Poster presentation

THE USE OF CYNODON DACTYLON AS SOIL COVER FOR DIRECT SEEDING IN MADAGASCAR

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Introduction

Bermuda grass (*Cynodon dactylon*) is known as a very invasive weed, difficult to get rid of. All over the world, practices have been developed to try to eradicate this widely spread and common weed (Burton and Hanna, 1984). They are often based on intense land preparation with several ploughings, especially at the beginning of the dry season, and important work for removing the rhizomes and weeding during the cultivation period.
However, *Cynodon dactylon* is a good forage, widely used by farmers to feed their animals.
But it also has several properties of a good cover crop: growing on poor soil, rapidly covering the soil and thus preventing erosion, having a deep and dense rooting system (improving soil structure, recycling nutrients), suppressing most other weeds, etc.
Trying to get benefit from these qualities instead of fighting against this "weed", TAFA (Tany sy Fampandrosoana) and CIRAD (Centre de Coopération Internationale en Recherche Agronomique pour le Développement), with farmers, have developed techniques of direct seeding, using *Cynodon dactylon* as a soil cover, in various agro-ecological areas of Madagascar.

Material and method

Experiments to control *Cynodon dactylon* started in 2001/2002 cropping season in the Highlands, in controlled plots conducted by TAFA, with direct planting of beans in the mulch. (4 replications, 0.5 ha). Simple tests to adapt the kind (glyphosate, paraquat and fluazifop-p-butyl) and dose of herbicides needed to control (keeping it alive for a living cover) or kill the grass (dead mulch) were conducted simultaneously.
The good results obtained, with over 2.2 t/ha of bean harvested on average every year (for less than 1 t/ha with traditional techniques) and the dramatic reduction in working time (Michellon et al., 2005; Charpentier et al., 2005), led in 2003/2004 to:
i) try this technique with other crops such as soybean, Bambara bean (*Vigna subterranean*) and rice
ii) propose it for extension/tests with farmers, and
iii) adapt the practice for various environments (Alaotra lac region and Highlands , hillsides and rainfed lowlands)

Within two years, 20 farmers adopted this technique in Antsampanimahazo village (1650 m above sea level, where TAFA/CIRAD first proposed this system for extension) in the highlands, and 16 in the Alaotra region (900 m a.s.l.).

Results

Cropping practices
Four years of experiments and tests with farmers yielded knowledge and experience. Cropping practices adapted to specific situations and crops can already be proposed:

* For legumes:

1. *Cynodon dactylon* can be used as a dead mulch for cultivation of legumes (bean, soybean, cowpea and Bambara bean). In that case, it is killed with 1800-2160 g/ha of glyphosate (or

alternatively 400 g/ha paraquat, more expensive and harmful than glyphosate, but with a faster effect). Legumes are directly seeded in its mulch. Yields increased (doubled on average) as compared to traditional practices is very significant, and fertilisation is not needed.

2. *Cynodon dactylon* also can be used as a living cover for cultivation of legumes (bean, soybean, etc.). In that case, it is simply controlled (but not killed) with 900-1080 g/ha of glyphosate (or 300 g/ha paraquat) before direct planting of legumes. The *Cynodon* must be controlled in such a way to avoid competition with the legume, but it should be able to start developing under the main crop. This requires precise herbicide application and is more difficult to master than cultivation on a dead mulch. However, it has the advantage of being cheaper, as fewer herbicide is used, but also to produce more as a synergy seems to appear between the two plants when Cynodon is kept alive.
   Also, as *Cynodon* will recover and starts growing again, this system can be reproduced the next year and the soil is permanently kept covered, which is not the case with the first system. However, it is advised to alternate cultivation of bean with another legume (soybean for instance) to avoid risks of fungal disease.

In case of insufficient control of the *Cynodon* by the initial herbicide application and risk of competition, it is possible to apply a total herbicide (glyphosate or paraquat) between the legume rows, with a protection, or to apply in full stand 62.5 g/ha of fluazifop-p- butyl.

<u>* For rice:</u>

3. *Cynodon dactylon* can be used as dead mulch for direct seeding of upland rice. It is killed, as for legumes, with 1800-2160 g/ha of glyphosate. To grow a cereal on a cover made of grass, mineral fertilisation (50-100 N/ha) is needed at sowing, as mulch decomposition leads to N immobilisation in the beginning of the plant cycle. Thanks to a good soil structure (due to *Cynodon* roots), rice yield over 4 t/ha can be reached with proper fertilisation application.
4. The best practice for rice cultivation (especially in areas with a long dry season as in the Lac Alaotra) consists in killing *Cynodon* (1800-2160 g/ha of glyphosate) at the end of the previous rainy season (when it is in full vegetative stage, and very sensitive to systemic herbicides) to install a legume (as *Dolichos lab lab*) which will grow in the dry season and fix nitrogen. The next rainy season, rice can then be directly planted in the mulch made by *Dolichos*, simply cut or rolled on the ground.

This technique can be used in the upland as well as in the paddy fields with poor water control which are often invaded by Bermuda grass in the Alaotra region.

Yield and economic performances

With direct seeding on a Cynodon cover, the economic return for Bean, soybean or cowpea cultivation is extremely high as

- Yield is doubled on average as compared to traditional practice with soil tillage (table 1).
- The working time is dramatically reduced as ploughing is replaced by a simple herbicide application and weeding is not necessary. As a consequence, the labour is very well valorised (over 6 000-12 000 Ariary/day as compared to 1 500 Ariary/day for manpower)
- The cost of herbicides (25 000-30 000 Ariary/ha for living cover, 45 000-50 000 for killing the *Cynodon* with glyphosate) is equivalent to the cost of one ploughing with oxen (when two or three ploughing are needed to reduce *Cynodon* pressure).

The net return is extremely interesting for Bambara bean as yield increase is tremendous (300-400 %) with a soil cover as compared to a tilled, bare soil.
In the rich *Baiboho* (recent alluvial soils, usually with poor water control), with a Bean production of 2.4 t/ha without fertilisation, the net return reaches an exceptional 2 millions Ariary /ha (800 euros), and the labour productivity is 16 000 Ariary/day (Charpentier et al., 2005).

Rice yield also is doubled, which makes very interesting production of 2.5-3 t/ha to 4 t/ha according to soil type and fertiliser amount. The interest of cultivating first a legume before rice is very clear in the Alaotra region as in the Highlands (Table 1).

As for bean, the best results are achieved on "baiboho", where 3.4 t/ha were obtained with only 80 N/ha, and 4 t/ha with 74N – 33 P_2O_5 – 24 K_20. Net margins for systems with rice and Dolichos lab lab reach 1.3 to 1.5 millions Ariary/ha. Even for the degraded hillsides ("tanety"), with rice production of 2.5 t/ha, without ploughing or weeding, the labour is valorised at a level of 6 000-8 000 Ariary/day (Charpentier et al., 2005).

Table 1. Yield and net margin of legumes and rice grown on *Cynodon*, in two regions of Madagascar

Crop	Alaotra lake region				Highlands		
	Number of fields	Yield (kg/ha)	Net margin (x 1000 Ariary/ha)	Yield (kg/ha) Traditional technique	Number of fields	Yield (kg/ha)	Yield (kg/ha) Traditional technique
Bean	3	1534	400-2 000	500-800	13	1 820	700-1000
Soybean					15	1784	800-1000
Bambara bean	1	2660	1 250	700-1100			
Cowpea	1	1330	585	700-800			
Upland rice (Tanety)	10	2500		< 1000	2	2 025	600-800
Rice after legume*	7	3090	1300-1500	<1500	1	3 750	

* Dolichos lab lab in Alaotra region, Soybean in highlands

1 euro = 2 500 Ariary

Conclusions

Although very recent, these systems based on direct planting on a permanent soil cover made of a local grass are being rapidly adopted by farmers.

Cynodon can even be installed for use as cover crop: For legumes, a living cover with a sterile hybrid of *Cynodon* (*Cynodon Tifton*) has been tested with success and is now recommended for extension. Other plants such as Kikuyu grass (*Pennisetum clandestinum*) also are used as living cover (and forage production at the same time), also with success (soybean yield reaching 2.3 to 2.9 t/ha in the highlands).

Experiments to use *Cynodon* for direct planting of other crops (such as Cassava) are being conducted.

In the same spirit of using nature strength, local grass species known for their ability to improve soil structure (*Hypparhenia sp.*, *Stenotaphrum sp.*; etc.) have been tested and are now used by farmers for direct planting in their mulch. Very promising results have been achieved with upland rice on *Aristida sp.* in the South East coast of Madagascar, on hydromorphous soils, usually uncultivated.

It can be expected that such systems, which combine respect and protection of the environment with agronomic and economic performances will rapidly improve Malagasy farmers' conditions.

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