has been planted around the field margins of 70,000ha of land. By cutting the alfalfa several times a season, beneficial insects are encouraged to move into the cotton areas, significantly reducing the number of *Aphis gossypii*, a damaging cotton pest in the region.[6] Similarly in Eastern India, intercropping cotton with lucern, cowpea and groundnut enhanced natural enemy populations, but cotton yields and overall profit of the system varied depending upon which crop was used. For example, cotton performed the worst when intercropped with sorghum and performed the best when planted with groundnut and chilli, highlighting the need to manage trade-offs between IPM concerns and system productivity and profitability.[7]

CASE STUDY 3: The control of cocoa pests in North Borneo

In 1961, cocoa was a recently introduced crop grown in large clearings and faced severe pest damage. The cocoa was devastated by pests such as cocoa loopers, bagworms, cossid borers and a new pest to science – the bee bug – was damaging the pods. The fields were heavily and repeatedly sprayed with insecticides, sometimes with organo-chlorides such as DDT, but with little intended effect. In their original environments, natural enemies would have controlled these pests, but even those enemies in North Borneo were dying off from the use of pesticides.

Counting beans in a cocoa pod. Credit, Irene Scott, AusAID

Recognising that the pesticides were not working, all spraying was stopped and soon after, the branch borer and cocoa looper came under control by parasitic wasps. The bagworms were then controlled by the use of highly selective pesticide use before eventually being controlled by a parasitic fly. Destroying a large secondary forest tree, the borer's host, largely

eliminated the rink bark borer population. Within a year, all pests were satisfactorily controlled.[8]

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[8] Conway, G 2012, One Billion Hungry, Can We Feed The World? Cornell University Press, Ithaca and London.