UTILIZATION OF AGRICULTURAL BIODIVERSITY FOR MANAGEMENT OF CEREAL STEMBORERS AND STRIGA WEED IN MAIZE-BASED CROPPING SYSTEMS IN AFRICA—A CASE STUDY

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MAIZE is one of the most important cereal crops, which serves as a staple food for millions of people in Africa. It often provides well over 50% of staple calories. However, the yields are low, fluctuating around 1.0 t/ha. Several African countries have ocused attention on increasing maize production in the small holder agricultural sectors, but such efforts have been ineffective particularly because of extremely heavy pre- and pos -harvest losses due to pests and weeds.

Among the most important biotic constraints to maize production are lepidopteran stemborers, which feed inside plant stems, and the parasitic weeds belonging to genus *Striga*, which rob the maize plant of water and nutrients. Stemborers seriously limit potentially attainable maize yields by infesting the crop throughout its growth, from seedling stage to maturity. Seventeen species in two families--Pyralidae and Noctuidae--have been found to attack maize in various parts of Africa. However, *Chilo partellus* (Swinhoe), *Chilo orichalcociliellus* Strand, *Busseola fusca* Fuller, *Sesamia calamistis* Hampson, and *Eldana saccharina* Walker are of greates importance. The yield losses caused by stemborers to maize vary widely in different regions and range from -40% according to the pest population density and phenological stage of the crop at infestation.

Parasitic weeds of genus *Striga* (Family Scrophulariaceae) threaten the lives of over 100 million people in Africa and infest 40 percent of arable land in the Savanna reg on causing an annual loss of $7 to $13 million. Another 40 percent of arable land ma become infested in the next ten years. Between 10 and 100 percent loss in crop yield is caused by parasitic weeds. Among 23 species o *Striga* in Africa, *Striga hermonthica* is indisputably the most important species parasitising crops such as maize, sorghum, millet, fonio, rice and sugarcane and is one of the most severe constraints to cerea production in sub-Saharan Africa and into the southern part o the Arabian peninsula. In eastern Africa, *Striga hermomthica* is the most important species attacking cereals. The problem is more widespread and serious in areas where both fertility and rainfall are low and striga infestation continues to extend to new areas.

Reducing the losses caused by stemborers and striga weed through improved management strategies could significantly increase maize production, and result in better nutrition and purchasing power of maize growers. No other single method of control has so far provided a solution to the stemborer and striga problems. To put stemborer and striga control within the reach of African farmers, simple, inexpensive measures need to be developed that are tailored to the diversity of African cropping systems. A susta nable solution would be an integrated approach that simultaneously addresses both of these major problems.

As part of a habitat management programme for controlling stemborers and striga weed in maize-based cropping systems, the International Centre of In sect Physiology and Ecology (ICIPE), the Institute for Arable Crops Research (IACR -Rothamsted), the Kenya Agricultural Research Institute (KARI) and the Ministry of Agriculture, Livestock and Marketing (Govt. of Kenya) have discovered new approaches. The new approaches utilize the benefits of biodiversity of gramineous and leguminoceous plants in the cultivation of maize, and how to manage these plants in order to reduce stem borer and striga infestation and increase stemborer parasitization by natural ene mies in cerea cropping systems has been demonstrated. The approaches rely on enriching the biodiversity of plants and the pests' natural enemies in and around the cropping environment. Based on the understanding of the volatile semiochemicals employed by the stemborers in locating suitable hosts and avoiding non-hosts, a novel pes management approach utilizing a 'push-pull' or stimulo-detterent diversionary strateg has been developed. In this habitat management system, which involves combined use o trap and repellent plants, insects are repelled from the main crop, and are simultaneously attracted to a discard or trap crop. For maximum efficiency, these systems also exploit natural enemies, particularly parasitic wasps, which are important in suppressing pes populations. Plants, which repel stemborers as well as inhibit striga weed have also been identified.

Several plants have been identified which could be used as trap or repellent plants in a push-pull strategy. Particularly promising are Napier grass (*Pennisetum purpureum)*, Sudan grass (*Sorghum vulgare sudanense)*, molasses grass (*Melinis minutiflora)* and the legume silverleaf (*Desmodium uncinatum)*. Napier grass and Sudan grass have shown potential for use as trap plants, whereas molasses grass and silve rleaf repel ovipositing stemborers. All the four plants are of economic importance to farmers in Africa as livestock fodder and have shown great potential in stemborer and striga management i on-farm trials.

Napier grass, a commercial fodder grass, ca provide natural control to stem borers by acting as trap plan , and as reservoi for their natural enemies. Although the stem borers oviposit heavily the attractive Napier grass, only very few larvae are able to complete their life cycles (Fig. 1) (Hutter 1996). Napier grass has its own defense mechanism against crop borers. When the larvae enter the stem, the plant produces a gum like substance, which causes the death of the pes .

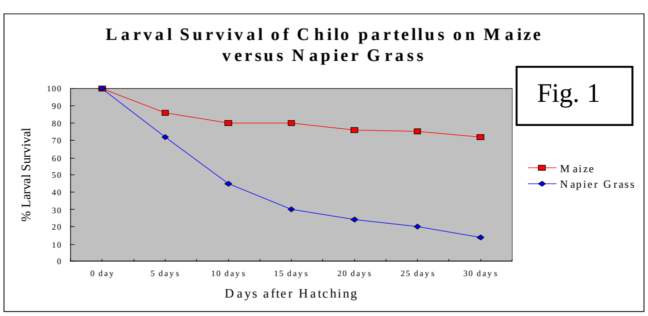


Fig. 1

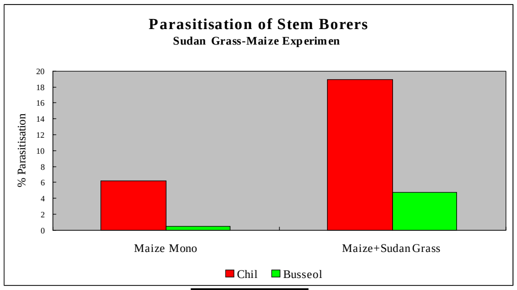
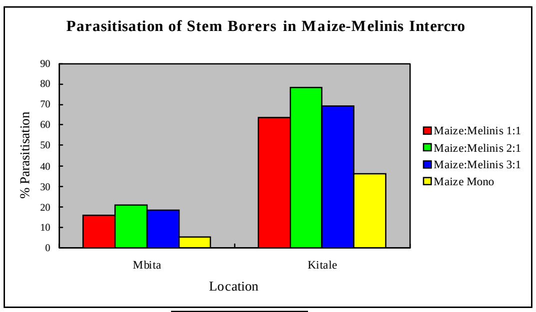


Fig. 2

Sudan grass, also a commercial fodder grasses, can provide natural control to stemborers by acting as trap plants for stem borers, and as reservoirs for their natural enemies. Planting Sudan grass around maize field reduced stemborer infestation on maize and also increased efficiency of natural enemies (Fig. 2) (Khan et al. 1997b).

Molasses grass, when intercropped with maize, not only reduce d infestation of crops by stemborers, but also increased parasitism particularly by the native larval parasitoid, *Cotesia sesamae* (Fig. 3) (Khan et al. 1997a). The plant releases volatiles that repel ste borers, but a racts parasitoids without being damaged. Such plants with an inheren ability to release such stimuli could be used in ecologically-sound crop protection strategies. Molasses grass, which originated in Africa, but spread to other tropical areas in the world, is well known as a valuabl pasture and hay grass. The grass also has high anti-tick properties especially when green. The grass is familiar to farmers in eastern Africa and is reported to be preferred as fodder for both dairy and beef cattle .



. Fig. 3

Silverlea (*Desmodium uncinatum*), a high-value, commercial fodder legume, when intercropped with maize, repelled ovipositing gravid stemborer females, and suppressed striga by more than 40 times.

During 1998, on-farm trials using these fodder plant , conducted with 90 farmers in Kenya confirmed that these approaches, conducted separately (as 'pull' or 'push') and together ('push-pull'), worked, giving significant yield increases (Table 1), and were found to be highly acceptable at the subsistence farmer level (Table 2).

The habitat management strategy manifests important features which render it distinctively more advantageous than other methods. The first of these features is its suitability to conditions of mixed agriculture, which is prevalent in eastern Africa. The cultivation of the grasses and legumes ca increase both crop yield and livestock productivity.

A second key feature of the proposed technolog is that it introduces practices which are already familiar to farmers in Africa. The approach has affinity to the common agricultural practice of multiple cropping (a system that is based on the diversity of crops rather than a monocrop), and it is based on the use of economically valuable plants. For example, the cultivation of Napier gr ass for livestock fodder and soil conservation i being encouraged in eastern Africa and is already widely applied.

The third feature of this proposal is its contribution to the conservation of plant biodiversity and in providing a sustainable crop protec tion system

i) Conservation of plant diversity. The habitat management approach embodies maintenance of species diversity, i.e. by intercropping with different plants as a means of avoiding the pest problems inevitably encountered with the production of crops as a monoculture. It is well established that wild host plants on uncultivated land adjacent to crop fields can provide extremely important refugia for natural enemies as well as sources of nectar, pollen, and host/ alternate prey. The worsening o most pest problems is linked to the expansion of crop monocultures at the expense of natural vegetation.
ii) Sustainable crop protection. In this approach, the full integration of several crop protection approaches, i.e. trap crops and increased parasitism o f pests, prevents high selection pressure on any single approach, thereby creating a sustainable system b obviating rapid development of resistance/adaptation by pests which is a feature common to single control measures, e. g. pesticides or genetically-based resistance.

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Table 1. Comparison of means of stemborer damage, striga rating and yield from a 'push-pull' trial, long rain season, 1998

Parameter	Maize+Sudan grass+*Desmodium*	Maize mono	Difference
Borer damage (%)	11.1	22.0	-10.9*
Striga rating	0.1	2.4	-2.3*
Yield (t/ha.)	6.7	5.2	1.5

Table 2. Percent of farmers willing to participate in 1998 in new farmer-managed trials in four villages in Trans-Nzoia district of Kenya

Village	Farmers willing to participate	
	No.	%
Wamuini	34	95
Yuya	37	97
Kisawai	33	92
Kiminini	53	93