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Striga asiatica : a driving-force for dissemination of conservation agriculture systems based on *Stylosanthes guianensis* in Madagascar

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Introduction

Striga is estimated to infest up to 50 million hectares of crop lands and to adversely affect 300 million people in sub-Saharan Africa. Areas of otherwise productive agriculture have been abandoned because of this scourge. *Striga* is a growing pandemic, undermining the struggle to attain food security of the continent (Ejeta, 2007). Hearne (2009) reviewed a wide range of control options for *S*triga *hermonthica* and *Striga asiatica*, the most noxious species to cereals. She explained the elusive wide-scale effective control of *Striga* by variable reliability of technology, poor access and cost of control technology, limited practicality of the methods, and poor information.

In the middle-West of Madagascar (elevation: 700 to 1100 m; rainfall: 1000 to1500 mm/year with a 6 months-long dry season), *S. asiatica* infestation in uplands often pushed farmers to abandon cultivation of cereals such as rice (*Oryza sativa*) or maize (*Zea mays*; Sorèze, 2010). It was urgent to propose practical cropping practices controlling *Striga* to allow farmers to produce their own staple food. The objectives of the study were to design, test and disseminate such cropping systems.

Materials and Methods

From 2002/03 cropping season, TAFA (a local NGO) and CIRAD set up experiments on a former farmer field abandoned because of high *S. asiatica* pressure. Various Direct seeding Mulch-based Cropping systems (DMC) were tested (2 to 4 replicates, 200 m² plots) and compared with the conventional practices with tillage. The DMC systems are part of the Conservation Agriculture practices, with introduction of multifunctional cover crops growing in association with the main crops or whenever climatic conditions are too risky for planting a commercial crop. This increases biomass production and the efficiency of the systems, which function as tropical forest ecosystems (Séguy et al, 2006; Kassam et al., 2009).

Most of the tested systems were based on a rice//maize rotation, as it is favoured by farmers.
Rice//Maize rotation with conventional tillage (CT) was compared with:
(i) Rice + *Stylosanthes*//Maize + *Stylosanthes* (CA St), with *Stylosanthes guianensis* cv CIAT 184 used as dead mulching material for direct seeding
(ii) Rice//Maize + *Brachiaria ruziziensis* + *Cajanus cajan* (CA Br C), used as dead mulch
(iii) Rice//Maize + *Vigna unguiculata* (CA Cp), used as dead mulch
(iv) Rice + *Arachis* sp.//Maize + *Arachis* sp. (CA Ar), with *Arachis pintoï* or *A. repens* kept alive, controlled with low rates of herbicide before direct seeding.

From 2004/05, extension programmes conducted by FAFIALA, ANAE and SD-Mad (local organisations, members of the Direct Seeding Group of Madagascar, GSDM) started the dissemination of the best cropping systems identified by TAFA/CIRAD.

In 2009/10, a specific study was conducted in TAFA experimental plots to measure *Striga* seeds remaining in the soil and the number of *Striga* plants that had germinated and parasited maize plants three months after sowing. Cylinders of soil (12 cm in diameter, 10 cm high) were sampled at 0-12 cm and 24-36 cm from maize rows at 0-10 cm and 10-20 cm soil horizons (2 samples in each of the two replicates for the CA/DMC systems, 2 samples in each of the 5 replicates for CT system) to measure the number of *Striga* plants parasitizing maize. The number of ungerminated *Striga* seeds was measured in 25 g of soil for each sample. Variance analysis was conducted after square root transformation of the measured data.

Results and Discussion

Among the various cropping systems designed for the conditions of the middle-West of Madagascar, several cropping systems actually control *S. asiatica*. Table 1 shows that the best control of *Striga* (number of *Striga* seeds remaining in the soil, and number of *Striga* plants parasitizing maize) is obtained with perennial *Arachis* (*A. pintoï* or *A. repens*) or *Stylosanthes guianensis*.

Systems based on *S. guianensis* always produce more rice than other systems (Figure 1). Over a six year period, these systems produced significantly more (Fisher pairwise comparison, least significant difference, p-value = 0.05) than all other compared systems (4.27 t/ha of rice on average for CA St; 1.81 t/ha for CT). The second best system associates maize with cowpea (3.16 t/ha of rice after such an association). Surprisingly, the system with perennial *Arachis*, which was the most efficient in controlling *Striga*, was the only system not significantly different from conventional tillage (AC Ar, 2.36 t/ha on average). This can be explained by competition for water between the main crop and the living cover crop when it is not properly controlled, especially during dry years (2004-05 and 2006-07). This system requires a specific know-how. It is rarely adopted by farmers.

Inversely, systems based on *S. guianensis* proved to be practical, robust and resilient systems, adapted to various farm conditions: from small-scale farming with very limited means to large commercial farms. They can be managed with very limited inputs (no herbicide, very low fertilisation, etc.) or at large scale (mechanical or chemical control of the cover crop), etc. The cropping intensity can be adapted to the available space and technical know-how of the farmers, i.e., production of a cereal crop once every other year (the simplest to manage, with very low inputs), twice every three years or every year (the most complex to manage, requiring good mastery and inputs to compensate nutrients exported with the grains).

The high adaptability and practicality of these systems based on *S. guianensis* make them easily adopted by farmers. They represent 60 to 70 % of the CA/DMC systems extended in the middle-west of Madagascar, which disseminate rapidly (Figure 2). The possibility to re-introduce cereals in the systems thanks to *Striga* control has been identified as a major factor of CA/DMC adoption (Sorèze, 2010). Thus, with such systems, the main constraint to conventional agriculture in the area (*Striga*) becomes a major driving-force of dissemination of CA/DMC systems.

Table 1: *Arachis repens*, *Arachis pintoï* and *Stylosanthes guianensis* control *Striga*. First data indicates the average number of seeds or plants for the 0-20 cm soil horizon. Data in parentheses are the mean values of the transformed data (square root). Mean values in each column followed by the same letter(s) are not different in Fisher pairwise comparison (least significant difference, p-value = 0.05).

Cropping systems Maize +	**Average number of *Striga* seeds (0-12 cm)**	**Average number of *Striga* seeds (24-36 cm)**	**Average number of parasite striga plants (0-12 and 24-36cm)**
(CA) *Arachis repens*	0.5 (.000) a	0.0 (0.000) a	4.0 (1.414) ab
(CA) *Arachis pintoï*	1.0 (1.000) a	2.5 (1.118) ab	0.0 (0.000) a
(CA) *Stylosanthes*	1.5 (1.207) a	1.5 (1.207) ab	1.0 (0.707) a
(CA) *Brachiaria+Cajanus*	4.5 (1.914) ab	4.0 (1.984) bc	3.5 (1.725) bc
(CA) Cowpea	15.5 (3.845) c	1.5 (0.866) ab	3.0 (1.732) bc
(CT) Tillage	8.6 (2.792) bc	8.6 (2.939) c	8.4 (2.928) c

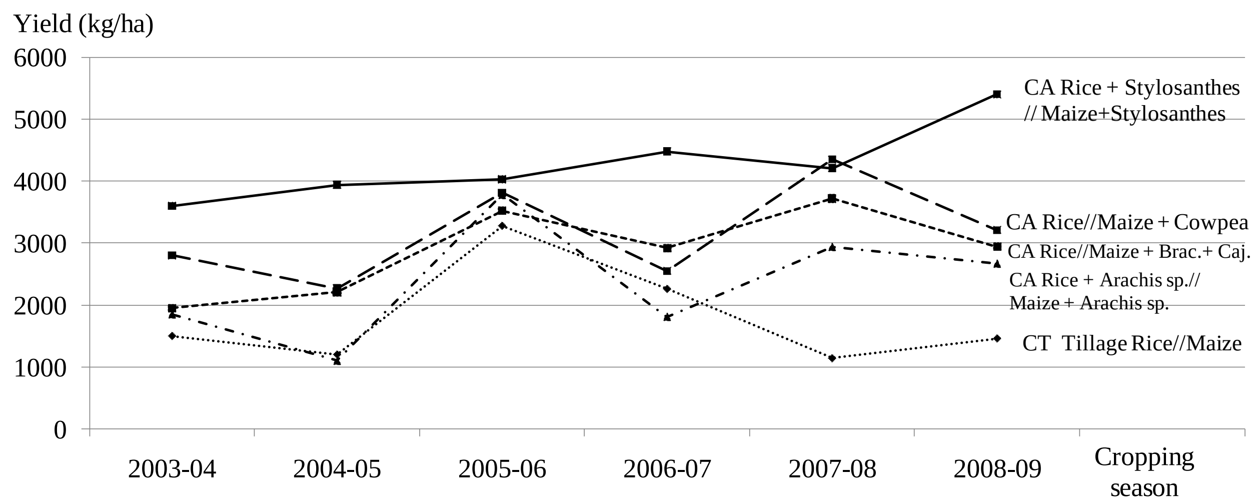

Figure 1: CA cropping systems based on *Stylosanthes guianensis* produce more and more regularly than any other system under high *Striga* pressure. Rice yield in kg/ha, for the recommended fertilization level (5t/ha manure + 50 N - 30 P – 40 P). "Rice//Maize" indicates a crop rotation with rice the first year, maize the following year. "+ " indicates an association crop + cover crop

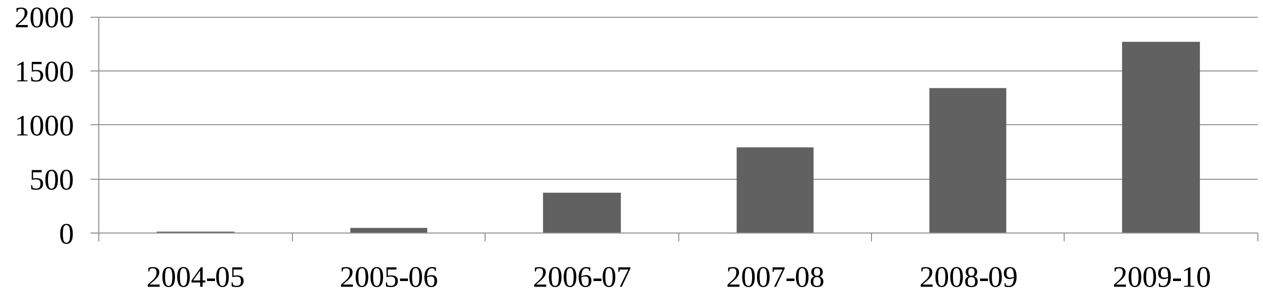

Figure 2: Extension of Direct seeded Mulch-based Cropping systems in the middle –West of Madagascar. Surface area in ha.

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