The use of *Cynodon dactylon* as soil cover for direct seeding in Madagascar

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Green bean in a mulch of Cynodon dactylon

*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 and important work for removing the rhizomes and weeding.*
However, Cynodon dactylon *is a good forage and 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, TAFA and CIRAD have developed with farmers techniques of direct seeding, using Cynodon dactylon *as a soil cover.*

Material and method

Experiments to control *Cynodon dactylon* started in 2001/2002 cropping season in the Highlands, in controlled plots, with direct planting of common bean in a *Cynodon dactylon* mulch as compared to ploughing (4 replications) and simple tests to adapt the kind and dose of herbicides needed to control (keeping it alive for a living cover) or kill the grass (dead mulch).
The good results obtained two consecutive years (over 2.2 t/ha of green bean directly seeded for less than 1 t/ha with ploughing) and the dramatic reduction in working time (Michellon et al., 2005; Charpentier et al., 2005), led to rapidly try this technique for other crops (rice, soybean, cowpea, etc.) and in other regions, and to propose it for extension/tests with farmers.
Results presented here are those achieved by the first farmers who tested direct seeding in Bermuda grass in 2003/2004: 20 farmers in Antsampanimahazo village (1650 m above sea level) in the highlands, and 16 in the Alaotra region (900 m a.s.l.).

Results

Cropping practices

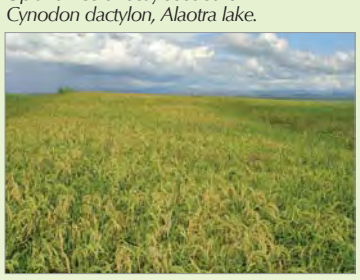
**Legumes*

1. *Cynodon dactylon* can be used as a dead mulch for cultivation of legumes (green bean, soybean, cowpea, Bambara bean). In that case, it is killed with 1800 to 2160 g/ha of glyphosate and legumes are directly seeded in its mulch. Fertilisation is not needed.

Green bean directly seeded in Cynodon dactylon *(front) or after ploughing (back). Ferrallitic soil, Madagascar highlands.*

2. *Cynodon dactylon* also can be used as a living cover for cultivation of these legumes. In that case, it is simply controlled (but not killed) with a lower dose of herbicide: 900 to 1080 g/ha of glyphosate before direct seeding. The *Cynodon* must be sufficiently controlled to avoid competition with the legume, but not killed to produce biomass after harvesting the crop. This requires precise herbicide application, but has the advantage of being cheaper and 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 (alternating legume species is recommended) and the soil is permanently kept covered, which is not the case with the first system.
In case of insufficient control of the *Cynodon* by the initial herbicide application and risk of competition with the legume, it is possible to apply a total herbicide (glyphosate) between the legume rows, with a protection, or to apply in full stand 62.5 g/ha of fluazifop-p- butyl.

Upland rice directly seeded on Cynodon dactylon, Alaotra lake.



** Rice*

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 to 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 uplands (*"Tanety"*) 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 green bean, soybean or cowpea cultivation is extremely high as:
- Yield is doubled on average as compared to traditional practices with soil tillage (table 1).
- The working time is dramatically reduced for land preparation and weeding. As a consequence, the labour is very well valorised (over 6 000 Ariary/day as compared to 1 500 Ariary/day for manpower).
- The cost of herbicides (45 000 to 50 000 Ariary/ha for killing the *Cynodon* with glyphosate) is equivalent to the cost of one ploughing with oxen (when ploughing at least twice is needed).

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	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 the highlands — 1 euro = 2 500 Ariary

The net return is extremely interesting for Bambara bean as yield increase is tremendous (300 to 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 gren bean production of 2.4 t/ha without fertilisation, the net return reaches a high 2 millions Ariary /ha (800 euros), and the labour productivity is 16 000 Ariary/day (Charpentier et al., 2005).

Rice yield also is doubled and reaches 2.5 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). 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"), the labour is valorised at 6 000 to 8 000 Ariary/day (Charpentier et al., 2005).

Gren bean and soybean grown on a living cover of Kikuyu grass also used as forage for cattle feeding..

Conclusions

Local grass species known for their ability to improve soil structure (*Hypparhenia sp., Stenotaphrum sp.;* etc.) also can be used for direct planting in their mulch. Very promising results have been achieved with upland rice on *Aristida sp.* in the South Eastern coast of Madagascar, on hydromorphous soils, usually uncultivated.
Other plants such as *Cynodon Tifton* or Kikuyu grass (*Pennisetum clandestinum*) have been tested (soybean yield reaching 2.3 to 2.9 t/ha in the highlands) and are now used by farmers as living cover (and forage production).
Experiments to use *Cynodon* for direct planting of other crops (such as Cassava) are being conducted. It can be expected that such systems, which combine protection of the environment and agro-economic performances, will rapidly be adopted on large scale by Malagasy farmers.

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References

Burton, G. W. and W. W. Hanna. 1984. Bermudagrass. In R. F. Barnes, D. A. Miller, C. J. Nelson, eds. Forages. Iowa State University Press. Ames, Iowa. pp.421-424.
Charpentier, H.; Razanamparany, C.; Andriantsilavo, M.; Andriamandraivonona, M. and Rakotoarivo, C., 2005: Projet d'appui à la diffusion des techniques agro-écologiques à Madagascar: Rapport de campagne 2003/04. Lac Alaotra, Sud-Est et Morondava. TAFA, Antsirabe, Madagascar, 102 p + annexes.
Michellon R., Razanamparany C., Moussa N., Andrianasolo H., Fara Hanitriniaina JC., Razakamanatoanina R., Rakotovasaha L., Randrianaivo S., Rakotaniaina F. (2005). Projet d'appui à la diffusion des techniques agro-écologique à Madagascar. Rapport de campagne 2003-2004. Hautes-Terres et Moyen Ouest. TAFA, Antsirabe, Madagascar, 113 p.