Groupement Semis Direct de Madagascar
Lot VA 26 Y Ambatoroka,
Route d'Ambohipo, ANTANANARIVO (101), Madagascar
Email : gsdm@moov.mg
site web: www.cirad.mg/fr/anx/gsdm.php
Tél.: (261) 20 22 276 27

Documentation and Synthesis of Conservation Agriculture in Madagascar (FAO)

RAKOTONDRAMANANA
Olivier HUSSON
Frank ENJALRIC

FINAL Version

January 2010

Table of Contents

List of Tables

List of Figures

Glossary of Malagasy Names Used in the Document

- ***Baiboho***: soils of alluvial origin, accumulated in lowlands ; rich soils that are in general very cultivated over two seasons per year, when moisture is available
- ***Tanety***: hillsides as opposed to lowlands and include the slopes and the plateau. *Baiboho* are the products of erosion of hills of watersheds involved.
- ***Tavy***: traditional system of slash and burn cultivation of forest and regrowth.
- ***Hatsake***: traditional system of slash and burn cultivation of forest and regrowth, a term used in the Malagasy South

List of Abbreviations and Acronyms

AFD	Agence Française de Développement (French Development Agency)
ANAE	Association Nationale d'Actions Environnementales (National Association for Environmental Actions)
ANDRI-KO	Name of a Seed Cooperative based in the Lac Alaotra Area
ASJA	Private University Athénée Saint Joseph Antsirabe
AVSF	Agronomes et Vétérinaires Sans Frontières
BDD	Database
BRL	Bas-Rhône Languedoc Madagascar
BTS	Brevet de Technicien Supérieur
BVLAC	Bassins Versants Périmètres Irrigués du Lac Alaotra (Watersheds and Irrigated Areas in the Lac Alaotra Area)
BVPI	Bassins Versants Périmètres Irrigués (Watersheds and Irrigated Areas)
BVPI-SEHP	Bassins Versants Périmètres Irrigués Sud Est Hauts Plateaux (Watersheds and Irrigated South East and High Plateaus Regions)
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement (International Cooperation Center in Agronomic Research for International Development)
CA	Conservation Agriculture (SCV in French)
CSA	Centres de Services Agricoles (Agricultural Service Center)
DEA	Diplôme d'Etudes Approfondies (In depth Study Degree)
DSRP	Document de la Stratégie de la Réduction de la Pauvreté (Poverty Reduction Strategy Paper)
FAFIALA	*Fanapariahana ny vokatry ny Fikarohana momba ny ALA sy ny ala vadim-boly* (Centre de diffusion des résultats de recherche en foresterie et agroforesterie) (Center for Diffusing the Results of Research in forestry and Agroforestry)
FAO	Food and Agriculture Organization of the United Nations
FASARA	Programme d'Appui aux filières Agricoles et d'amélioration de la Sécurité Alimentaire de la région Androy (Support Program to Agricultural and Food Security in the Androy region)
FEKRITAMA	*Federasiona Kristianin'ny Tantsaha Malagasy* (Confédération des Agriculteurs Malagasy) (Christian Confederation of Malagasy Farmers)
FFEM	Fonds Français pour l'Environnement Mondiale (French Funds for the Worldwide Environment)
FIFAMANOR	Etablissement public de recherche et développement avec appui de la Norvège (Public Research and Development Establishment with Support from Norway)
FOFIFA	Centre National de Recherche Appliquée au Développement Rural (National Center of Research Applied to Rural Development)
GRET	Groupe de Recherche et d'Echanges Technologiques (Group for Research and Technological Exchanges)
GSDM	Groupement Semis Direct de Madagascar (Madagascar Direct Seeding Grouping)
HASYMA	*Hasy Malagasy* (société de développement du coton reprise par DAGRIS) (Cotton Development Company taken over by DAGRIS)

INTER AIDE MANAKARA	ONG française INTER AIDE basée à Manakara (French NGO INTERAIDE based in Manakara)
ISPM	Institut Supérieur Polytechnique (Université privée Antananarivo)
KfW	Nom d'une banque allemande de Développement (Name of a German Development Bank)
KOBAMA	*Koba Malagasy* (minoterie) (Flour mill)
PACA	Production Agricole dans la plaine d'Ankililoaka et le Couloir d'Antseva (Agricultural Production in the Plain of Ankililoaka and the Corridor of Antseva)
PADR	Programme d'appui au Développement Rural (Support Program to Rural Development)
PAE	Plan d'Action Environnemental (Environmental Action Plan)
PAMPA	Programme d'Actions Multi Pays en agro-écologie (Multiple Country Action Plan in Agro ecology)
PLAE	Programme de Lutte Anti Erosive (Anti erosion Program)
PNDR	Programme National de Développement Rural (National Rural Development Program)
PSASA	Projet de Sécurisation de l'Approvisionnement en Semences pour l'Androy (Project for Securing Seed Supply for the Area of Androy)
PTA	Programme Transversale en Agroécologie (Crosscutting Program in Agro ecology)
RMME	Rizière à Mauvaise Maîtrise d'Eau (Paddies Fields with Poor Water Control)
SCAC	Service de Coopération et d'action culturelle (Ministère Français des Affaires Etrangères) Service for Cooperation and Cultural Action (Service of Cooperation and cultural actions within the French Ministry of Foreign Affairs)
SCRiD	Systèmes de Cultures et Riziculture Durable (Unité de Recherche associant le FOFIFA, le CIRAD et l'Université). (Systems of Cultivation and Sustainable Rice Cultivation ,Research Unit associating FOFIFA, CIRAD, and the University)
SCV	Semis direct sur Couverture Végétale permanente (Direct Seeding on Permanent Crop covers e.g. CA)
SDMAD	Semis Direct de Madagascar (Madagascar Direct Seeding)
SEBOTA	Groupe de variétés de riz polyaptitudes crées par 3 chercheurs CIRAD au Brésil: Séguy, Bouzinac et Taillebois (Group of Polyaptitude Rice Varieties by 3 CIRAD Researchers in Brazil : Séguy, Bouzinac, and Taillebois
TAFA	Tany sy Fampandrosoana (Terre et Développement) (Land and Development)
TAMS	*Tetik'Asa Mampody Savoka* (nom d'un projet de reboisement de l'ANAE) (name of a afforestation project of ANAE)
URP	Unité de recherche en partenariat (Unit of Research in Partnership between CIRAD, FOFIFA and the University of Antananarivo)
USAID	US Agency for International Development (Agence US pour le development international)
VERAMA	Les VERgers d'Anacardes de Masiloka (the Cashew nut Orchards of Masiloka)
VJT	Valorisation de la Journée de Travail (Enhancement of Work Day)
WWF	Fonds Mondial pour la Nature (World Wide Fund For Nature)

Summary

The summary provides a synthesis of existing CA data and information in Madagascar on the following aspects:

- Stakeholders and their roles and capacity (e.g. human resources, programming, material resources etc) in the promotion of CA.
- Extent of CA practice by various stakeholders
- Appropriateness of various models or approaches used for promoting CA by various stakeholders.
- Policy and socio-economic environment and institutionalization of CA

Madagascar has a wide range of climates and soils which can be grouped as four main agro-ecological zones: *(i)* the high altitude zone (> 1200 m asl) with high rainfall and relatively low average temperature and 6 months of dry seasons, *(ii)* the medium altitude zone (600 – 1000 m asl) with long dry seasons (6 to 7 months), *(iii)* the subtropical humid zone at low altitude with high rainfall (> 1500 mm) and *(iv)* the semi arid zone with low rainfall (300 – 600 mm) and long dry season. Research on CA started in the 90's and has already covered these 4 agro-ecological zones thanks to CIRAD experiences from Brazil, but the diffusion started in 2003 as part of the Environment program I and covered the main rice producing irrigated areas as part of a wide watershed program mostly under French support through AFD (Agence Française de Développement). The policy is to practice CA techniques on the hillsides to minimize the erosion sediment in the infrastructure (canals and dams) and in the paddy fields.

The analysis of data bases from stakeholders in CA diffusion shows that total area under CA in rainfed conditions crops in 2008/09 cropping season was 5200 ha with some 8200 small scale farmers (average size of land less than one ha). Under residual moisture or under irrigation in the paddy fields after rice harvest some 500 ha of CA were recorded with 2800 small scale farmers. These figures do not take into account the voluntary adoptions in the diffusion area (estimated between 10 and 20%). The main area where the rate of adoption by farmers was the highest was in the mid West (medium altitude area) and the Alaotra Lake areas (main producing rice areas in the country). The analysis of data shows also that the yields of the main crop increases with the number of years under CA, assuming that crop residues and cover crop biomass are maintained from cattle grazing. So the reason for CA adoption was the yield increase with time of CA practice, the labor saving due to no tillage and therefore the higher value for the farmer's man-day. Also, one of the main reasons for CA adoption is the lower incidence of *Striga asiatica* on rice and maize and the low incidence of *Pyricularia oryzea* on susceptible rice varieties.

The main CA systems adopted by farmers in the principal zones were analyzed from the data bases: the dominant systems were *Stylosanthes guianensis* (anthracnose resistant variety CIAT 184) associated with rice and legumes cover crops (*Dolicos lablab*, *Vigna unguiculata*, *Vigna umbellata* or *Mucuna pruriens*) associated with maize followed by rice. Under irrigation or residual moisture the cover crops were *Dolicos lablab* or *Vilosa pilosa* (vetch). In the subtropical area of the coast the main systems were cassava associated with *Brachiaria sp* or *Stylosanthes guianensis*. *Arachis pintoï* and *Arachis repens* were also developed as cover crops for coffee trees. In the semi arid zone the main CA system was *Vigna unguiculata* associated with maize followed by cotton.

Introduction

The "Groupement Semis Direct de Madagascar" (Madagascar direct Seeding Grouping) was commissioned by the « Task Force[1] » on Conservation Agriculture to capitalize what has been acquired in conservation agriculture. The mission committed to the GSDM is stipulated in a memorandum of understanding with FAO, the terms of reference of which are annexed to the present report. In this report, the two terms « Conservation Agriculture» and « Direct Seeding on Permanent soil covers or CA» are used without distinction because they refer to the same thing. The CA systems developed in Madagascar perfectly correspond to the definition by FAO for Conservation Agriculture (CA) and fulfill 3 essential criteria:

- Permanent soil coverage during the whole year whether the land is cropped or not;
- No soil ploughing (no tillage, no pseudo-tillage neither minimum tillage in order not to disrupt the superficial part of the soil where the biomass accumulates);
- Successions and/or associations of crops with legume crops in order to improve fertility and structuring type crops such as Brachiaria to replace tillage.

The CA years are noted as follows:

- Y_0 for systems on tillage in entry into CA: these are plots on tillage on which the cover crops are planted at the same time as the food crop.
- In the following years where there is no more ploughing ,CA are noted as Y_1 (first year under CA), Y_2 (2^{nd} year under CA) etc…

1. Context of Conservation Agriculture in Madagascar

Madagascar is an agricultural country in which nearly 80% of the population is rural, involved in agricultural production, essentially in rice production. There exist considerable constraints on the various factors of agricultural production, at both the land tenure level which is rarely secured , and the access to credit which is limited, as well as the workforce which is also restricted due to lack of mechanization.

Madagascar is a country of contrast providing a unique range worldwide in terms of populations, climates, and soils with sub temperate (altitude), tropical humid , and even dry Sahelian ecosystems (AFD , 2006). People may also find both temperate and tropical crops in that country, especially regarding fruit and vegetables.

The major Malagasy agricultural production is rice that is produced in several areas of the country. The other products are essentially maize, cassava, sweet potato, sorghum (in the South) and pulses (bean, butterbean, black eyed pea, cowpea...). cash crops are essentially coffee, vanilla and cloves

Livestock is dominated by extensive cattle, pig, and poultry breeding.

Soil degradation is caused by:

- The hilly relief type aggravated by
- The fragility of soils, especially in the rift of tectonic origin of Lac Alaotra type;
- An aggressive climate (high rainfall intensity entailing considerable gully erosions, considerable wind erosions in the Southern part) ;
- The absence of plants covers because of repeated bush fires and/ or traditional slash and burn techniques, known as *tavy*, in forest areas;
- The occurrence of a long dry season (6 to 7 months) that creates a considerable lack of fodders and results in overgrazing and soil exposure to considerable erosions at the beginning of rains ;
- A transhumance breeding that is a source of slash and burn agriculture in semi arid areas

[1] The Task Force on Conservation Agriculture: pools all public and private stakeholders in Conservation Agriculture and the secretariat of which is ensured by FAO.

In many areas of the country, the lowlands that can be cultivated with irrigated rice are saturated because of increase in population number; therefore, it became necessary to cultivate the poor *tanety* through conservation agriculture.

Four major agro ecological zones may represent the whole situations:

- The tropical climate areas with an altitude higher than 1,200 m: e.g. the high lands (Vakinankaratra and Itasy) ;
- The mid altitude areas (600 to 1100 m) with a long dry season: e.g. the Lac Alaotra and Middle West;
- The humid tropical areas of the East coast that are lower than 500 m altitude;
- The semi arid areas of the South West and the Androy (300 to 600 mm rainfall).

Figure 1 : The Major Four Agro ecological Zones in Madagascar and the TAFA reference Sites

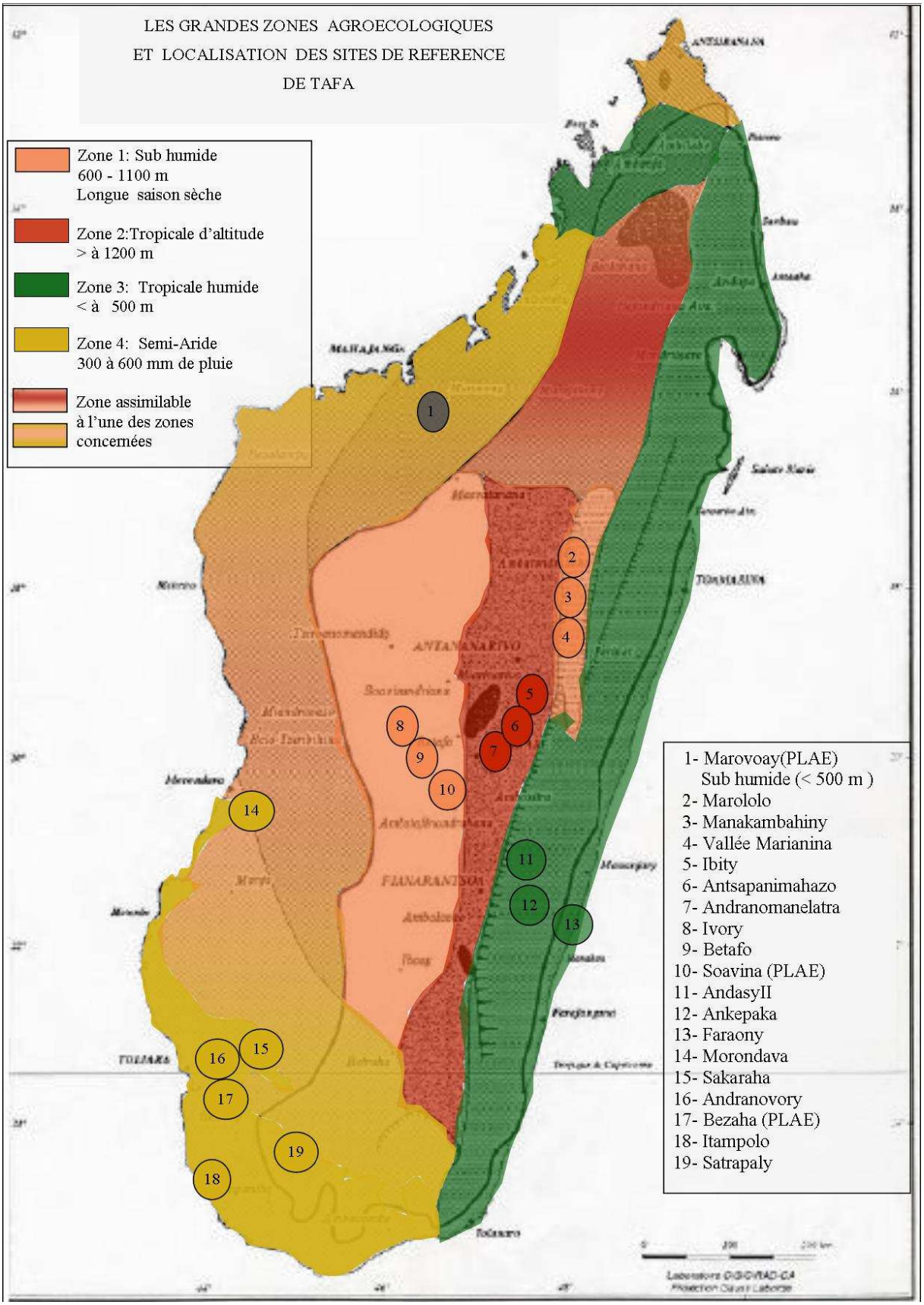
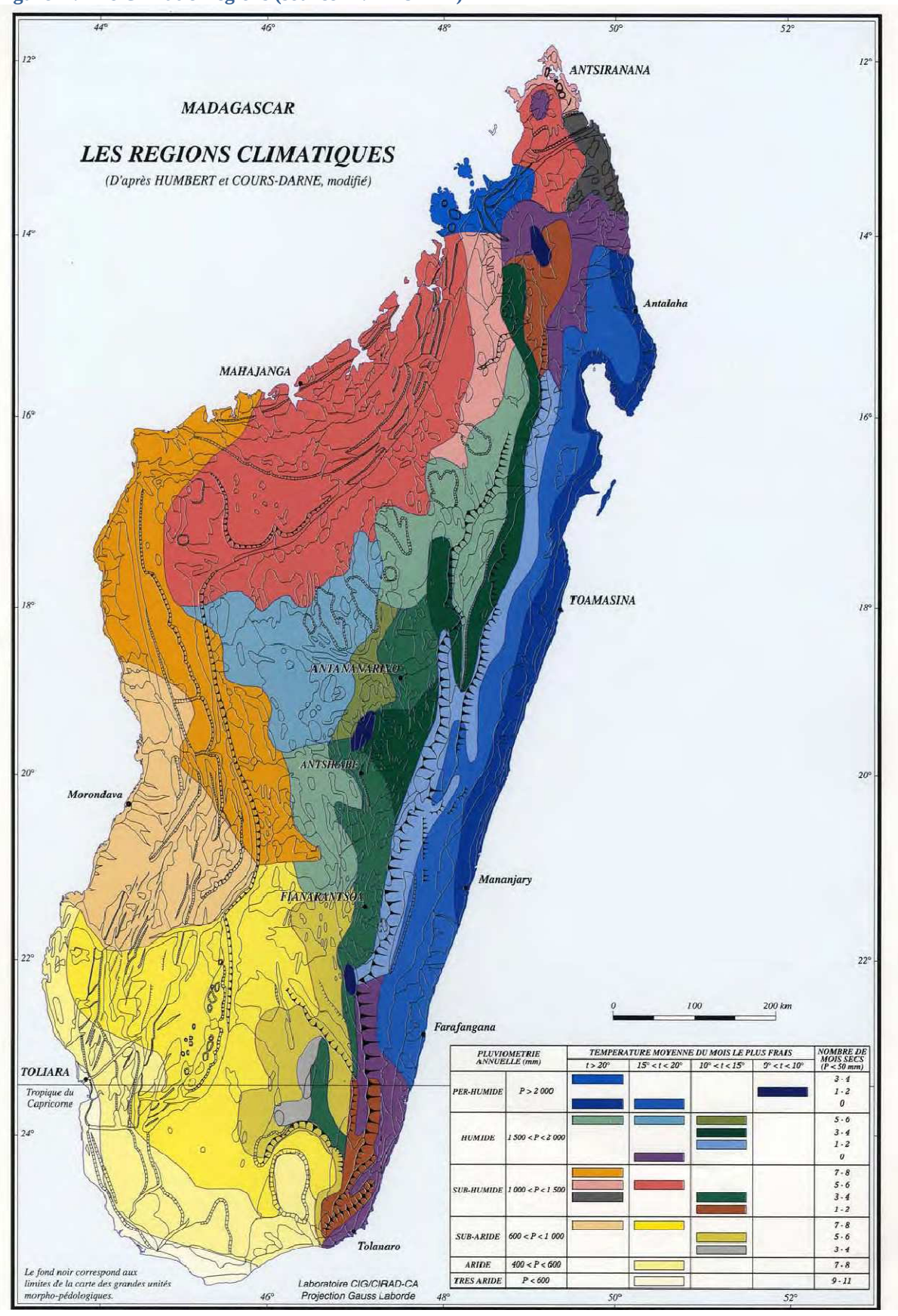


Figure 2 : The Climatic Regions (source M. RAUNET)



The first tests for Direct Seeding on Permanent soil Coverage (e.g. CA) date back to the 1990s and took inspiration from the Brazilian experience (L. Séguy, CIRAD) to meet the required modernization of large scale cereal production systems. They started on the High Lands (Antsirabe) with the implementation of reference sites, the objectives of which were to create, control, and reproduce a range of CA systems which are compared to the traditional tillage based system, in terms of technical and economic performances. In each major agro ecological zone, soil variability is covered in the way that the reference sites crossed all range of soils from the richest soils, to the poorest and the intermediary soils in the area. Various levels of crop intensification and integration with livestock are also tested in such areas – and that allows proposing a wide range of systems that are locally adapted to the agro ecological conditions of one given zone, among which we can choose the systems the most adapted to a given agricultural production system.

In the Vakinankaratra (high lands), the reference site of Andranomanelatra (the oldest one) was implemented by the TAFA NGO in 1990/91; followed, in the South West (semi-arid) by that of Andranovory (1993/1994) and that of Sakaraha (1994/95). Thereafter, other study and evaluation sites were implemented from 1998 in diverse agro ecological zones of Madagascar under the « Environment Project I »:

- In the altitude areas, in addition to the site of Andranomanelatra (1,500 m), on latosoil derived from volcano lake deposit, that of Antsampanimahazo and that of Ibity (1,600 m), on recent volcanic soil, that of Betafo (1,300 m),
- In the mid altitude areas (600 to 1,100 m), 3 sites in the Lac Alaotra area (poor soils of the west bank, « rich » soil of the East bank, average fertility soils in valleys of the South, by covering each time *tanety*, *baiboho*, and paddies fields with Poor Water Control [Rizière à Mauvaise Maîtrise de l'Eau (RMME)], one site in the Middle west on latosol from basalt (Ivory),
- In the subtropical climate of the East coast, 3 sites in the South east on hydromorphic soils (Ankepaka), on forest regrowths on basalt (Andasy II) and on fallow hydromorphic lateritic soil covered by Aristida (Faraony),
- In the semi arid climate of the South West two sites in the area of Morondava (1998) and two sites on the Mahafaly plateau (Satrampaly in 2003 on the plateau and Itampolo in 2004 on the coastal area) have been added to the two sites of Sakaraha (on lateritic soil) and of Andranovory (on compacted sandy iron latosol).

Within the framework of collaboration with the PLAE Project, 3 other reference sites have been added later (in 2006 and 2007): that of Marovoay on sandy iron latosol, that of Soavina (Amoron'i Mania) on latosol with a climate of the Middle West and that of Bezaha in semi arid climate.

Such initial works on conservation agriculture techniques served as benchmark for developing diverse rural development projects. As a matter of fact, major projects took inspiration from such conservation agriculture techniques for addressing, first of all, the Protection and the Development of Watersheds and Irrigated areas , then overall of other rural development areas.

Such initiatives are in keeping with the National Rural Development Policy. It is important to primarily quote the National Policy for the Protection of Watersheds and Irrigation which conditions the rehabilitation of downstream infrastructures (dams, channels...) for which the Malagasy State has benefited from significant support from donors, through the protection of watersheds by means of conservation agriculture. On the other hand, conservation agriculture is included in the PNDR[2] and the PADR[3].

[2] National Program for Rural Development
[3] Support Program to Rural development

2. The Stakeholders in Conservation Agriculture in Madagascar

These stakeholders in Conservation Agriculture are:

- The donors and the institutions
- The Research component
- The GSDM
- The projects
- The stakeholders in diffusion
- The stakeholders in diffusion who are mostly members of GSDM

2.1. Donors and Institutions

The main donors who are involved in conservation agriculture in Madagascar are:

- The Agence Française de Développement (AFD): it is the principal donor for conservation agriculture in Madagascar through many projects such as PSO, Wheat (KOBAMA) Projects, Agro ecology and national support in agro ecology projects (GSDM), BV LAC 1 and 2 projects , BVPI-SEHP project , Plateau Mahafaly project (AVSF) ;
- The KfW : PLAE Project in co financing with the AFD : CA project in Marovoay, Soavina (Amoron'i Mania), Bezaha, Andapa and Ambanja ;
- The GEF : plateau Mahafaly (WWF)
- The European Union : Food Security Projects with CA component with co financing by AFD: PACA Project in the South West, FASARA Project in the Androy, Food Security Project Vohipeno
- The World Bank and AFD in the « Environment I » Project
- The MAE[4] within the programs of SCAC, PTA, and PAMPA which essentially target training.
- The USAID in some actions by Koloharena (Lac Alaotra).

All these projects are cofounded by the Malagasy State at least through the payment of taxes.

2.2. Research and Support

The TAFA NGO was the pioneer structure in the development of the CA systems in Madagascar with the support from AFD and the technical support of CIRAD. It is thanks to their research and development work in their reference sites that the current cropping systems have been developed and the various stakeholders have been trained.

The SCRID research unit that associates FOFIFA, CIRAD, and the University of Antananarivo was in charge of the thematic research from 2001 on topics that are of interest to conservation agriculture: varieties, diseases, insects and and entomopathogenous fungies, soils and organic matters, microbiology, etc.. SCRID is also very much involved in the training and backstopping of trainees.

IRD is involved in research on the conservation agriculture related to carbon sequestration.

2.3. The GSDM (or Madagascar Direct Seeding Grouping)

Madagascar has the particularity of associating the principal actors in conservation agriculture within one institution, e.g. GSDM.

GSDM, a non profit association established in 2000, is a national coordination structure which groups all the stakeholders in conservation agriculture with, in total, 16 organizations involved in research and diffusion of conservation agriculture. GSDM is in charge of coordinating the stakeholders, of monitoring and evaluating the implementation of actions , of group animation among its members and partners, of training and capitalizing of results. It has an executive management supported by CIRAD and it is steered by a Board of Directors, and has benefited since 2002 financial support from AFD. The Agro ecology Project of which GSDM is in charge has a Steering Committee; composed of the Ministry of Agriculture (chairman), the Ministry of Agricultural

[4] Ministry of Foreign Affairs (France)

Research , the Ministry of Environment and Forestry, the Support Program to Rural Development (PADR) and GSDM. AFD is invited to attend the meetings of the Steering Committee.

2.4. Projects

The main projects including an important component of conservation agriculture are (fig.1):

2.4.1. The Watershed and Irrigation Project in the Lac Alaotra Region:

BV LAC 1st phase 2003-2008 (CMG 1158) and 2nd phase 2008-2013 (CMG 6011), the project management of which is ensured by CIRAD.

Such project is financed by AFD and the Malagasy Government, and its missions consist in:

- Increasing and securing farmer's income;
- Conserving natural resources in watersheds and securing the investment downstream, and;
- Supporting farmer's organizations with a view to providing their autonomy in managing their development.

GSDM has supported the BV LAC project in the implementation of the Conservation Agriculture since its origin.
Such project included in its first phase an important component of conservation agriculture. The orientation of the 2nd phase strengthens such option and aims to accelerate the diffusion of agronomic innovations (especially conservation agriculture) so as to come up with a transformation of the landscapes on the watersheds and have an actual impact on the works downstream. The project envisages to work in synergy with Japanese similar actions in the Lac Alaotra area (JICA). BV LAC's stakeholders in conservation agriculture diffusion are BRL, AVSF/ANAE, SD MAD/AGRO BP.

2.4.2. Project for Supporting the Diffusion of Agro ecological Techniques in Madagascar (CMG 1174) and National Support in Agro ecology (CMG 6011)

The management of the Project for Support to the Diffusion of Agro ecological Techniques in Madagascar (CMG 1174) is delegated (by the Ministry of Agriculture) to GSDM (2004-2008) and the project National Support in Agro ecology (CMG 6011) was subject to a concession to GSDM (2008-2013). The expected results from those two projects are:

- Development of a wide range of CA techniques that are adapted to the diverse agro ecological and socio economic situations;
- Scaling up for the diffusion of agro ecological techniques;
- Establishment of an active agro ecology network;
- Development of means for training decision makers, technicians, and farmers in such techniques ;
- Establishment of conditions to the development of CA techniques.

The Project for support to the diffusion of agro ecological techniques in Madagascar (CMG 1174) provided the continuity of the technical support and training schemes (the TAFA sites), thematic research (SCRID), training for decision makers, technicians, and farmers. It also ensured the role of relay project, i.e., it maintained the technical teams that have been trained and the ongoing actions pending another project that is in the course of preparation: e.g. (*i*) the relay diffusion project in the South East with BRL and AVSF with a view of taking over by the BVPI SEHP project, (*ii*) the relay diffusion project in the area of Ampary (Itasy) with BRL with a view of taking over by BVPI under World Bank financing, (*iii*) the project for diffusion test including capacity building in potential areas in the Middle West, in the district of Mandoto with FAFIALA that is currently taken over by BVPI SEHP, and in the Bongolava with ANAE with a view of taking over by another project. Such Project for supporting the diffusion of agro ecological techniques in Madagascar (CMG 1174) also allowed co funding for EU food security projects while introducing conservation agriculture in such projects (projects PACA, FASARA, project AVSF over Vohipeno). Thus, through such co funding system, the project allowed introducing CA through the PLAE Project (Anti erosion Program) under KfW funding in several regions through . Similarly, through a co financing of the Région La Réunion, the project has been able to document the

integration of livestock in CA. Among the important results from such project, there comes out the training of decision makers and technicians, the GSDM members and its partners and the capitalization of results.

2.4.3. Project on Watersheds and Irrigation on the South East and High Plateaus (BVPI-SEHP)

The BVPI SEHP project under AFD financing (CMG 6003) covers the irrigated areas in the regions of Vakinankaratra, Amoron'i Mania, Vatovavy Fitovinany, and the South East. The Middle West of Vakinankaratra (district of Mandoto) was added to the intervention areas of this project in 2008 after actions that were initiated by GSDM. The main challenge for the project is to achieve the development of watersheds that are taken as a coherent geomorphologic set (including both lowland and the hillsides), through the development of productive activities that take into account the various potentials provided by the successive landscape units (irrigated crops, rain fed crops on hills or on lowlands more or less irrigated, rangelands, forestry). Such approach relies on the implementation of conservation agriculture techniques in widely varied climates. The operators of such project are SD MAD, SD MAD/RAMILAMINA, FAFIALA, and AVSF. GSDM provides the monitoring of the implementation of the conservation agriculture techniques in this project.

2.4.4. INTERREG Project

This project that is financed by la Région Réunion was subject to a partnership between CIRAD La Réunion and the Malagasy organizations involved in conservation agriculture and integration with livestock (FIFAMANOR, TAFA and GSDM). Its objective is to produce technical notes in French and in Malagasy on the production and uses of fodder, and the integration of livestock with conservation agriculture.

2.4.5. FASARA/PSASA Project in the Semi arid Area of Androy

The Program for supporting the agricultural commodities and for improving food security in the Androy area (FASARA, 2005 – 2008) was implemented by GRET, principal applicant for the European Union grant, and by GSDM, the secondary applicant and contributor for part of own resources. The project aims to provide food security for the households in this semi arid area experiencing high wind erosion in the Androy by increasing the local production of the main food stuff (sorghum, *Dolicos lablab*, cowpea, maize, cassava, millet,..) through a perennial production system by means of conservation agriculture in which GSDM and its partners (TAFA and FOFIFA) have brought their skills. The actions by the FASARA project are continued under the PSASA project (Project for Securing Seed Supply for the Androy, 2008-2010), the main objectives of which are the same but with emphasis on seed production.

2.4.6. PACA Project in the South West Area

The objective of the PACA Project (Agriculture Production in the plain of Ankililoaka and the corridor of Antseva, 2006 - 2010) that is located in such fertile region in the South West where water is available all over the year is to show that it is possible to increase food crop productions (rice, maize) at the same time as cash crops (cotton, groundnut). The project results from a response to a request for proposal from the EU in which the principal applicant was the TAFA NGO and at the secondary applicant, SD MAD and HASYMA. GSDM funded part of the project resources. The project includes the conservation agriculture based on the TAFA and GSDM experiences on cropping systems based on cultivation on cover crops.

2.4.7. PLAE Project

The objective of the PLAE Project (Anti erosion Program, funded by the German KfW), is to conduct anti erosion actions in the erosion sensitive sites of the watersheds in the irrigated areas of Marovoay (Boeny region, since 1998), Soavina (Amoron'i Mania region, since 2005) and Bezaha (South West region, since 2006). In a subsequent phase, the project extended its actions in Andapa area (SAVA region) and Ambanja area (DIANA region). PLAE requested from GSDM a study on the opportunities of diffusing CA in its branches in Marovoay, Soavina, and Bezaha. Following such studies, reference sites and demonstration plots were implemented in such 3 branches, and the PLAE staff benefited from training and exchange visits. Subsequent support from GSDM and TAFA allowed for diffusion in such 3 branches and that of Andapa.

2.4.8. Conservation Agriculture in the Plateau Mahafaly in the South West Region

One first phase of the project for conserving the plateau Mahafaly was financed by FFEM/AFD (CMG 1185 01 T, 2002-2008) and implemented by WWF, which requested from the SOKAKE NGO the transfer of management to communities bases. WWF was also in partnership with AVSF for the diffusion of fodder crops. In the same plateau, SAGE was also in a contract with UNDP for the development of PCDs ; and the TAFA NGO (AFD funding) was in charge of implementing CA reference sites (Satrampaly and Itampolo) whereas the Maison des paysans (farmers Union) was in charge of diffusing CA based on results by TAFA. The project supports the extension of the National Park Tsimanapesotsa and seeks to restrict slush and burn through sustainable production systems in both agriculture and livestock, by using conservation agriculture. In brief, they set to restrict what is called *hatsake* (slash and burn agriculture*)* by proposing production and livestock systems for settling the populations in the areas that have been cleared.

The objective of a 2nd phase called COGESFOR[5] (2009-2012), of which the part on the plateau Mahafaly is financed by FFEM/AFD and implemented by WWF in partnership with AVSF consists in capitalizing what has been acquired and scaling up of the diffusion.

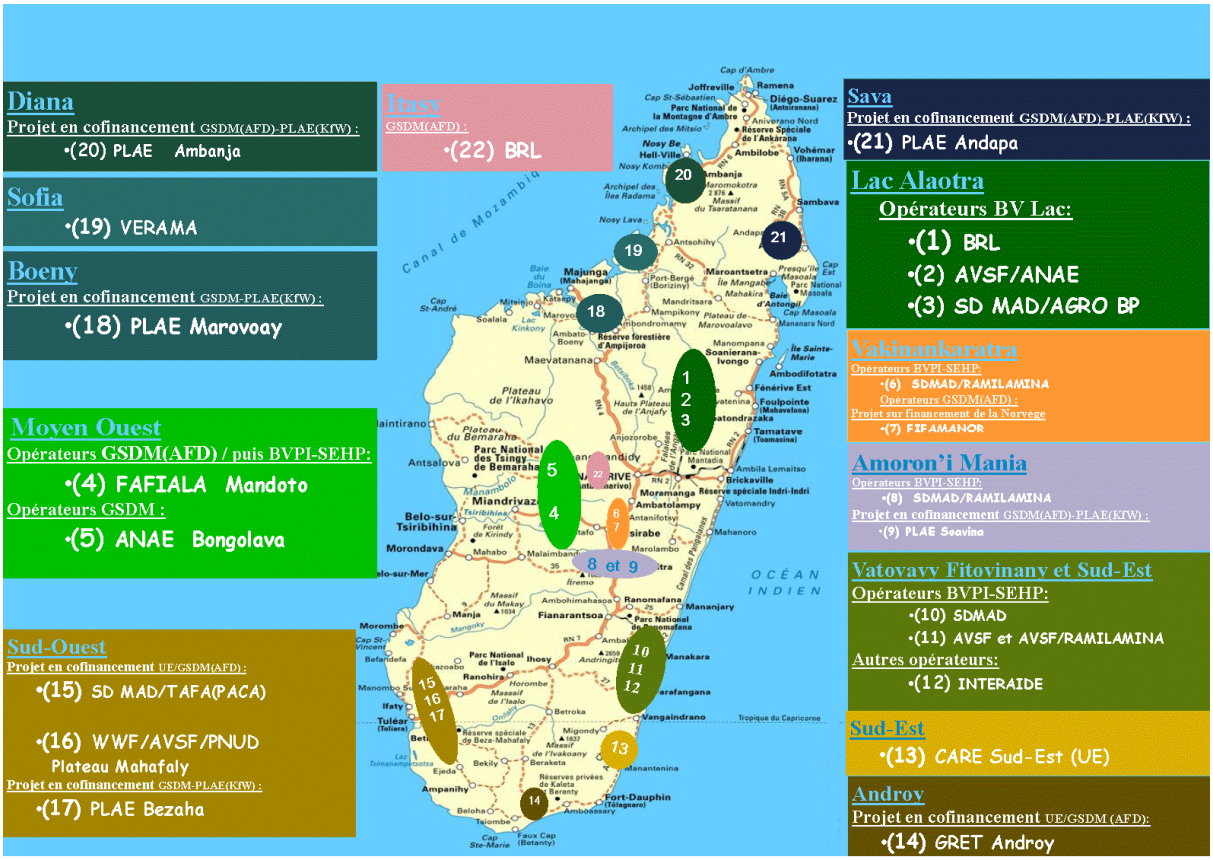
Another project that started in January 2010 is funded by GEF/UNDP, and implemented by WWF-UNDP has the same objectives in 5 pilot communes in the plateau Mahafaly and the plateau of Karimbola.

2.4.9. Conservation Agriculture around the National Park of Andasibe

Funded by Conservation International[6], ANAE amongst other activities diffuses the conservation agriculture around the National Park of Andasibe, thus complementing its project TAMS[7] that is funded by the World Bank under EP III.

[5] Project for Sustainable Management of Natural Resources in the 3 Biodiversity Hotspot Areas in Madagascar (2009-2012). The 3 Hotspots are the plateau Mahafaly, the forest of Didy (CIRAD) and Vohimana (Man and the Environment).
[6] Sustainable livelihoods activities
[7] TAMS: TetikAsa Mampody Savoka : project for replanting woody species, of which precious wood (palissander, rosewood…)

Figure 3 : The Stakeholders in the Diffusion of Conservation Agriculture in Madagascar



2.5. Stakeholders in Diffusion

The main stakeholders in diffusing conservation agriculture are essentially GSDM members. In addition to GSDM members, there are also GSDM partners projects such as PLAE and private organizations.

2.5.1. ANAE

The National Association for Environmental Actions is an NGO working in the area of the environment (afforestation, conservation agriculture) and that of conservation and improvement of soil fertility through actions in sensitizing, training, and rural development. With regard to diffusing conservation agriculture, ANAE was already involved under the Environment Project I, and currently is involved i) in the Lac Alaotra area under the BV LAC project; ii) in the Bongolava under a contract with GSDM, and iii) in the project around the National Park Andasibe on a World Bank project (EP III). The project around the National Park of Andasibe is in the framework of the Carbon sequestration project. ANAE has executives and technicians who have been trained in conservation agriculture.

ANAE is a founding member of GSDM

2.5.2. ANDRI-KO

The ANDRI-KO cooperative, based in the Lac Alaotra area, is in charge of producing and diffusing food crop seeds (rice, maize, bean …) and cover crops seeds. Its members practice conservation agriculture in their seed production plots.

ANDRI-KO has been accepted as a member of GSDM since 2009.

2.5.3. AVSF (Agronomes et Vétérinaires Sans Frontières)

AVSF is a French NGO involved in diffusing conservation agriculture in the Lac Alaotra area and in the South East. In the past AVSF had experiences in diffusing conservation agriculture in the South West, especially in the Mahafaly plateau. Currently AVSF is involved in diffusing conservation agriculture in the Lac Alaotra area (BV LAC) and in the South East (BVPI SEHP). AVSF is known for its actions in integrating agriculture/livestock and in support to animal health. AVSF has executives and technicians trained in conservation agriculture.

AVSF has been accepted as a member of GSDM since November 12, 2004.

2.5.4. BRL-Madagascar

Initially involved essentially in hydraulic infrastructure programs, the Company Bas-Rhône Languedoc-Madagascar (BRL Madagascar) has participated since 1999 in projects for diffusing Conservation Agriculture, in an approach encompassing watersheds as a whole (Lac Alaotra, South East). Currently, the diffusion of conservation agriculture in the Lac Alaotra area by BRL-Madagascar, especially on the East bank, is experiencing high adoption by farmers. Since 2006, BRL-Madagascar also committed in diffusing Conservation Agriculture in the area of Ampary (area of Itasy), a recent volcanism area with a high density of population and a rapid deterioration of the environment.
BRL-Madagascar has executives and technicians who have been trained and who have good experience in conservation agriculture.
As a member of GSDM, BRL-Madagascar is currently part of the college of moral entities of GSDM Board of Directors.

2.5.5. CARE INTERNATIONAL MADAGASCAR

CARE INTERNATIONAL MADAGASCAR is an international NGO that conducts rural development actions in various areas of Madagascar. Since 2004, with support from TAFA, BRL-Madagascar, INTER AIDE, and FOFIFA, CARE has introduced in the region of Anosy, in 8 rural communes in Fort Dauphin, the conservation agriculture techniques, and the management of RMME with the SEBOTA varieties. CARE was admitted as a member of GSDM on June 7, 2006.

2.5.6. The FAFIALA Center

The Experimentation and Diffusion Center for farmer management of hillsides or *tanety*[8] (or FAFIALA) works on the High Lands (Imerina) and in other areas of Madagascar. It trains farmers and technicians, and conducts development actions on the *tanety*, based on agro-forestry, conservation agriculture, and environment protection.

In conservation agriculture, after the training of its whole team within TAFA, FAFIALA committed itself in CA diffusion in the Middle West of Vakinankaratra (district of Mandoto) which resulted in high farmers adoption of *tanety* cropping systems based on *Stylosanthes*. Apart from the profitability of the systems proposed (increased yields along the CA practice years); efficiency on the impact of *Striga asiatica* is one of the reasons for the high adoption of conservation agriculture in this area.

[8] Tanety : hills

FAFIALA has trained executives, technicians, and social organizers having good experience in conservation agriculture.

FAFIALA is a founding member of GSDM

2.5.7. Confederation of Malagasy Farmers or FEKRITAMA

FEKRITAMA is a central farmer union that animates farmers for human development following the Christian philosophy. It groups 9 national organizations of producers. Several associations members of FEKRITAMA were involved in conservation agriculture in the 2000s. In 2009, representatives of such organization benefited from refresh courses in short duration training in conservation agriculture with TAFA. FEKRITAMA was admitted member of GSDM on September 14, 2007.

2.5.8. FIFAMANOR

This research and rural development center in agriculture and in livestock is based in Antsirabe.

It contributes to diffusing the conservation agriculture and has a network of diffusion agents in the Vakinankaratra. It involves itself in systems integrating fodder soles regenerating soil fertility and in smoldering techniques in some altitude areas. FIFAMANOR is also very much involved in seed production and in training, especially on integration with livestock.

Following the training of its executives and its technicians in 2004, FIFAMANOR provided the diffusion of conservation agriculture in some areas of the High Plateaus. FIFAMANOR also ensures the production of seeds for some cover crops and played a role in the integration of agriculture and livestock.

FIFAMANOR is a founding member of GSDM

2.5.9. The Group for Research and Technological Exchanges or GRET

GRET is a French NGO that conducts a rural development program known as « Objectif Sud » in the area of Ambovombe. Since 2005, with support from GSDM and TAFA, GRET has implemented activities in conservation agriculture within the FASARA/PSASA projects with funding from the European Union and AFD with the development of CA in such semi arid area marked by a high wind erosion. The trials and demonstrations in farmer environments allowed opening the way to conservation agriculture systems that may be proposed to diffusing and introducing new species/ varieties of food crops (millet…) and cover crops.

GRET has trained executives and technicians having good experience in conservation agriculture in the semi arid area of Androy.

GRET was admitted member of GSDM on June 7, 2009.

2.5.10. INTER AIDE MANAKARA

Inter Aide Manakara is a French NGO which has for long worked in rural development (school sector, health, hydraulic, area development, agricultural diffusion) in the area of Manakara, and it also involved in extending conservation agriculture among small holding farming communities. It has joined GSDM since November 12, 2004.

2.5.11. Semis Direct de Madagascar (SD-MAD)

SD-MAD is a SARL (Ltd Liability company) that is very much involved in diffusing conservation agriculture in the area of Lac Alaotra, in the South East, the South West, and on the High Plateaus. It is well known in the management of paddies fields with poor water management (RMME), drainage of low lands in the South East and the setting up of pioneer fronts. SD-MAD is the main producer of seeds of food crops and cover crops. SD-MAD associates with another private company in the area of Lac Alaotra to support the large farms in the conduct of conservation agriculture amongst others.

SD-MAD has trained executives and technicians and having good experience in conservation agriculture, seeds, and mechanization of conservation agriculture.

SD-MAD has been a member of GSDM since on November 12, 2004 and is currently part of the college of moral entities of the board of directors of GSDM.

2.5.12. WWF Madagascar or Wild World Funds for Nature

WWF, a nonprofit organization having its head office in Switzerland and operating in other countries in favor of nature and as an international organization, works on the Malagasy territory with a representation in Antananarivo. With funding from the French Funds for the Global Environment (FFEM/AFD), WWF implemented with AVSF and other operators the Plateau Mahafaly project, the objective of which is to propose sustainable production systems based on conservation agriculture and fodders as an alternative to *tavy* in the cleared areas of such chalky plateau and on the coastline with a view of settling the populations on the same area.

WWF was admitted as a member of GSDM on May 15, 2008.

2.5.13. The VERgers d´Anacardes de MAsiloka or VERAMA

VERAMA, a subsidiary of the UNIMA Group, initiated the large scale planting of cashew nut trees on very compacted poor soils in the rural commune of Antonibe, district of Analalava, Region of Sofia. VERAMA tried various cover crops to regenerate its soils and got support from TAFA and GSDM. VERAMA was admitted as a member of GSDM on 12 November 2004.

2.5.14. Other Operators

A private Company in the area of Lac Alaotra, AGRO BP Conseil, also associated with SD MAD for providing support to the mechanization of the conservation agriculture under the BV LAC project.

BEST, a company specialized in support to farmer organizations, is involved in support to credit in operations for diffusing the conservation agriculture in the BV LAC and the BVPI-SEHP projects.

2.6. Environment of the Rural Development

2.6.1. The Agricultural Services

Extension services in rural development are excessively weak, or even absent in Madagascar. Indeed, for a long time the agricultural services were present but defaulting, or did not exist at all in several regions of the Country. The recent establishment of the Centers for Agricultural Services or CSA may open a new way to agricultural

services by providing farmers with service opportunities through the professionalization of farmers who are considered leaders and particularly enterprising.

2.6.2. Credit on Agriculture

Credit on Agriculture was most of the time promoted by rural development projects. The national Development Bank (BTM), which is currently privatized and taken over by the Bank of Africa (BOA), experienced many credit failures in the past - which entailed a poor culture of credit in the Country. Certain State initiatives of « Voucher » credit that have not been reimbursed also created unsuitable habits of credit non reimbursement among farmers. Many micro finance institutions (OTIV, CECAM, FIVOI, TITEM, etc..) have established for the last 10 years and promoted the system of joint guarantee among members. Thereafter, some micro finance institutions such as CECAM switched later to individual credit. The micro finance institutions (IMF) have a penetration rate that is fairly low (5%) and an insufficient coverage rate (20% of communes) (MAEP, 2006). The current interest rates for credits are not within the reach of small holders and lend more to the commercial action of collection and resale than to agricultural production.

2.6.3. Suppliers of Agricultural Input and Machines Specific to Conservation Agriculture

The input that is necessary for conservation agriculture is available with the local suppliers but its price has increased much over time in part because of monetary erosion. On the opposite, the machines specific to conservation agriculture (essentially seeders and sprayers) are not available at all. Prototypes of jab planters were introduced but their manufacturing by local artisans was not successful because of lack of quality materials.

2.6.4. Seeds

Private companies (SD MAD, ANDRI-KO) were created for the production and distribution of seeds of cover crops. Organizations such as FOFIFA or FIFAMANOR have for long produced fodder seeds that are also used as cover crops. But, in a general way, imports of new varieties were made by TAFA, then by GSDM. The development projects also contributed to multiply among farmers seeds or cuttings of the main cover crops in order to avoid too high transportation costs from one area to another. This sector is insufficiently developed in Madagascar, and the availability of cover crops seeds is frequently a limiting factor on the development of conservation agriculture techniques.

2.6.5. Farmer Organizations

Many farmer organizations were created under the impulse of projects in order to structure the support that is provided and the diffusion of messages. Some organizations created central structures which are still working currently: FEKRITAMA, FIFATA (supported by FERT), Maison des Paysans (farmers unions initially supported by the PSO project) etc..

2.6.6. The Agricultural Product Market

The agricultural products market experiences a considerable seasonal variation. It is not particularly organized and agreements are generally made between farmers and collectors. In many cases, such as for rice, conservation agriculture has a huge comparative advantage compared with traditional agriculture. As a matter of

fact, it allows an early seeding and yield, and then a more favorable selling in order to secure a better price for farmers.

2.6.7. National Coordination Structure

Madagascar is particular for having associated the main stakeholders in conservation agriculture within a grouping, the "Groupement Semis Direct de Madagascar", a nonprofit association (GSDM, 2008), which facilitates the coordination, monitoring and evaluation of the committed actions. In keeping with the National Agro ecology Program, GSDM provides animation and support to the various rural development operations based on a clearly defined strategy. Such strategy takes into consideration the various scales and intervention levels from the plot level to the watershed level by going through the farm level which is the essential level for all socio economic aspects.

The national program on Watersheds and Irrigation (BVPI) benefits from several funding sources (World Bank, AFD, JICA, KfW...).A coordination unit at the national level (CNBVPI) establishes an approach strategy for the set of stakeholders in the « Policy Letter for the Development of Watersheds and Irrigation » (MAEP, 2006). The Policy Letter for the Development of Watersheds and Irrigation (BVPI) is fully related with the global process of poverty reduction and growth promotion defined in the Poverty Reduction Strategy Paper (PRSP). It coincides with the Action Plan for Rural Development (PADR) and is consistent with the orientations drawn up in the National Program for Rural Development (PNDR). It specifically indicates the objectives and orientations of the Government in terms of development of watersheds and irrigation, as well as the intervention methods and the implementation means. The new BVPI concept proposes a holistic approach with actions that are diversified, complementary, and articulated because of the fact that the irrigated area and the neighboring watersheds constitute a consistent geomorphologic, economic, and social set.

2.6.8. Policy, Economic Environment, and Institutional Framework of the Conservation Agriculture

2.6.8.1. Action Plan for Rural Development (PADR)

Such action plan introduces the PRSP and presents the referential process of the Government in the sector of rural development. It orientates the rural development projects and programs especially under orientations 2 and 3 which consist in « urging the emergence of economic stakeholders who are partners of rural development » and « increasing and promoting agricultural production with an optimal use, as well as sustainable management of resources and infrastructures».

2.6.8.2. National Program for Rural Development (PNDR)

PNDR in all its orientations responds to the concerns of the new BVPI policy, particularly at the level of the strategic focus « Agricultural Productivity Improvement » and in order « to value natural resources and to conserve the natural production factors ».

2.6.8.3. Environmental Action Plan (PAE)

PAE includes in its sector strategies the management of watersheds because this is fundamentally important at the economic level. Erosion is known as harmful for rice production and fish resources in the estuaries. It obliges over dimensioning of infrastructures, contributing to accordingly increase the investment required, and the periodical maintenance cost to be undertaken frequently over time.

2.6.8.4. The third and last current phase of the Environmental Project or EP-3

EP-3 provides that the stakeholder have the reflex to appropriate the environmental actions that are from now « automatically » and systematically integrated. In the strategy of EP-3, CA is acknowledged as a mean to protect the protected areas.

2.6.8.5. Land issues

Land security is a fundamental element of the BVPI procedure and in terms of conservation agriculture because CA results may be obtained only over time and in a framework of secure land tenure; hence the importance of land titles or land certificates. The current implementation of the National Land Program is very important in that regard.
In keeping with this program, several hundreds of land certificates are issued each year in communes thus allowing securing the land to farmers who want to invest in their production means and especially in CA.
In irrigated areas, land tenure security also influences production methods and network maintenance: engagement in intensification, secure those who occupy the land and the forecoming rights such as sharecropping, tenant farming or other ones. The role of Communes and the local governance especially through the development of land taxation are also involved. Such security is more important in the watersheds of the areas, in which situations of free access and occupancy of slope areas accentuate the phenomena of erosion and accumulation of sand in the downstream irrigated areas.

3. Research and training outputs

3.1. Improvement of Cropping Systems

A large number of cropping systems were implemented and tested in differentiated ecologies according to different intensification levels by SCRiD and TAFA. The cropping systems that are a priori possible were screened across various agronomic soil types and socio economic conditions. Many adaptation trials were necessary to identify and to control the best adapted cropping systems. The role of TAFA mainly consists in developing CA systems responding to the agro climatic constraints of an area and in providing the required adaptations needed by the development operators.
SCRiD, in addition to its activities for selecting rice varieties, particularly set to assess the performances of CA and to explain the working thereof through thematic research.

3.2. URP/SCRiD research output

3.2.1. Thematic Aspects of the Research Activities

The aim of the thematic research activities conducted by URP/SCRiD, under the Project for Support to the Diffusion of Agro ecological Techniques in Madagascar, was to understand and to explain the biological, physical and chemical mechanisms underlying the performances of CA based on rain fed rice. Such research actions were essentially oriented on major problems, which were faced by GSDM diffusion operators, in their actions for diffusing such techniques in Madagascar, such as the selection of performing varieties/lines that are adapted to the various ecological areas and are resisting to/ tolerating the various diseases, of which mainly rice blast, the proliferation of attacks by main pests, the soil born insects and the stem borers, soil erosion, production of a good biomass, the degradation of soil fertility and of the environment by the emission of greenhouse gases … .

3.2.1.1 *Improved Line/Variety Selection*

The objective of such activity is to develop and extend a plant material adapted to the constraints of the environment with resistance to or tolerance of rice blast. With regard to strategy, crossings with diversified sources of tolerance to cold coming from Japan or Nepal were initially implemented on the High Plateaus with the aim of widening the genetic base. The selection that is conducted in the materials from such new crossings granted particular attention to the resistance to blast disease. The procedure for widening the genetic base was initiated through the introduction of populations of CIAT which allowed starting a recurrent selection scheme. On the other hand, more than 300 lines were introduced from Brazil (SEBOTA), CIAT in Columbia, Yunnan or IRRI. Various modalities of deployment of varietal mixtures or mixtures of isogenic lines (multilinear) are

appraised. The genealogic selection that was conducted on the Highlands in the area of Vakinankaratra (1600 m) was also implemented in the Middle West (900 m). Specific crossings are carried out for each ecology. Such selection strategy in the long run allowed creating, by recombination, a genetic variability that is complementary of the one that is created by traditional controlled crossings. The set of material that is selected on the sites of Vakinankaratra and the Middle West of Vakinankaratra was also appraised in the conditions of low altitude in the area of Manakara (Table 1).

The degree of susceptibility of varieties to blast disease is as follows (FOFIFA – SCRiD, 2009) :

- Very susceptible: FOFIFA 154, Exp. 604, 905, 503, 504 ; Shin Ei, Exp. 101, 203, 301, 410 and 501, Cirad 447
- Moderately susceptible: Exp. 003, 007, 015, 201, 207, 401 and 910.
- Resistant : Exp. 411, currently called FOFIFA 172, with a monogenic resistance

Relatively resistant: Sebota 182

Table 1 : Results of Selection of Rain fed Rice Varieties under CA in the Middle West of Vakinankaratra

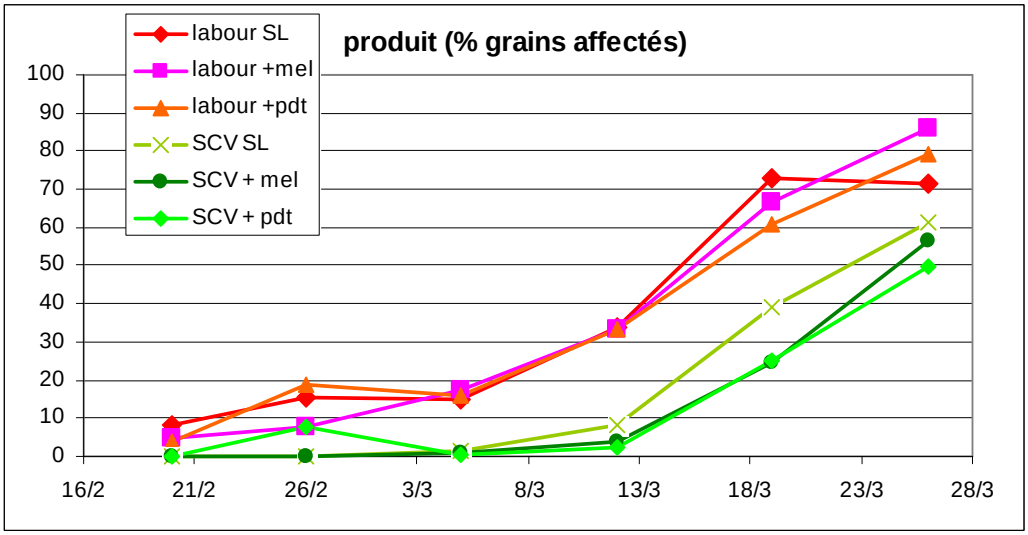
variete	destination	Rendement	SNK	Pct_Nerica4	Pct_B22	Floraison_50	Maturite_50	nb_talles	nb_talles_fertiles	Hauteur	Pyri_surface_feuille	Long_Larg_grain	couleur_cariopse	fertilite	poids_1000gr	rendement_paille_frais
NERICA 11	Essai varietal Ivory	6000,00	a	117,36	147,90	80,50	112,00	56,00	53,00	94,50	0,30	3,45	B	91,31	25,38	14,81
SCRID6 4-3-M	Essai varietal Ivory	5671,30	ab	96,58	118,65	83,50	114,50	71,00	71,00	134,50	1,50	3,03	B	89,17	36,02	18,06
SCRID036 4-1-1-5-M	Essai varietal Ivory	5587,96	ab	96,48	114,65	88,50	120,00	97,50	97,50	105,00	0,35	2,80	B	89,02	47,83	13,15
WAB 878	Collection testee bis	5430,56	ab	110,57	106,94	83,50	114,50	54,00	53,50	108,50	0,00	3,28	B	92,71	33,32	15,83
SCRID036 4-1-1-4-M	Essai varietal Ivory	5425,93	ab	98,63	110,47	84,00	115,00	79,50	79,50	109,00	0,10	3,08	B	82,22	43,20	13,89
NERICA 9	Essai varietal Ivory	5398,15	ab	111,09	147,41	79,00	110,00	66,50	65,00	95,00	0,10	3,46	B	77,64	24,59	13,80
Yunlu48	Collection testee bis	5356,48	ab	125,65	120,67	99,00	131,00	73,50	72,00	100,00	0,25	2,63	B	90,65	35,80	15,28
NERICA 13	Collection testee bis	5125,00	ab	120,02	131,77	82,50	114,00	68,00	68,00	117,00	1,75	3,39	B	89,84	36,57	16,67
Nerica 4	**TEMOIN**	**4959,49**	**ab**			**80,88**	**111,94**	**60,31**	**56,69**	**97,94**	**0,19**	**3,57**	B	**82,29**	**30,84**	**11,41**
C537B_1305-....	NON	4884,26	abc	96,80	104,23	83,50	114,50	68,00	68,00	117,50	0,10	2,49	R	87,18	42,21	13,89
NERICA 7	Collection testee bis	4879,63	abc	100,91	133,46	76,50	107,50	45,00	41,50	121,50	5,50	3,34	B	93,68	31,82	17,69
NERICA 12	Collection testee bis	4791,67	abc	93,88	120,82	76,50	107,50	61,00	57,50	112,00	0,75	3,53	B	90,37	34,21	17,59
NERICA 8	Collection testee bis	4675,93	abc	92,51	122,68	76,50	107,50	54,50	53,00	99,00	0,00	3,49	B	90,61	28,92	15,46
WAB450-I-B-P-20-HB	Essai varietal Ivory	4666,67	abc	114,09	106,78	83,50	114,50	70,50	66,50	115,00	2,00	3,58	B	85,77	38,19	11,94
WAB450-25-2-9-4-1-B-HB	Collection testee bis	4652,78	abc	87,34	90,85	80,50	112,00	82,50	80,00	109,50	0,00	2,90	B	82,37	30,05	11,02
NERICA 16	Collection testee bis	4615,74	abc	92,65	102,30	79,50	110,50	59,00	52,00	107,00	0,30	3,63	R	92,08	30,34	17,59
IRAT 134	NON	4606,48	abc	95,43	110,23	83,50	114,50	75,50	73,00	77,50	4,00	2,47	B	92,14	35,95	10,74
NERICA 18	Collection testee bis	4532,41	abc	91,86	106,10	80,50	111,50	53,00	49,50	116,50	0,20	3,62	R	90,98	27,66	15,28
B22	**TEMOIN**	**4420,72**	**abc**			**79,07**	**110,19**	**55,31**	**53,25**	**116,25**	**9,20**	**3,18**	B	**92,92**	**36,87**	**15,12**
SCRID022 4-1-1-3-M	NON	4351,85	abc	79,41	90,61	84,00	115,00	70,00	70,00	107,50	0,25	3,39	B	84,02	49,43	12,50
Yunlu47	NON	4296,30	abc	82,25	87,01	98,00	131,00	78,50	77,50	106,50	2,25	2,63	B	91,00	35,21	20,83
NERICA 15	Collection testee bis	4287,04	abc	90,67	105,35	79,50	110,50	40,00	36,00	111,00	0,20	3,62	R	90,83	33,46	15,28
Exp 206	Collection testee bis	4226,85	abc	104,83	94,61	84,00	115,00	60,50	60,00	110,00	1,50	2,43	B	89,40	31,67	9,72
Exp 202	NON	3879,63	abc	82,60	84,09	76,50	107,50	42,50	40,50	117,00	0,05	2,56	B	93,49	42,52	11,94
NERICA 1	NON mais cycle	3842,59	abc	71,47	93,64	71,00	102,00	61,00	55,00	95,50	0,00	3,41	B	93,90	29,31	14,63
WAB450-11-1-1-P31-HB	NON mais cycle	3666,67	abc	76,01	75,98	70,00	101,00	67,00	65,50	91,00	0,05	3,10	B	92,59	26,06	9,07
Exp 006	NON mais cycle	3662,04	abc	91,44	80,80	69,00	100,00	63,00	63,00	103,00	0,30	3,05	B	89,68	40,27	6,02
NERICA 17	NON	3287,04	abc	67,62	76,09	84,00	114,50	65,00	62,00	111,00	1,55	3,53	R	78,88	34,63	11,11
SCRID100 7-2-M	NON	3189,81	abc	50,90	78,71	75,00	106,00	56,50	53,00	98,00	10,00	2,88	B	89,61	30,83	7,92
NERICA 10	NON mais cycle	3037,04	abc	57,74	77,61	69,00	100,00	45,00	38,00	79,00	0,00	3,44	B	89,65	26,82	7,31
IRAT 265	NON mais cycle	2810,19	bc	57,02	65,64	70,00	101,00	45,50	44,00	100,00	1,60	3,04	B	89,40	38,11	10,00
IAC 1204	NON	2023,15	c	44,92	50,95	99,00	131,00	90,50	90,50	84,00	7,00	3,91	B	75,96	27,68	11,02

3.2.1.2. Variety resistance to *Pyricularia oryzea*

Considering that, irrespective of the varietal resistance, the incidence and the severity of the blast disease, also depends on temperature and humidity conditions in which the fungus develops, as well as on the physiological status of plants (content in nitrogen, water stress), a study on the interactions between cropping systems (Tillage vs CA) and the development of the disease was conducted. The parameters raised may be modified by the cropping system; so there are possibilities of managing the disease by adopting a good cropping system. CA favors the mineral balance in the plant, decrease water stress thanks to the presence of soil coverage and the absence of tillage.
The study conducted during three years of the project consists in comparing Rice blast disease epidemics over a variety that is very sensitive to blast in the area (Fofifa 154) cultivated with or without mineral fertilizer in one hand and same rotations in tillage and in CA in another hand.
For the first two years the monitoring was dynamic with a scoring of the disease from the appearance of the symptoms until the harvest. On the third year the scoring was made as needed.
The findings from such observations highlighted an effect of the cropping system on the incidence and the severity of the disease at foliar stage as well as at the panicle stage initiation. On the first year it was especially a delayed effect : as the panicle blast disease comes later in CA, it also had less impact on yield. On the second year the final level of disease was low in CA. On the third year the disease level was still higher in tillage, especially with the addition of mineral fertilizer, which thus confirms the importance of the trophic conditions of plants.

In that respect, the effects of plant associations were appraised: It is observed that the way of conducting the association of rice with Crotalaria, Cajanus and Eleusine (***mel***) or with Bambara bean (***pdt***), presents an influence on the occurrence of Rice blast, expressed by the percentage of grains affected. Figure 4 indicates that whatever the system, rice in pure stand or in association, Rice blast is more severe in tillage than in CA (FOFIFA-URP SRiD, 2007).

Figure 4 : Evolution in the percentage of grains affected by blast disease as a function of the cropping system: Tillage (labour) vs CA (SCV). Tillage or CA, in pure stand (*SL*), in association with Crotalaria, Cajanus and Eleusine (*mel*) or in association with bambara bean (*pdt*).



3.2.1.3. Combatting Heteronycus sp.

Soil borne insects are severe constraints for rice cultivation, and various treatment attempts have been completed especially with entomopathogenous fungi *Metarhizium anisopliae* .
It was thus observed that, whatever the status of the soil surface, the larval individuals of *Heteronychus* sp, are more numerous without seed treatment than when they are treated, either with Gaucho^{R}, or with entomopathogenous fungi (RAZAFINDRAKOTO *et al*, 2008, RAZAFINDRAKOTO *et al*, 2009). When the soil is not tilled and kept covered, fewer species are recorded on the plots that were treated with entomopathogenous fungi than on the ones treated with Gaucho^{R}. There is a positive interaction between CA and the treatment of seeds with entomopathogenous fungi. As a matter of fact, without treatment of seeds, the « rice / *Dolicos lablab* » system accommodates higher numbers of *Heteronychus* sp.(e.g. 5.3

individuals/m²), about the double of those of the « rice/Stylosanthes » system, in which the fewest pest individuals are recorded. But with a seed treatment with Gaucho^{R} or with Metarhizium, the number of pests on rice/ *Dolicos lablab* system is drastically reduced compared with that of the natural fallow plot. It is noted, however, that the importance of the combined effect of the system and the seed treatment varies as a function of CA system.

3.2.1.4. Evaluation of Biological Life

It was revealed through the evaluation of impacts of CA regarding the changes brought by the cultivation of natural fallows and by the quantity and quality of C entries in such systems, on the parameters and functions, indicators of the biological activity of the soils (macro fauna, abundance, and functional activities of micro flora) that the plant population of the macro fauna is more important for CA systems than in tillage systems, whatever the fertilizer levels; but it is not as intense than that of natural fallow. The effect of CA may differ as a function of the cover type and the fertilization. CA on mulch from crop residues (rotation maize/ soya in CA on crop residue cover) is richer in macro fauna than the ones on permanent green cover (maize/ maize in CA on permanent Desmodium cover and rotation bean/soya on permanent Kikuyu cover), especially with the minimum fertilization level (manure only). The same applies to the macro fauna biomass (RABARY B. *et al* 2008).

3.2.2. Evaluation of the Performances of the CA cropping systems

3.2.2.1. Carbon Sequestration

It was revealed through a study conducted on a clay latosol that compares the traditional tillage practice and the effect of systems in direct seeding with cover crops (CA) on the stock of soil organic carbon, the stability of aggregates of soil, the location of stored carbon and its protection level against the microbial mineralization (RAZAFIMBELO T. M. *et al*, 2008) that:

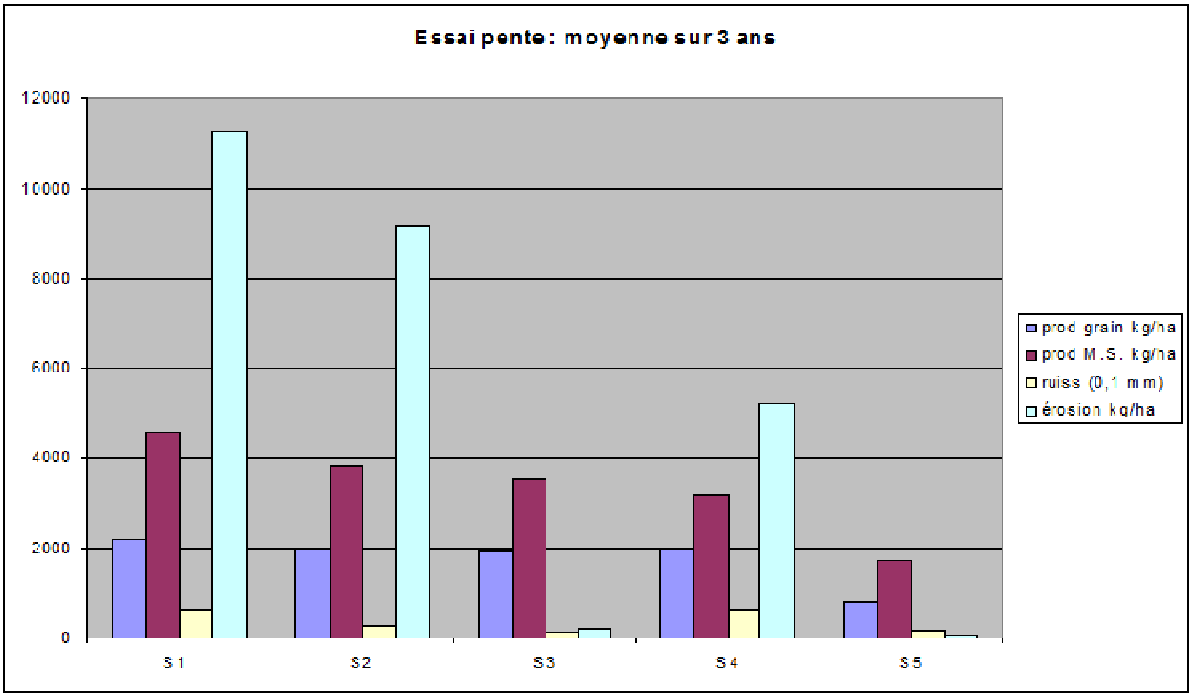
- Soil under systems of direct seeding with soil coverage (Maize / Soya in CA), receiving an important quantity of residues, shows higher C contents and C stocks, of about 0.7 $MgC.ha^{-1}.year^{-1}$, compared with soils that has been tilled in a traditional way (LB) for 11 years, which doesn't receive crop residues, and which is considered on equilibrium. The measured C storage is due to the effect of non tillage, combined with the effect of the restitution of residues. The high annual C storage under CA systems that is measured here is then attributed principally to the important quantity of biomass restituted by such systems compared to tillage treatment.
- Compared with tillage, the CA systems mainly enable an increase in C contents for the fine fraction of the soil (F0-50 µm) for the layers 0-5 and 5-10 cm (40 to 90 % of the stored C is located in there) and in a secondary way from the internal SOM particle to the aggregates for the 0-5 cm layer. It may be attributed to the important role played by the fauna of soil to incorporate and transform the raw plant debris (> 50µm) into fine fraction (< 50µm) which favor the formation of stable macro aggregates.
- The CA systems also enable an increase in particle SOM trapped in aggregates > 50 µm. Such particle OM were not mineralized by the microbial biomass during their exposure to mineralization through the destruction of such soil aggregates > 50 µm. They are partially biochemically protected against mineralization.

As a conclusion, for the clay latosol under study, the tested CA systems prove to be very effective to store C in the soil. Such storage is attributed to the considerable quantity of C restituted to the soil. Such stored C is relatively stabilized since it is protected, at least from a physical and chemical point of view, against microbial mineralization. More over, such systems enable enhancing the structural stability of soil and, with the use of cover crops, they enable effectively protecting the soil against erosion.

3.2.2.2. *Erosion*

The studies conducted aimed to quantify the intensity of the erosion in CA systems, compared with that of tillage systems. It appears after 3 years that the productions of grain and dry matter are relatively comparable. Runoff remains low, but more important on tillage (S1: Maize + bean, and S4: Maize + bean / rice) than on CA. Average erosion expressed by soil losses were up to 12 t/ha/year on tillage, versus 140 kg/ha/year only under CA system. System 5, with *Brachiaria* associated with maize, even though it is very performing against erosion, seems to be the lowest in grain producing.

Figure 5 : Average over **3 seasons of productions, runoffs and erosions of the 5 systems conducted on the land in slope. (Data from Douzet J.M et al., 2007)**



Season	2004/2005	2005/2006	2006/2007
S1: maize+bean	tillage	tillage	Tillage with export of crop residues
S2: maize+bean	tillage	CA	CA
S3: maize+bean	CA	CA	CA
S4: [maize + bean] // rice	Gramineae fallow	tillage	tillage
S5: [maize + bean]// rice	Gramineae fallow	CA	CA with *Brachiaria ruziziensis* instead of bean in 2006

In conclusion, CA enables efficiently reducing runoff and especially erosion. They were able to divide by 12 the runoffs and by 200 the erosions. The main factor of such reductions seems to be the surface status of the soil and particularly its coverage, whether by crop residues or by cultivated cover crops.

3.2.2.3. *Socioeconomic Performances*

Reference farm networks were set up in 3 regions (Lac Alaotra, Vakinankaratra/Middle West and South East) in Madagascar with the contribution of 2 development projects (the projects BV lac and BVPI-SEHP) following surveys characterizing the activity systems (farming + household). Such networks of 30 to 50 farms are representative of a typology that enables classifying the farm types, understanding the innovation processes, identifying the main farming strategies, and understanding the constraints, on the one hand, but also the adoption opportunities on the other hand (PENOT E. *et al*, 2010).

The data acquired already enable following the performances of systems in terms value of the man-day and gross margin at the plots level. The following step in this approach will be to have an economic balance sheet with regard to farming and to be able to simulate the farmer choices or the economic hazards.
A prospective analysis for identifying the most interesting scenarios per farming type is based on prior analysis of the innovation processes with a priority on CA in rain fed crops, but also the SRA/SRI systems (Intensive rice system) in irrigated cultivation and agriculture-livestock integration.

3.2.3. Training output

In that area, diverse training types and qualities have to be distinguished according to whether they address professionals or are in keeping with an academic curriculum.

Training to Research through Research. The scientific activities of URP/SCRID provide support to training course themes for trainee students supervised by researchers from URP. About thirty students were supervised within URP, on themes relating to varied scientific disciplines for preparing their end of study academic degree for High Technician, for Engineer and for DEA (≈ MS degree), or for Doctorate for national researchers working on a thesis. Such students come from diverse public or private university institutions, but most frequently from ESSA (faculty of Agronomy) and the Faculty of Science of the University of Antananarivo and the private Catholic University of Athénée Saint Joseph Antsirabe

Therefore, according to the type of degree prepared and their institution, their number per year is as follows:

Table 2 : Number of Students Supervised by URP/SCRiD as a function of Degree Types

Degree prepared	2004/05	2005/06	2006/07	2007/08	Total
DEA (≈ MS Degree)	3	3		**1**	**7**
Engineer Studies (≈MS Degree, professionnal)	7	7	6		**20**
Maîtrise in Phytopathology (≈BS Degree)	1				**1**
BTS in selection Or in Phytopathology (technician level)	4				**4**
BTS in Entomology (technician level)	2	2			**4**
Total	**17**	**12**	**6**	**1**	**36**

Table 3 : Number of Students Supervised by URP/SCRiD as a function of University Institutions

University Institution	2004/05	2005/06	2006/07	2007/08	Total
ESSA	9	8	4	**1**	**22**
Faculty of Science University of Antananarivo	2	3			**5**
Faculty of Sciences University of Majunga	1				**1**
ASJA	5	1			**6**
ISPM			2		**2**
Total	**17**	**12**	**6**	**1**	**36**

3.3. TAFA research outputs

Historically TAFA initiated its activities in 1995 on development of cropping systems based on cover crops following FOFIFA and the KOBAMA wheat operation diffusion, and it was in charge of creating and continuously adjusting to the local conditions and expectations of potential users cropping systems on cover crops, basis of a sustainable and rapid development, with the purpose of contributing to the real improvement of the living conditions of rural populations.
With the objectives of soil preservation and conservation, development of production capacity, through rational use of soils, enhancement of soil and crop management to contribute to the improvement of farmer living conditions, TAFA has built a large number of very concrete outputs in response to major issues of rural development and management of the environment, namely:

- Cropping systems developed in the sites of the various regional branches. 266 cropping systems have been experimented in the diverse sites of the TAFA NGO,
- Reception of trainees and training capacities.

3.3.1 Development of CA Systems

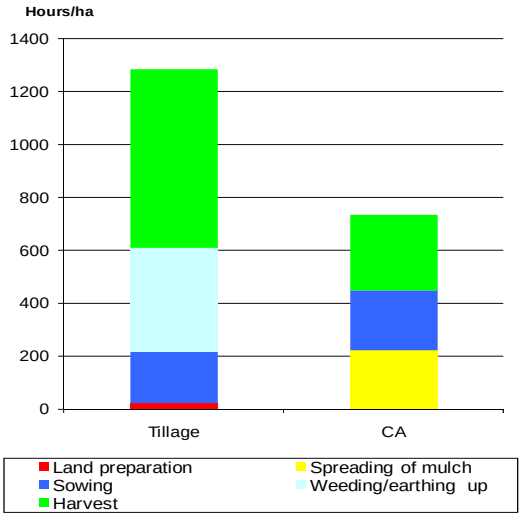
Regarding the development of cropping systems, the works addressed a wide range of technical itineraries according to a matrix based methodology crossing systems by fertilizer levels and the topographical sequence of sites.

The systems considered being the most relevant, already adopted by farmers, or presenting interesting results, relate to:

- Cropping systems on cover crops with feeding of dairy cows,
- Cropping systems on permanent plant cover with minimum input,
- Optimization of work organization,
- Fight against plant pests ; case of *Striga asiatica*,
- Restoration of very degraded soils with *Brachiaria humidicola*, also as accompaniment for traditional crops (cassava, …)
- Cotton cultivation in direct seeding on crop residues,
- Maize cultivation associated with Cowpea,
- Selection of cultivars of rain fed rice obtained from crossings of the variety B22,
- Evaluation of Carbon sequestration capacities in the soil under plant cover system in various soil and climatic conditions,
- Soil smoldering

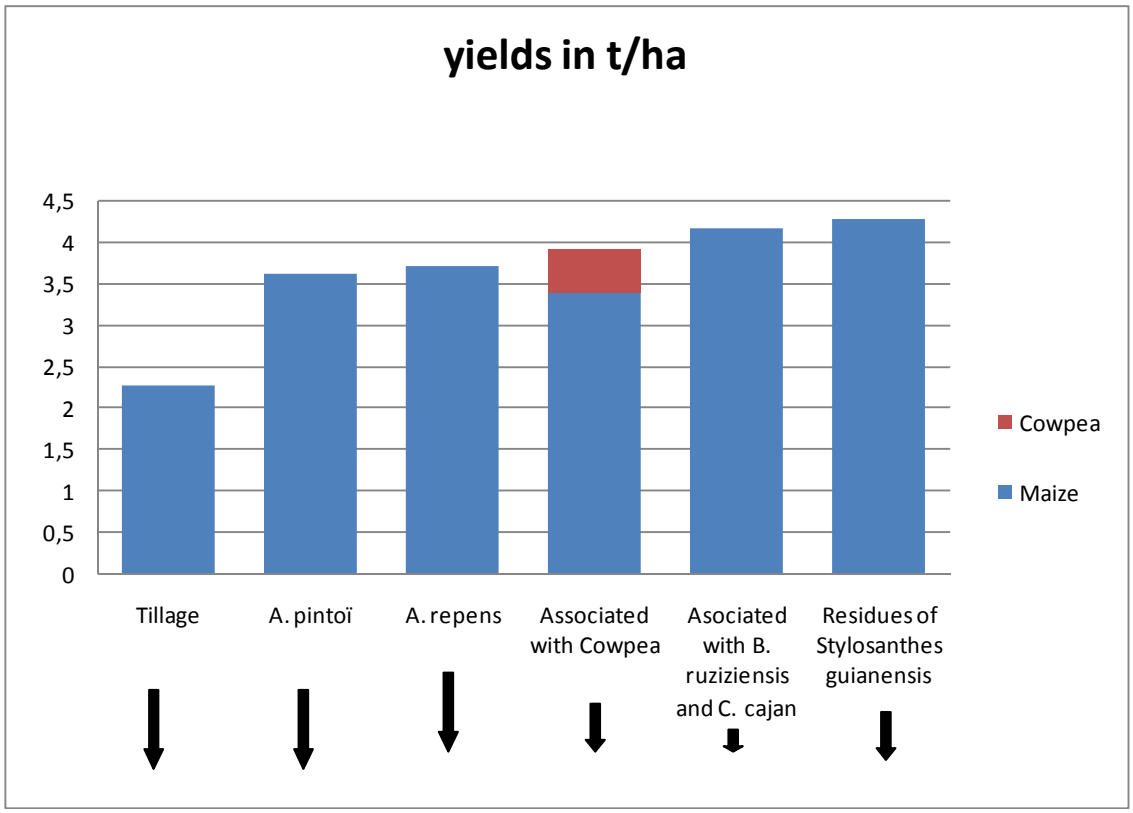
To illustrate the optimization of the working times, it is noted that CA significantly reduce the time spent on field work (figure 6) and enabled a net improvement of production. They save working days on soil tillage or ploughing and, weeding. The traditional cultivation practice requires 1,300 hours/ha works versus 700/hours/ha only under CA.

Figure 6 : Comparison of working time in tillage and in CA, site of Ibity (TAFA, 2010)



In another example obtained on the reference site of Ivory in the Middle West, a hot spot area for *Striga asiatica*, maize yield is very low on tillage compared with the other tested systems; the best system is the one based on Stylosanthes, the system that currently makes some 1,000 ha in the area.

Figure 7 : Maize yield in pure stand on tillage or in CA on crop residues or on living cover (6 year average 2003 – 2009) and scoring of Striga in 2009, reference site of TAFA in Ivory in the Middle West (MOUSSA N. *et al*, 2009)



Infected holes in %	7 (weeded)	1	0	11	12	<1
Number of striga plants per hole	9 à 10	2 à 3	0	10 à 42	1 à 30	1
Striga develop-ment	Big plants, with many branches (>25 cm)	Small and etiolated plants (<10 cm)		Plants of various sizes (between 10 and 20 cm)		Small and etiolated plants (<10 cm)

3.3.2. Training by TAFA

For its training activities the TAFA NGO has the required skills and relies on its reference site network to propose a whole range of oriented training modules, but not only towards professionals.
The TAFA NGO has a training capacity suitable to various recipients according to their objectives and their availability.
There are diverse training types depending on duration, content, and the assistance involved. The following may be distinguished:

- Long length training (6 to 12 months), which bring theory and practice during a whole agriculture season to control a wide range of CA systems.
- Short length training (3 to 8 weeks), with the theoretical aspects of CA and the necessary practice for controlling particular operations or simple itineraries.
- Sequential training to bring theory and practice all along the cultivation schedule with periodical support in the recipients' intervention areas,
- Point in time or sensitization training having to respond to cyclical particular needs identified by the operators

This enables the TAFA NGO ensuring the training for professionals coming from an academic course and who have to work for operators of agricultural development. The most provided themes are the basic principles of CA with practical control of technical itineraries adapted to the conditions of recipients.
So far TAFA has trained in total 1,346 people in terms of CA. Most of such training are of short length (68%), 16 % are of sensitization type, 9 % of long term, and 7% of sequential type.

The following table recapitulates the training sessions provided by TAFA as a function of the types of recipients and training:

It is noted that most training sessions are short terms, so necessarily focusing on particular themes; and most recipients are development technicians or fields agents. Long term training sessions manifestly address supervision officers.

Table 4 : Number of training sessions achieved per training type (TAFA, 2010)

Training Types	Technical Agent	Farmer	Trainer	Engineer	Socioeco. Technician	Technician	Grand Total	%
Short length	256	103	2	91	7	456	915	68
Long length 6 – 12 months				28		63	91	7
Sequential	1	9		5		103	118	9
Sensitization	74	73	3	71		1	222	16
Grand Total	331	185	5	195	7	623	1,346	
%	24.6	13.7	0.4	14.5	0.5	46.3		100

Overall the training sessions are made up of two parts: one common part on the objectives and missions of the TAFA NGO and on the principles of agroecology; one second part that is more thematic and organized in modules. About fifteen modules are proposed (See Annex I)

module 1 : initiation in agroecology for institution executives
module 2 : long length training for engineers
module 3 : long length training for technicians
module 4 : sequential training
modules 5: practical training for farmers
module 6 : Smoldering
module 7 : Weeds
module 8 : crop protection and CA

module 9 : tavy alternative
module 10 : restoration of degraded soils
module 11 : CA and livestock
module 12 : rice cultivation
module 13 : seed production in CA
module 14 : Vegetable production under CA
module 15 : cultivation of fruit trees

The diverse modules are adapted to each recipient type and they include the adopted methodologies, the training venues, the periods favorable for training; TAFA also provides the possibility of customized training, monitoring and post training support, as well as advice support and developments of cropping systems.

3.3.3. Trainee and Visitor hosting

The TAFA NGO also receives trainees coming from various academic establishments. Thus 50 trainees were supervised in their research work as part of requirement for obtaining their degree. They are as follows:

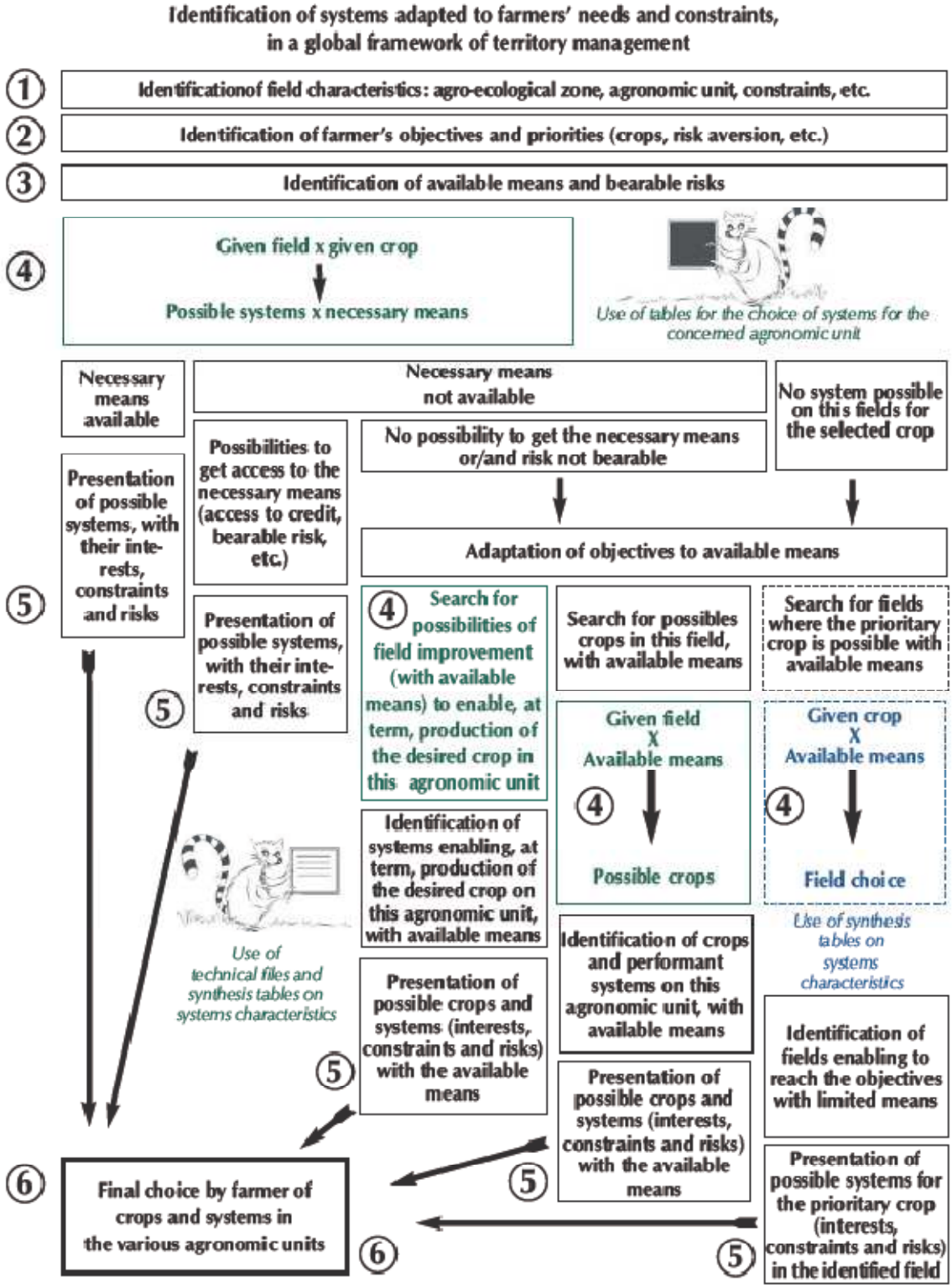
- 1 technical assistant in agriculture
- 4 DAA Degree in Agronomy (CNEARC and INA – PG)
- 12 DEA « Ms degree » (University of Antananarivo)
- 1 DESS from the University of Paris X
- 13 Bachelor Degree in Agriculture (CNEARC, University Saint Joseph of Antsirabe)
- 2 masters (Universities of Montpellier and of La Réunion)
- 15 dissertations by engineers (INA-PG, ISTOM, University Saint Joseph of Antsirabe, University of Antananarivo, Ecole Nationale du Génie Rural, des Eaux et Forêt)

In addition to such training aspects, TAFA takes advantages of its reference and experimental sites by exchange visits for farmers, professionals in rural development, students, decision makers, etc… Thus between 1999 and 2008, 11,821 visitors were discovering the field output of TAFA in agro ecology : these are 8,272 farmers, 597 regional authority officers, 772 students, and 2,181 agricultural technicians.

4. Diffusion

The first years of research activities enabled developing and identifying a range of cropping systems for each major agro ecological zone of Madagascar. Such system range enables adapting the recommendations to the individual conditions in each farming, with varied levels of risks and intensification, starting from commodities chosen by farmers. Based on this, the diffusion is targeted to landscape unit (terroir) taking into account the needs, means, and constraints for each farmer. Among the possible systems that are adapted to the involved landscape units (climate x water regime x soil), the point is to identify the systems that are the most adapted to the conditions of the farm involved and to propose them to farmers. It is necessary to present such systems to the farmer including the package needed (input, work, capital, material, etc..), their production potential, the potential risks, the required knowledge, etc.. Then, the farmers may choose in an informed way, based on such information. The whole process for identifying systems to be proposed to farmers is the object of the volume II of « Practical Manual of Direct Seeding in Madagascar » and may be summarized according to Figure n° (fig.8) :

Figure 8 : Procedure for Identifying CA Systems Adapted to the Needs of Farmers

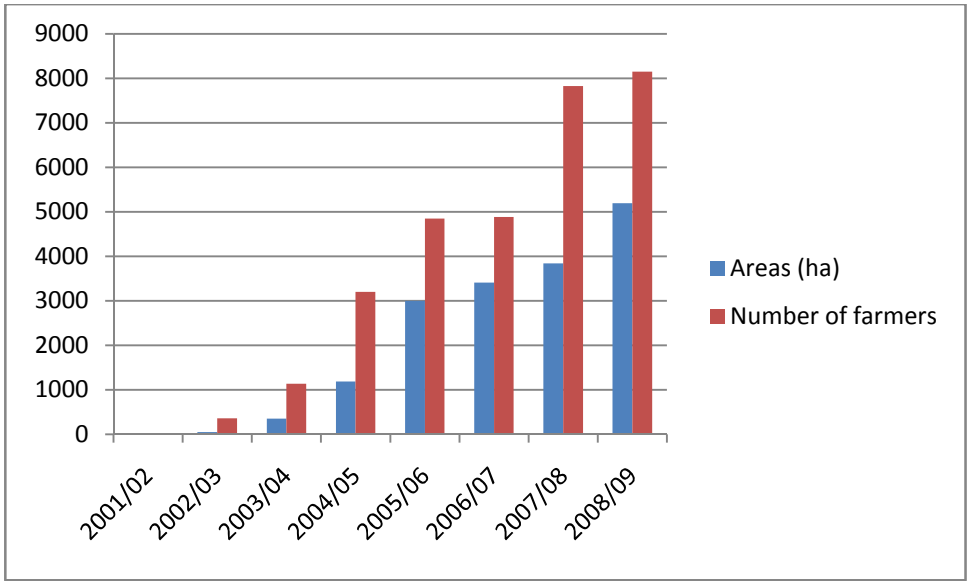


Volume IV of this Manual , presents the range of the interesting systems by agronomic unit,for each agro ecological zone.

The diffusion phase, started in 2003 at the end of a long experimentation period, relies on a strategy of GSDM based on an overall approach of the region and is organized according to the agro ecological zones of Madagascar: *(i)* Medium Altitude Zone (600 to 1,100 m) with long dry season, *(ii)* Zone of Altitude higher than 1,200 m, *(iii)* Humid tropical Zone (lower than 500 m), *(iv)* Semi arid Zone (300 to 600 mm rainfall).

In all the zones quoted in the following part of the document, the figures given as diffusion are the areas supervised directly by the projects but do not include the spontaneous diffusions. At the national level, the evolution in conservation agriculture is presented in the following graph in terms of areas and number of farmers involved (GSDM, 2009). It is thus noted that there has been a regular increase in areas and number of farmers adopting CA since the beginning of the diffusion. It will thereafter be seen that the evolution in adoption is not the same in all agro ecological zones of the Country.

Figure 9 : Evolution of the areas under CA and the number of farmers supervised at the national level



4.1. Medium altitude area (600 to 1,100 m) with long dry season (Lac Alaotra and Middle West)

4.1.1. Soil and Climatic Characteristics, and Cropping systems Proposed for diffusion in medium altitude Zone

Medium altitude climate zones with long dry season present agro climatic and socioeconomic characteristics (size of farming higher than the national average particularly, land pressure, and place of livestock that are less important than on the high lands, etc.) which make it that the diffusion of conservation agriculture techniques is particularly interesting there. Such techniques enable removing easily and rapidly the major agronomic constraints primarily with:

- Erosion and soil degradation of *tanety*;
- Poor water control in paddy fields;
- Parasite pressure by Striga on cereals in the Middle West;

Several systems diffuse widely and rapidly, adapted as a function of the agronomic units (soil type x water regime):

4.1.1.1. Systems based on Stylosanthes on degraded tanety

On *tanety*, particularly the degraded ones very prone to striga, the Stylosanthes based cropping systems are particularly interesting. They enabled a rapid regeneration of soils, the total control of striga, and thus to grow crops (including rain fed rice) on such soils that were generally abandoned by farmers. As the Stylosanthes grows slowly, it competes very little with the crops and therefore associates very easily with rice, maize, cassava, etc.

Depending on soil fertility, climate, priority crops, and the available space, it is possible to manage the Stylosanthes in a wide range of cycles that are of variable intensity. The main cropping systems in CA based on the use of Stylosanthes are presented herein after:

- Rotation of One crop / Stylosanthes (e.g. maize + Stylosanthes // Stylosanthes // rice + Stylosanthes // Stylosanthes, etc.);
- Rotation of of 2 years crops and one year of Stylosanthes (rotation maize + Stylosanthes // Stylosanthes // rice + Stylosanthes // Stylosanthes, etc.);
- cultivating food crop each year associated with Stylosanthes and extending its growth after the harvest (rice + Stylosanthes each year or rotation rice + Stylosanthes // maize + Stylosanthes in humid climate or on *baiboho*), etc.
- The initial crop in which the Stylosanthes is intercropped varies as a function of the soil fertility level (and striga pressure): cassava, Bambara bean, groundnut or bean on poor soils, maize on rich soil, rice on rich non compacted soil.

Controlling Stylosanthes can be made manually (by simple scraping with an *angady* (a spade), mechanically and/or chemically, which provides large flexibility in management, for all farming types. Seed production is easy. Stylosanthes is sowed at low rate (2 to 6 kg/ha according to the seeding mode and rate of germination) and can even be managed with a natural reseeding.

Stylosanthes (and consequently all Stylosanthes based cropping systems) presents very numerous interests, of which:

- nitrogen fixation (70 to 200 kg N/ha), extraction of low soluble phosphorus, recycling of bases and trace elements that benefit to the following crop (http://www.fao.org/ag/AGP/AGPC/doc/Gbase/data/pf000070.htm) ;
- production of high biomass, of varied quality: leaves and small roots with low C/N ratio, which decompose rapidly, and big roots and woody stems with high C/N ratio, which mineralize slowly and enrich the soil in organic matter;
- restructuring of soil though its powerful root system and its capacity of boosting the biological activity ;
- total control of most weeds and particularly striga, rothboellia, borrerias, etc.
- excellent fodder and, in addition, is a nectar plant.

It is therefore an ideal species for conducting systems in direct seeding on permanent soil coverage with minimum input, integrated with livestock and adapted to all agriculture types under the tropics.

4.1.1.2. Legumes crop with Grain on Cynodon

On the very numerous plots invaded by *Cynodon dactylon*, a very performing system consists in producing a legume crop (groundnut, cowpea, *Dolicos lablab*, *Vigna umbellata*, Bambara bean, and bean) in direct seeding in the Cynodon cover which has been killed in advance with a herbicide or kept as living cover. Such system enables entering direct seeding which perpetuates, with minimum labor, very little investment (limited to herbicide, used at low rate in living cover) but which yield twice as much as with tillage

4.1.1.3. Maize + voluble legumes (Dolicos lablab, cowpae, Vigna umbellata, mucuna) // rice on moderately rich tanety and baiboho

Associating maize with voluble food legumes (*Dolicos lablab*, cowpea, *Vigna umbellata*, etc.) is a system that is particularly valued by farmers for its numerous interests:

- Applicability

Such systems can be set up in all agro ecological zones of Madagascar and primarily in medium altitude areas. They can be used without fertilizer on highly or moderately fertile soils of *tanet*y, on *baiboh*o, or on non flooded soils in plains, etc.

- Ease of implementation

Managing associations is easy by playing essentially on spacing between plants, the seeding date of diverse species, and probably fertilization.

Weeds management is also easy through such association type enables a rapid soil cover. Besides, the possibility of choosing the associated plant enables to best adapt to the conditions of the environment:

- Cowpea best withstands high humidity conditions;
- Dolicos lablab best withstands drought thanks to the power of its root system, and provides the highest biomass production during the dry season. It also provides the best soil cover thanks to its woody stems which decompose less rapidly than those of cowpea or of *Vigna umbellata*;
- *Vigna umbellata* poorly withstands high drought at the end of rainy season (on *tanety*) but is more resistant to insect attacks;
- On non compacted and relatively rich soils, mucuna produces high biomass and brings much nitrogen. Its grains are not eatable but can be used for feeding pigs.

Last, planting again food crops is very easy as such various species are annual plants that naturally end their cycle and do not need to be controlled for the seeding of the following crop.

- Economic Profitability

Such association enables producing two crops in the same year, without affecting the maize yield. Such systems are therefore very interesting economically speaking, particularly on rich soils where fertilizers are not indispensable. Besides, risks are limited in case of difficult climate conditions or insect attacks (different sensitiveness to such stresses for the two plants).Even in areas where locust attacks may occur legumes crops gives always a production. Last, such association enables considerably reducing the labor costs (preparation of the plot and weed control in particular) thanks to the high biomass produced.

4.1.1.4. Rice/legumes(vetch, Dolicos lablab, bean) on baiboho, non flooded soils in the plain and in paddies fields with poor water control in which counter season crop is possible

In all plots (*baiboho*, ***non flooded*** soils in the plain, paddies fields with poor water control) in which the ground water table is accessible in dry/cool season, it is possible to grow counter season vetch or another legume (*Dolicos lablab*, *Vigna umbellata*), just after (probably some weeks before) rice harvest. Vetch may be associated with bean or oat to produce a high biomass in dry/cool season, used to seed directly rain fed rice (on *tanety*) or poly-aptitudes rice varieties (in RMMEs) in the next season.

Such system is extremely simple to implement and requires no knowledge or particular material. The only constraint is the availability of vetch seeds.

The economic interest of such system lies in its very low cost, very largely compensated by the net gain from the rice yield that comes after it and benefits from the high input of nutriments (nitrogen in particular) and the weed control by vetch.

The vetch capacity to restructure the soil (mainly in surface, under the effect of roots and the high biological activity); its very high power of fixing nitrogen and its aptitude to extract potassium and phosphorus that are present in very low quantity in the soil, make it that vetch is an excellent precedent for rice.

Vetch is capable of dominating most weeds, including the hardy weeds such as the Cynodon dactylon which would have been poorly controlled during the first year of CA (year “zero”). With its thick mulching, it leaves a plot very clean, enabling cultivation without herbicide for the following cycle. In addition it hosts many arthropods and insects predatory of

pests. In Madagascar, it enables considerably reducing the pressure of *Heteronychus sp.* and other insects larvae which are a major constraint to rice cultivation at medium and high altitudes. Last, vetch provides an excellent fodder, which can be used partially for animals and at last, vetch is honey constituent. .
Dolicos lablab has the advantage of better using deep water and is therefore preferable on soils where the water withdraws rapidly.

4.1.1.5. The other interesting systems in medium altitude environment

In addition to those particularly interesting systems, a wide range of systems may be proposed for diverse cultivation, particularly with:

- Brachiaria based systems, with low level of input, with production of fodder on degraded soils of *tanety:*
  - Cassava + Brachiaria // Brachiaria
  - Groundnut + Brachiaria // Brachiaria
  - Bambara bean + Brachiaria // Brachiaria
- Systems associating Cajanus or crotalaria with bambara bean or groundnut (or bean) on degraded *tanety*
- Rice after smoldering on *tanety*
- Maize + finger millet, Brachiaria and/or Cajanus on moderately rich *tanety* soils
- Rice/Vegetable on crop residues on *baiboho* and on non flooded soils in the plain

4.1.2. Conservation Agriculture in the medium altitude area –Lac Alaotra

The watershed of Lac Alaotra is one of the largest rice producing areas in Madagascar, with nearly 100,000 ha of paddies fields, of which 30,000 ha irrigated (the irrigated areas) and 70,000 ha with more or less poor water control (known as RMME[9] in this paper). It is one of the rare areas of the Country that has excess rice production. It is an area resulting from tectonic movement that ended with the formation of the lake. The watershed itself of Lac Alaotra is a depression formation of about 700 km², located 150 km North East of Antananarivo at an altitude of 750 m to 1,100 m. On the periphery, a ring of hills made up of lateritic massifs shapes the watersheds of the depression. The wetland of the watershed of the Lac Alaotra (7,000 km²) is part of the international convention on RAMSAR[10] wetlands for some years; the demarcation of protection sectors inside this set started in 2006 with support from international NGOs.

The diversity of soils, their fragility with considerable erosive and geological phenomena such as those of « *lavaka* » (huge gully erosion on *tanety*), the massive deforestation on the hills and in the valley bottoms and the lower slopes and the extensive cattle breeding initially based on the common rangeland created a high diversity in landscapes and conditions for land reclamation.

The area of Lac Alaotra is characterized by a humid tropical climate of medium altitude with a long dry season from May to October (6 months or more). The annual average temperature is higher than 20°C whereas the average rainfall per year is 1,000 mm (average of 1963-2009, Station of Bevava). The essential of precipitations occurs between November and March. Rainfall is very irregular and rain distribution considerably influences yields. The cool temperatures, from May to October, do not allow double rice crop every year.

The following CA systems are diffused as a function of the environments:

On poor soils of *tanety* : entry systems in CA :

- *Bambara bean (or Groundnut) + stylo or Bambara bean (or groundnut) + brachiaria*
- *Cassava + stylo or Cassava + brachiaria*

On rich soils : rich *tanety*, *baiboho* (recent alluviums), lower slope:

[9] RMME : Paddies with Poor Control Water
[10] RAMSAR: The objective of the Ramsar Convention (ratified in 1971 in Ramsar in Iran) is to put a halt on the trend of disappearance of wetlands, to favor their conservation, as well as their flora and their fauna, and to promote and favor their rational use.

- *[maize + voluble legumes]//rice*. (Legumes are dolicos lablab, *Vigna umbellata*, and cowpea). Dolicos lablab which has the capacity of seeking water in depth is preferred to the other legumes when the ground water table goes down rapidly.
- *System [rice + stylo]//rice*: such system that is in high progression is perennial, i.e. the stylo reseeds naturally after rice.

On irrigated paddies fields and RMME

- Intra annual *rice/vetch* succession
- Vetch based Systems : *bean + vetch*
- Vegetable on mulch of crop residues

Table 5 summarizes the crop associations in 2008/2009 on *tanety*, *baiboho*, and RMMEs in the valley of the South East of the Lac Alaotra in which the diffusion of CA is the oldest one and, therefore, the plots are the most perpetuated (Y_7). What is first noted is :

- the predominance of rain fed rice, in general on *baiboho*, and that will be followed by counter season of vetch or *Dolicos lablab*.
- then the systems of cassava + Stylosanthes and groundnut + Stylosanthes, in general on poor soils when fallow is put under cropping again.
- The 3rd group is made up of associations of maize + legumes (maize + *Dolicos lablab*, maize + cowpea, maize + mucuna) that will be followed by rice in the next season.
- At last, one notes many implantations of Brachiaria in pure stand, in general for fodders.

Table 6 summarizes the associations of crops in 2008/2009 on *tanety*, *baiboho* and RMMEs of the North East bank of the Alaotra Lake where farmers, on the opposite of the Valley of the South East above, have no or few irrigated paddies fields.

- It is noted in one first group the predominance of rain fed rice, in general on *baiboho*, which will be followed by vetch or *Dolicos lablab* cultivation in counter season.
- This is followed by a 2nd group made up by the associations of maize + legumes (maize + *Dolicos lablab*, maize + cowpea, maize + *Vigna umbellata*) that will be followed by rice in the following season.
- The 3rd group is made up of associations on poor soils: groundnut + Stylosanthes, Bambara bean + Stylosanthes.
- The 4th group is made up of groundnut and Bambara bean in pure stand: according to the explanation of the extension staff, some farmers were unable to obtain credit to buy fertilizers and then put groundnut or *Dolicos lablab* on a good mulch of the previous crops without tilling the soil (e.g. under CA).

Table 5 : Associations of crops on *tanety*, *baiboho,* and RMMEs of the Valley of South East in the Lac Alaotra area in 2008/2009

Systems (crop associations)		*Year under AC and acreage (ha)*								
Main crop	**Associated crop**	**Y_0**	**Y_1**	**Y_2**	**Y_3**	**Y_4**	**Y_5**	**Y_6**	**Y_7**	***Total***
Groundnut	***Stylosanthes***	14,3	0,4	0,2						***14,8***
Groundnut	***Pure stand***	5,1	0,9		0,1					***6,0***
Arachis pintoi	***Pure stand***	0,0	0,1	0,2	0,0					***0,3***
Brachiaria	***Pure stand***				0,3			0,2		***0,4***
Brachiaria brizantha	***Stylosanthès***		0,9	1,4	2,3					***4,6***
Brachiaria brizantha	***Pure stand***	0,7	2,1	6,0	14,9	0,2	0,3			***24,2***
Brachiaria humidicola	***Stylosanthès***				0,6					***0,6***
Brachiaria humidicola	***Pure stand***		0,0	0,2	1,4					***1,6***
Brachiaria ruziziensis	***Stylosanthès***		0,3	0,0		0,2				***0,5***
Brachiaria ruziziensis	***Pure stand***		0,7	0,6	0,1	0,2	0,2			***1,7***
Bean	***Stylosanthès***	2,1	0,1							***2,2***
Bean	***Pure stand***	1,0	2,1	0,2	0,1	0,0				***3,5***
Maize	***Groundnut***	0,9	0,3							***1,2***
Maize	***Dolicos lablab***	10,6	0,8	0,7	0,8	0,1				***13,0***
Maize	***Haricot***	0,4	0,4	0,1	0,1	0,1				***1,1***
Maize	***Mucuna***	0,1		0,2	1,0	0,4				***1,8***
Maize	***Niébé***	11,5	2,6	1,7	0,7	0,2	0,1			***16,9***
Maize	***Bambara bean***	0,5								***0,5***
Maize	***Soya bean***		0,3							***0,3***
Maize	***Stylosanthès***	2,5	0,4	0,2	0,3	0,1				***3,5***
Maize	***Vigna radiata***	0,1								***0,1***
Maize	***Vigna umbellata***		7,0	3,0	1,4	1,0	0,4			12,7
Cassava	***Brachiaria brizantha***	0,2	0,1							***0,3***
Cassava	***Brachiaria ruziziensis***	0,7	0,2	0,1						***1,0***
Cassava	***Stylosanthès***	22,1	1,1	0,1	0,8					***24,0***
Cassava	***Pure stand***	10,4	0,1	0,6						***11,1***
Bambara bean	***Stylosanthès***	6,7	0,1		0,0					***6,9***
Bambara bean	***Pure stand***	1,1	0,1							***1,2***
Rainfed rice on RMME	***Éleusine coracana***		0,02							***0,02***
Rainfed rice on RMME	***Stylosanthès***	18,2	0,5		0,3					***18,9***
Rainfed rice on RMME	***Pure stand***	378,8	37,9	24,5	14,7	5,7	2,2	0,6	0,3	464,7
Stylosanthès	***Pure stand***	0,3	4,5	1,1	0,3	0,1	0,2			***6,5***
	TOTAL	***488,2***	***63,8***	***41,0***	***40,4***	***8,3***	***3,2***	***0,7***	***0,3***	***646,1***

Y_0 is under tillage, Y_1 and more is under AC

(BV LAC, 2009)

Table 6: Crop Associations on *tanety*, *baiboho*, and RMMEs on the North East bank of the Lac Alaotra in 2008/2009

Systems (crop associations)		*Year under AC and acreage (ha)*					
Main crop	***Associated crop***	Y_0	Y_1	Y_2	Y_3	Y_4	***Total***
Groundnut	***Pure stand***	11,3	6,3	1,7	0,7		***20,1***
Groundnut	***Stylosanthès***	*12,2*	*2,9*		*0,3*	*0,0*	***15,4***
Brachiaria	***Pure stand***	0,6	6,8	3,7	2,1		***13,3***
Brachiaria	***Stylosanthès***		0,3		0,2		***0,5***
Dolicos lablab	***Pure stand***	0,0	1,9		0,3	0,2	***2,4***
Maize	***Dolicos lablab***	*12,0*	*6,6*	*1,8*	*1,0*		***21,4***
Maize	***Bean***	*1,3*	*0,5*				***1,8***
Maize	***Cowpea***	*27,0*	*10,2*	*1,4*	*7,1*	*0,9*	***46,6***
Maize	***Pure stand***	*6,1*	*5,0*	*0,6*	*0,5*	*0,2*	***12,4***
Maize	***Stylosanthès***	*2,2*	*5,0*	*0,8*	*1,1*		***9,0***
Maize	***Vigna umbellata***	*4,1*	*0,6*				***4,8***
Cassava	***Brachiaria***	2,1	0,6	0,2	0,4	0,1	***3,3***
Cassava	***Pure stand***	1,6	1,1	0,5			***3,3***
Cassava	***Stylosanthès***	3,7	2,6	0,2	0,3		***6,8***
Cowpea	***Pure stand***	0,1	0,2		0,0		***0,4***
Bambara bean	***Pure stand***	3,9	15,7	0,5	0,8		***20,7***
Bambara bean	***Stylosanthès***	1,2	1,6				***2,8***
Rainfed rice on RMME	***Pure stand***	210,4	36,4	11,2	8,3	3,7	270,0
Rainfed rice on RMME	***Stylosanthès***	15,0	6,1	0,4	1,6	0,3	23,3
Stylosanthès	***Pure stand***	0,3	10,2	1,7	0,4	0,5	***13,1***
	TOTAL	**315,0**	**120,5**	**24,7**	**25,0**	**6,0**	**491,1**
Y_0 is under tillage, Y_1 and more is under AC							

(BV LAC, 2009)

Table 7 summarizes the crop associations in 2008/2009 on *tanety*, *baiboho*, and RMMEs on the West bank of Lac Alaotra. In such area where soils are poor, what is especially noted is the predominance of systems based on brachiaria and Stylosanthes. Some associations of maize with legumes (Dolicos lablab, cowpea, etc...) also exist in *baiboho* but with limited areas.

Table 8 summarizes the evolution in CA that have been directly supervised by the operators of BV LAC project since the origin. The true CAs are those on *tanety* which increase regularly from 2001/2002 to 2008/2009 in terms of area and farmer's number (fig.10). The column « fodders » mentioned here generally comes from CA entry systems on poor soils of cassava + Brachiaria type. The column «other systems » accounts trees hedges or herbaceous covers. In keeping with support to farming, the project also brings support to intensification of rice cultivation (SRI/SRA).

The cropping systems of the dry season are also in constant increase (fig.11). Such systems are dominated by vetch cultivation or crops associations with vetch: these systems have positive effects on rice yields.

Based on BRL data which are the oldest ones (table 9) it is noticed a constant increase in yields and in man-day value (VJT) along the years under CA even if the number of observations (plot number) is relatively low in year 3 and 4 (respectively 7 and 5 plots). In all cases, the yields obtained, all environments confounded, are higher under CA than under tillage. Such trends of results were regularly observed during the previous years (GSDM, 2008)

Table 7 : Crop Associations on *tanety*, *baiboho*, and RMMEs on the west bank of the Lac Alaotra in 2008/2009

Main Systems (crop associations)		*Year under CA and acreage (ha)*						
Main crops	**Associated crops**	Y_0	Y_1	Y_2	Y_3	Y_4	Y_5	*Total*
Groundnut	***Stylosanthès***	2,8						2,8
Brachiaria	***Pure stand***	8,2	0,5	5,8				14,4
Brachiaria	***Stylosanthès***			0,7				0,7
Bean	***Eleusine***	0,9						0,9
Maize	***Dolicos lablab***	3,0	0,7	0,3		0,2	0,4	4,6
Maize	***Cowpea***	6,0	0,4	0,3	0,0			6,7
Maize	***Stylosanthès***	0,5	0,2	0,1		0,1		0,9
Maize	***Vigna***	2,3						2,3
Cassava	***Eleusine***	0,9	0,3	0,0		0,1		1,3
Cassava	***Stylosanthès***	2,2	0,1	0,1				2,4
Cassava	***Stylosanthès + Bracharia***	0,3						0,3
Bambara bean	***Crotalaria***	0,6						0,6
Bambara bean	***Eleusine***	1,1						1,1
Bambara bean	***Stylosanthès***	7,5						7,5
Rainfed rice on RMME	***Pure stand***	122,4	0,9	0,9	1,0		0,8	126,0
Rainfed rice on RMME	***Crotalaria***	5,4						5,4
Rainfed rice on RMME	***Stylosanthès***	30,7	0,8	0,5	0,2	0,2	0,2	32,6
Soyabean	***Crotalaria***	0,8						0,8
Soyabean	***Eleusine***	0,6						0,6
Soyabean	***Stylosanthès***	1,5						1,5
Stylosanthès	***Pure stand***	4,8	0,1	1,2		0,1		6,2
	Acreage in ha	***202,2***	***3,9***	***10,0***	***1,2***	***0,7***	***1,4***	***219,4***

Y_0 is under tillage, Y_1 and more is under CA

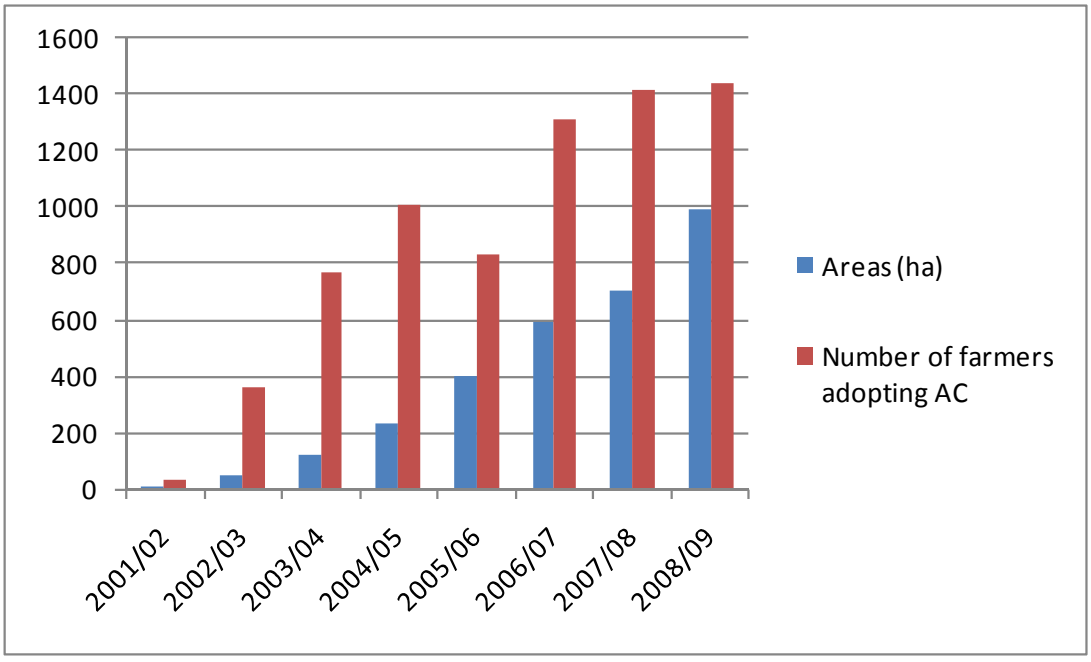
(BV LAC, 2009)

Table 8 Areas in ha of the Systems supervised by the BV LAC Project in rain season

Years	Others CA systems	Fodders derived from CA systems	RMME	CA on tanety	SRI/SRA (Intensive rice production System)	Total
Lac Alaotra						
2001/02				5		5
2002/03				49		49
2003/04	0	0	10	114		124
2004/05	0	38	300	232		570
2005/06	21	112	1313	398		1843
2006/07	0	159	652	591		1401
2007/08	22	193	530	703		1447
2008/09	48	97	349	994	835	2323

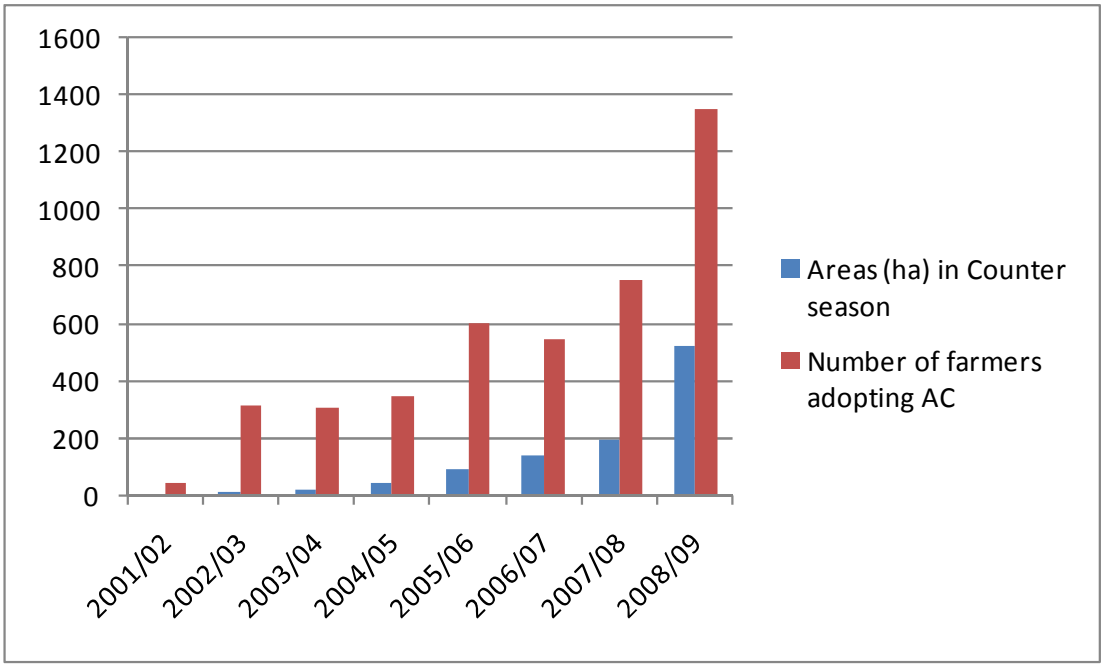
(BV LAC, 2009)

Figure 10 : Evolution in areas of tanety CA and in the Number of farmers adopting CA in the Area of Lac Alaotra in rain season



(BV LAC, 2009)

Figure 11 : Evolution of areas and Number of Farmers directly Supervised by BV LAC in counter season



(BV LAC, 2009)

Table 9 : Effects of number of years under CA on Rice Yields and on Value of one man-day (Ariary/day)

Crop management	Number of observations	Avg yields (kg/ha)	Minimum Yields (kg/ha)	Maximum Yields (kg/ha)	Std deviation (kg/ha)	C.V. (%)	Value of One Man-day (Ariary /day)
Tillage	304	2884	160	4850	977	34	13 247
Y_1 under CA	30	3166	488	5200	1042	33	16 702
Y_2 under CA	21	3312	2350	4314	508	15	14 359
Y_3 under CA	7	3096	2500	3782	505	16	13 081
Y_4 under CA	5	4268	2731	6000	1545	36	26 001
Total	**367**	**2982**	**160**	**11200**	**1065**	**36**	**13906**

(BRL, 2009)

4.1.3. Conservation Agriculture in the Middle West of Madagascar, Area of Vakinankaratra

The Middle West of Madagascar represents wide areas that are weakly populated (10 to 70 inhabitants/km^2), with a long dry season (6 to 7 months), a rainfall of around 1,200 mm, but highly erosive especially at the beginning of rain. Soils are latosols derived from basalt. The landscape is made up of vast grassy plains (of heteropogon, hyparrhenia, aristida type without any shrubs or trees) subject to bushfires nearly every year. The Middle West is characterized by strong attack of *Striga asiatica* on cereals (maize, rain fed rice) because of the decline in soil fertility especially in soil organic matter.

After some demonstrations in 2004/2005, CA diffusion by the FAFIALA Center in the Middle West of Vakinankaratra (district of Mandoto) experienced high adoption by farmers (table 10). The systems diffused are essentially Stylosanthes based systems:

- On poor soil : [groundnut (or bambara bean) + stylo]// Stylo//Rice : when the soil is poor the stylo needs 2 years to produce enough biomass. In many cases, however, it can make an average amount of biomass within one year and therefore farmers immediately proceed to food production.
- On relatively rich soil: [rice + stylo]//stylo//rice: what has to be noted is that when the soil is rich, the stylo manages to produce a good biomass within one year.

The various associations of crops on *tanety* in 2008/2009 are indicated in Table 11 and highlight the predominance of Stylosanthes based systems:

- The areas supervised in 2008/2009 on *tanety* are 1,117 ha for 939 farmers (2,303 plots) ;
- The systems as a whole is dominated by Stylosanthes based systems with a view to rain fed rice cultivation after obtaining a high biomass.
- Cultivation of fallows are done with associations of stylo with groundnut, bambara bean, or cassava.

Table 10 : Evolution in Extension of CA in the District of Mandoto, Middle West of Vakinankaratra (ha)

Cropping Seasons	Areas under CA	Total Number of farmers under CA	Avg size of land under CA per farmer in ha	Area of rain fed rice under CA in ha	Number of farmers growing rain fed rice under CA	Avg size of rain fed rice per farmer under CA
2005-2006	17	37	0,45	4,7	18	0,26
2006-2007	214	297	0,72	99	259	0,38
2007-2008	549	538	1,02	239	454	0,53
2008-2009	1117	939	1,19	409	683	0,60

(RAVONISON, 2009)

Table 11 : Crop Associations on *tanety* in the Middle West of Vakinankaratra in 2008/2009

Main Systems (crop associations)		***Year under CA and acreage (ha)***				
Main crops	**Associated crops**	**Y_0**	**Y_1**	**Y_2**	**Y_3**	**Total**
Groundnut	***Stylosanthes***	53,0	26,3	0,9		80,2
Brachiaria ruziziensis	***Pure stand***	0,3		3,1	0,3	3,7
Dolicos lablab	***Pure stand***	0,1	0,2	0,1		0,3
Bean	***Stylosanthes***	6,2	2,0			8,2
Maize	***Stylosanthes***	43,6	22,5	15,7	1,3	83,1
Cassava	***Stylosanthes***	13,5	27,1	5,9		46,5
Sweet potatoes	***Pure stand***	0,2				0,2
Bamabara bean	***stylosanthes***	33,6	15,7	1,6	0,6	51,5
Rain fed rice	***Crotalaria***		0,1	0,2		0,3
Rain fed rice	***Stylosanthes***	260,2	89,4	48,3	10,8	408,7
Soya bean	***Stylosanthes***	14,4	7,7	1,4		23,4
Sorghum	***Stylosanthes***	2,0				2,0
Stylosanthes	***Pure stand***	140,3	218,8	47,0	2,4	408,5
Vetch	***Pure stand***	0,6	0,1	0,1		0,7
		568,0	***409,8***	***124,1***	***15,4***	***1117,3***

Y_0 is under tillage, Y_1 and more is under CA

(BVPI-SEHP, 2009)

Moreover, it is noted a strong progression in supervised areas under CA each year and in yield increase over years under CA for all crops in general (table 12) as well as an increase of the man-day value with the number of years under CA (fig. 10). It is observed that the average yields obtained with the conservation agriculture are largely higher than the yields of traditional systems (which is actually about 0.5 t/ha). But the average yields in rain fed rice in 2008/2009 strongly decreased compared with the previous years because of the increase in fertilizer prices which led farmers to reduce the rates of application (RAKOTONDRAMANANA , 2009). But what is very interesting is the decrease of *Pyricularia oryzae* along the years under CA (fig. 12): indeed, with the increase in soil fertility especially the increase in soil organic matter, the nutrition of the plant is improved and enables it to better withstand the stresses like the stress due to *Pyricularia oryzae*.

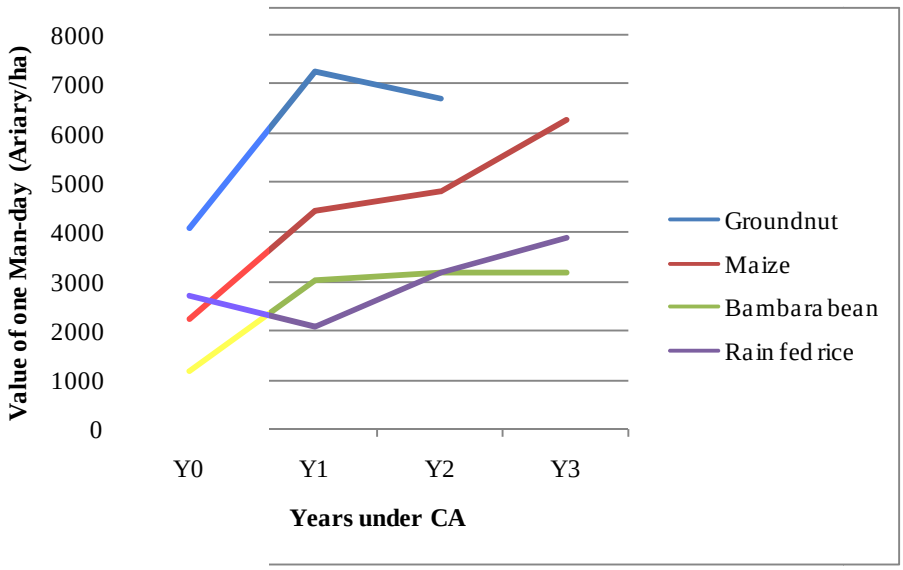
Table 12 : Yield obtained in 2008/2009 as a function of the Years under CA

		Years under CA				
		Y_0	***Y_1***	***Y_2***	***Y_3***	***Y_4***
Groundnut	Number of observations	127	40	4		
	Yields (t/ha)	***0,97***	***1,13***	***1,05***		
Maize	Number of observations	128	39	28	5	
	Yields (t/ha)	***1,65***	***1,58***	***1,78***	***2,08***	
Bambara bean	Number of observations	67	27	3	1	
	Yields (t/ha)	***1,21***	***1,39***	***1,41***	***1,4***	
Rice on RMME	Number of observations	51	28	19	5	1
	Yields (t/ha)	***2,09***	***1,79***	***2,26***	***1,88***	***3,75***
Rain fed rice	Number of observations	563	143	96	15	
	Yields (t/ha)	***1,68***	***1,35***	***1,81***	***1,97***	
Soya bean	Number of observations	55	18	4		
	Yields (t/ha)	***0,86***	***0,89***	***1,08***		

Y_0 is under tillage, Y_1 and more is under CA

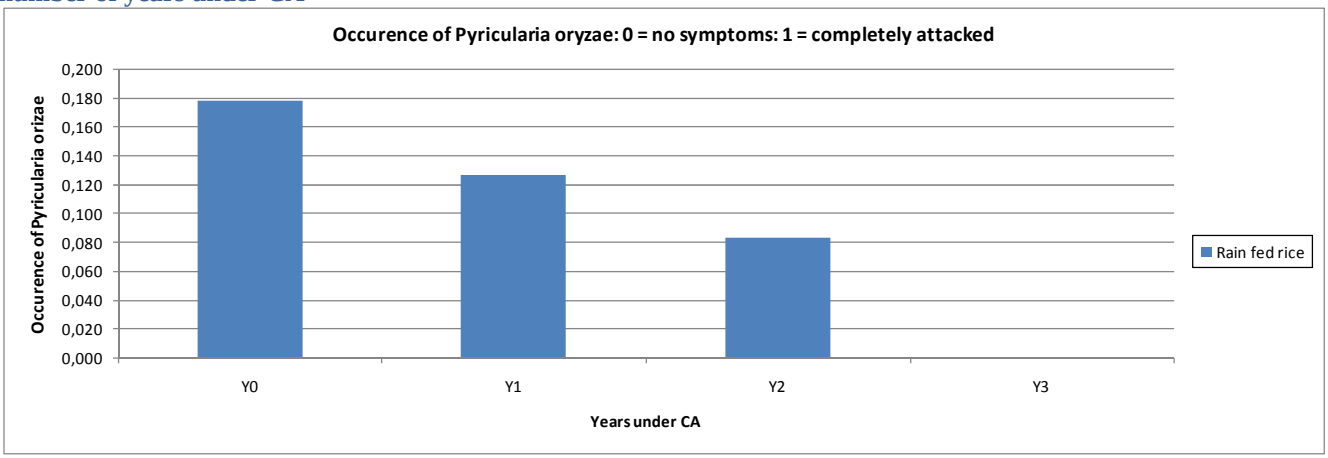
(RAVONISON, 2009)

Figure 12 : Evolution of the value of one Man –day according to the number of Years under CA



(RAKOTONDRAMANANA, 2009)

Figure 13 : Attack of Blast Disease (1 = presence of Blast Disease, 0.00 = without Blast Disease) according to the number of years under CA



(RAVONISON, 2009)

4.1.4. Conservation Agriculture in the Middle West of Madagascar, Area of Bongolava

The area of Bongolava presents the same soil and climatic environments as the Middle West of Vakinankaratra outlined in the paragraph above. ANAE provides the diffusion of CA in 7 communes of such area under the project "Support to the diffusion of agro ecological techniques" (GSDM/AFD).

The diffusion of CA in such area is more recent, and therefore the areas and the number of adopting farmers are lower but the systems diffused and the trend in results are the same as in the Middle West of the Vakinankaratra. What has, to be noted is the preference by farmers for the system [maize + mucuna]//Rice, a system that can also be found in the area of Itasy and, to a lesser extent, in the Lac Alaotra area. Mucuna has the advantage of providing a lot of biomass and grains that may be used for pig breeding.

The most adopted crop systems in the area of Bongolava in 2008/2009 were:

- The rice based systems [rice + Stylosanthes]//Stylosanthes//rice and [rice + crotalaria]//rice). These two systems accounts for 55% of the total surface area ;
- The maize based system [maize + mucuna]//rice, maize + Eleusine) accounts for 11% of the total surface area;
- Cover crops in pure stand (mucuna, Stylosanthes) with production of biomass for the preparation of the following season accounts for 29% of the total surface area.

The distribution of surface areas per crop system and per years under CA is presented in Table n°13 herein after:

Table 13 : Surface areas per CA systems supervised by ANAE in the area of Bongolava in 2008/2009

Systems	Number of adopting farmers	Surface area (ha)			
		A_0	A_1	A_2	Total
Rice based Systems (rice+stylosanthes, rice+Crotalaria)	49	98	12.2	0.3	110.5
Maize based Systems (maize+mucuna, maize+Eleusine)	7	16.2	6.4		22.6
Cover crops (stylo in general)	45	58.8			58.8
Cassava+stylosanthes	1	7.5			7.5
Bambara bean+cajanus	2	0.3	0.2		0.5
Bean+cowpea	2	0.5			0.5
Total	106	181.3	18.8	0.3	200.4

(ANAE, 2009)

4.1.5. Conservation Agriculture in the Middle West of Madagascar – Region of Amoron'i Mania (Soavina)

Soavina area in the Middle West of Amoron'i Mania (in the Betsileo region) is a watershed with North South orientation at an altitude ranging from 1, 050 m (bottom of the plain) to 1,847 m (crest of hills). The climate is of Middle West type: with an average rainfall between 1,100 and 1,200 mm over 4 months; the area is favorable for rain fed cultivation even though short cycle varieties have to be opted for. Two important points are worth underlining: *(i)* storm violence especially at the beginning of rain which is at the origin of important erosion when the young plants are still emerging, and *(ii)* flooding of the alluvial plain which may be a source of costly damage for structures. The 20 to 25°C temperature is favorable to the development of crops and the absence of frost in dry season enables developing all counter season crops where water is available.

Like all the areas in the Middle West, rain fed cereals (maize, rice) are considerably attacked by *Striga asiatica* (RAKOTONDRAMANANA, MOUSSA, N., RAVELONARIVO R, 2006). Rain fed crops on *tanety* are not very developed because of the importance of irrigated rice in the area (partly as double crop per year) and because of climatic hazards essentially due to short and erratic rainfall.
Most CA systems in such area are on entry in CA: i.e. in total 380 ha of CA exist, of which 310 ha are in Y_0, 60 ha in Y_1 and 7 ha in Y_2. The impact of the number of years under CA on yields is not perceptible yet because most plots are still on entry in CA (Y_0). The main most interesting cover crops are Stylosanthes (250 ha) and brachiaria (18.9 ha).

Table 14 : Stylosanthes based Systems in Soavina (Amoron'i Mania)

Main Systems (crop associations)		*Year under CA and acreage (ha)*			
Main crops	Associated crops	Y_0	Y_1	Y_2	Total
Ground nut	Stylosanthes	50,4	1,4		51,8
Banana trees	Stylosanthes	1,0			1,0
Brachiaria	Stylosanthes	0,5			0,5
Bean	Stylosanthes	13,5	1,1	0,7	15,3
maize	Stylosanthes	16,2	7,4	1,8	25,4
Cassava	Stylosanthes	61,3	11,7	1,3	74,3
Cassava	Stylosanthes		0,1		0,1
Cowpea	Stylosanthes	17,7	5,8	0,0	23,5
Orange tree	Stylosanthes	1,0			1,0
Bambara bean	Stylosanthes	42,0	5,9		47,9
Rain fed rice	Stylosanthes	2,7	0,5	0,0	3,3
Soya bean	Stylosanthes	2,1	0,2		2,3
Sorghum	Stylosanthes	2,7	0,9		3,6
Stylosanthes	Stylosanthes	0,2			0,2
Tomatoes	Stylosanthes	0,1			0,1
	TOTAL	211,3	35,0	3,9	250,2

Y_0 is under tillage, Y_1 and more is under CA
(BVPI SEHP, 2009)

Table 15 : Brachiaria based systems in Soavina (Amoron'i Mania)

Main Systems (crop associations)		*Year under CA and acreage (ha)*			
Main crops	Associated crops	Y_0	Y_1	Y_2	Total
Groundnut	Brachiaria	0,9			0,9
Coffee tree	Brachiaria			0,6	0,6
Bean	Brachiaria	0,3			0,3
Maize	Brachiaria	0,7			0,7
Cassava	Brachiaria	8,9	6,3	0,5	15,7
Orange tree	Brachiaria			0,1	0,1
Bamabara bean	Brachiaria	0,6			0,6
	TOTAL	11,4	6,3	1,2	18,9

Y_0 is under tillage, Y_1 and more is under CA
(BVPI SEHP, 2009)

The implantation of cover crops (stylo or brachiaria essentially) is done by intercropping them with farmers existing crops which would come up for instance in the case of cassava to the following systems:

- [Cassava + Stylosanthes]//Stylosanthes//rice
- [Cassava + Brachiaria]//brachiaria

Or in very poor soils using very adapted species like groundnut and bambara bean:

- [Groundnut + Stylosanthes]//Stylosanthes//rice
- [Bambara bean + Stylosanthes]//Stylosanthes//rice

Also Vetch based systems in *baiboho*, or in RMMEs, or even in irrigated paddies fields are in progression like in the Lac Alaotra area:

- intra-annual *rice/vetch* succession
- [vetch + bean]//rice

In the same irrigated perimeter of Soavina, PLAE with support from TAFA, implemented one reference site and demonstration plots. It is also noticed that the two projects BVPI and PLAE are complementary to each other, the former in charge of CA diffusion in general and the latter restricting to areas that are very sensitive to erosion and in which anti erosive actions are also under way. The PLAE/TAFA reference site of Soavina, which started from a Striga infested soil is now accumulating good biomass of stylo and, therefore a dramatic reduction of the infestation is now observed (RAKOTONDRAMANANA, 2009).

4.2. Altitude Area Higher than 1,200 m (High Land and Itasy)

4.2.1. Soil and Climatic Characteristics, and Systems Proposed in High Altitude Areas (Higher than 1,200 m)

High altitude areas present (agronomic and socioeconomic) constraints which make it that the diffusion of conservation agriculture practices is slower than in medium altitude areas:

- biomass production limited by cold season and sometimes by frost (but the need for CA systems is less because of a slow mineralization) ;
- high pressure on the land (high cultivation intensity with up to three crop cycles per year, very small size of lands) ;
- important (dairy) livestock entailing high competition on biomass because of regular and considerable profits brought by the sale of milk;
- low fertility and advanced degradation of soils;
- considerable precariousness of farms and very low availability of inputs.

In the Vakinankaratra particularly a number of systems were identified for their interest, as function of agronomic units. The diffusion operations are however more recent and the economic evaluations of such systems are still to be studied in depth (ongoing work). The interest in using biomass as fodder or putting it back into the soil varies with the price of milk, which sustains considerable fluctuations. As a consequence, the optimal speed for improving the soils (which largely depends on the restituted biomass) varies with the economic conditions. The improvement of soils may be rapid during the years with low price of milk, but will be slower when the price of milk is high and makes less profitable and less interesting in the short term the conservation of biomass in the soil for its regeneration. In all cases, the CA systems proposed must take into account the needs and performances of livestock systems. Given the high intensity of use of soils in the highlands, the easiest approach is to make intecropping with farmer'crops in order to increase the total production of biomass and thus to be able to restitute some to the soil as much as possible.

The following systems are proposed in such high altitude areas:

4.2.1.1. Cassava + Brachiaria on degraded soils of *tanety*

Installing Brachiaria in cassava enables at low cost implanting a perennial fodder plant, with high soil restructuring power. Fodder production is very much appreciated by breeders (particularly dairy cattle breeders). After some years of farming, it is possible to regenerate pastures by cultivating in direct seeding a crop that will benefit from the improvement of soil. We must therefore be vigilant and not export fodder of unreasonably, without fertilizers in return to compensate the exports. To plant again Brachiaria plots with food crops is very laborious or hard to control without herbicide.
The most adapted Brachiaria species varies as a function of its use. For a frequent renewal, in areas without frost, *Brachiaria ruziziensis* is an excellent fodder, which may be controlled for recultivation with a low rate of herbicide application. In areas with frost, *Brachiaria brizantha* and especially *Brachiaria decumbens*which withstand frost, are very good fodders, but require a high rate of herbicide for recultivation. Such species have the advantage of producing a high

root biomass which is saved from animal grazing and which assume a high input of organic matter into the soil and considerably contributes to its restructuration, .

4.2.1.2. Maize + [bean / potato + oat] on rich volcanic *tanety*

The dressing of the traditional system *maize + [bean/potato]* with oat enables increasing biomass production, producing a quality fodder in winter, cleaning plots from weeds (allelopathic power of oat), and considerably reducing work time by suppressing tillage. Potato is introduced in the system only once every two or three years to avoid diseases, and because of limited extension possibilities (high cost of seeds and fertilizers). The high rate of fertilizer applied to potato benefits to the following crop (which may be rice) during the following season.

4.2.1.3. Rice/vetch or fodder radish in paddies fields

In the same way as in medium altitude, the rice/vetch system is particularly interesting in paddies fields in high altitudes as it brings a high quantity of nitrogen which controls insects and reduces labor (no tillage, very little weed control). The partial use of vetch for feeding livestock is a major asset of such system in dairy farming which often lacks fodder in winter period. Besides vetch fodder, radish and oat (probably in mixture) are excellent plants for such environments. Fodder radish has the major advantage of producing high biomass and is repulsive for many crop devastating insects.

4.2.1.4. Other proposed systems

- Stylosanthes, which grows slowly above 1,200 m, is little recommended, and it is not recommended above 1500 m.
- Oat, vetch, and fodder radish are particularly interesting for their aptitude to grow during cold season or right from the first warm month, and thus to produce high biomass, available for setting up crops in direct seeding the following season, and which may be in part used as fodder. On the opposite, crotalaria (maize + crotalaria system) is appreciated by non cattle breeders because it is not palatable for animals, which therefore secures the restitution of biomass to the soil.
- When burning materials are available for conducting smoldering, planting potato (+ oat) is particularly interesting for the incomes it may provide. By enhancing very rapidly the soil fertility this way, while being very profitable right from the first season, smoldering enables a very rapid entry into CA systems.
- Last, crops on living covers crops are particularly interesting with, particularly Desmodium and clover which produce considerable biomass (that may be used partly as fodder), cover the soil permanently, fix nitrogen and control weeds. The difficulty of such systems lie in the know how required for adequately controlling the cover crop, and in the installation of the cover which is often made by cuttings and therefore require much work.

4.2.2. Conservation Agriculture in the areas of the Highlands of Madagascar, Areas of Vakinankaratra, Amoron'i Mania, and Itasy

4.2.2.1. Vakinankaratra High Altitudes

In the Vakinankaratra (irrigated areas[11] of Fitakimerina, Iandratsay, and Antsoso), the *tanety* systems account for 270 ha for 500 farmers in 2008/2009, of which 103 ha in Y_0 of CA, 131 ha in Y_1, 33 ha in Y_2 , and 3.4 ha in Y_3. Over such total, 74 ha were in associated crops essentially with oat and brachiaria (table 16), the rest in pure stand (fodders in general). Over the 74 ha of associated crops, 42 ha associate 3 crops (table 17), of which the 3rd associated crop succeeds to the 2nd (short cycle). Such association/succession systems of 3 crops may be very beneficial for biomass production if there is not too

[11] The BVPI SEHP Project especially diffused the conservation agriculture in the watersheds of the 3 irrigated areas of Fitakimerina, Iandratsay, and Antsoso.

much harvest (or grazing) for fodder. Indeed, it can be seen in such systems the preference by farmers for fodder based systems (oat, Brachiaria).

Table 16 : Crop Associations in the Vakinankaratra High Altitudes in 2008/2009

Main Systems (crop associations)		*Year under CA and acreage (ha)*				
Main crops	***Associated crops***	Y_0	Y_1	Y_2	Y_3	***Total***
Groundnut	***Oat***	0,3	0			***0,4***
Brachiaria	***Oat***		0,2			***0,2***
Bean	***Oat***	2,6	4,3	1	0,1	***8***
Cowpea	***Oat***		0	0		***0***
Petit pois	***Oat***	0	1,1	0,1		***1,2***
Bambara bean	***Oat***	0	0,3			***0,3***
Potatoes	***Oat***	13,4	26,2	0,9	2,9	***43,4***
Rain fed rice	***Oat***			0,1		***0,1***
Soyabean	***Oat***	0,2	0,4	0,1		***0,7***
Tomatoes	***Oat***	0,4				***0,4***
Groundnut	***Brachiaria***	0,5	0,2	0,1		***0,8***
Bean	***Brachiaria***	1	2,2	5		***8,2***
Maize	***Brachiaria***			0		***0***
Cassava	***Brachiaria***	0,1	0,4	0,5		***0,9***
Niébé	***Brachiaria***	0,5	1,1	1,7		***3,3***
Bamabara bean	***Brachiaria***	0,3	0,1	0,5		***0,9***
Potatoes	***Brachiaria***	0,3				***0,3***
Fodder radish	***Brachiaria***		0			***0***
Rain fed rice	***Brachiaria***	2	0,9	0,7		***3,6***
Soya bean	***Brachiaria***	0,8	0,3	0		***1,1***
TOTAL		22,5	37,6	10,8	3	***73,8***

Y_0 is under tillage, Y_1 and more is under CA

(BVPI SEHP, 2009)

Table 17 : Crop Associations and Successions in the Vakinankaratra High Altitudes in 2008/2009

	Year under CA and acreage (ha)				
Main Systems (crop associations)	***Y_0***	***Y_1***	***Y_2***	***Y_3***	***Total***
Brachiaria+[bean/oat]			0,1		0,1
Maize +[bean/oat]	6,4	2,9	0,2		9,5
Maize+[bean /Brachiaria]	4,6	17,4	2,7	0,1	24,8
Maize +[Cowpea /Brachiaria]	0,1	0,4	0,1		0,6
Maize+[Soyabean /Oat]	2,9	0,7	0,1		3,7
Maize +[Soyabean /Brachiaria]	0,4	0,3			0,4
Rain fed rice +[bean /oat]	0,2	0,7	0,4		1,4
Rain fed rice +[bean /Brachiaria]	0,1				0,1
Rain fed rice +[Cowpea/oat]	0,3	0,3		1,0	1,0
Maize +[potatoes /Oat]		0,04	0,03		0,07
TOTAL	15,0	22,7	3,6	1,0	41,6

Y_0 is under tillage, Y_1 and more is under CA
(BVPI SEHP, 2009)

4.2.2.2. Amoron'i Mania High Altitudes

The soils of high altitudes in such area are particularly poor latosoils from acid rocks (granite, gneiss). On the high altitudes of Amoron'i Mania (irrigated areas[12] of Ivato and of Kinjandrakefona), 66.5 ha of *tanety* CA systems are supervised by the BVPI SEHP Project over 813 farmers, of which the most important systems can be found on Table 18. What is noted first is the importance of brachiaria in the CA systems of such altitude areas with low fertility soils and, in particular, cassava + brachiaria system that develops much during the last two years. Currently, brachiaria is used around orange trees plants and associated with legumes (clover, arachis) to structure the soil and improve soil quality (RAKOTONDRAMANANA, 2009). Such practice is being extended in the communes producing oranges in such area.

[12] The BVPI SEHP Project diffused conservation agriculture in the irrigated areas of Ivato and Kianjandrakefona in such altitude areas of Amoron'i Mania.

Table 18 : Crop Associations in the Amoron'i Mania High Altitudes in 2008/2009

Main Systems (crop associations)		*Year under CA and acreage (ha)*			
Main crops	***Associated crops***	***Y_0***	***Y_1***	***Y_2***	***Total***
Pineapple	***Brachiaria***	0,2			***0,2***
Groundnut	***Brachiaria***	1,7	0,1	0,0	***1,8***
Oat	***Pure stand***	2,2			***2,2***
Oat	***Peas***	0,2			***0,2***
Oat	***Potatoes***	0,8			***0,8***
Brachiaria	***Pure stand***	17,4	0,5		***17,9***
Brachiaria	***Citrus tree***	0,5			***0,5***
Bean	***Pure stand***	0,8	0,2	0,1	***1,2***
Bean	***Oat***	4,2	0,4	0,1	***4,7***
Bean	***Brachiaria***	5,5	0,6	0,0	***6,0***
Bean	***Vetch***	0,2	0,1		***0,3***
Cassava	***Brachiaria***	8,9	1,0		***9,8***
Cassava	***Bean***	0,1			***0,1***
Orange tree	***Brachiaria***	1,8			***1,8***
Bamabara bean	***Pure stand***	0,2			***0,2***
Bamabara bean	***Oat***	0,1	0,0		***0,1***
Bambara bean	***Brachiaria***	2,9	0,4		***3,4***
Soyabean	***Avoine***	0,2			***0,2***
Soyabean	***Brachiaria***	1,3			***1,3***
Vetch	***en pure***	9,1	0,1		***9,1***
Vetch	***Oat***	0,2			***0,2***
	TOTAL	***58,3***	***3,3***	***0,3***	***61,9***

Y_0 is under tillage, Y_1 and more is under CA

(BVPI SEHP, 2009)

4.2.2.3. Itasy HighAltitudes (Ampary)

The diffusion of conservation agriculture in this area of Itasy is provided by BRL Madagascar in the irrigated area of Ampary. It is an area with recent volcanism soils with a high population density which has huge impact on natural resources (forest and herbaceous covers). Altitude varies from 1,300 to 1,400 m between the bottom of the plain and the cultivated plateaus in altitude. The climate is of tropical type with altitude effect with an average rainfall of 1,600 mm and a dry season of 5 to 6 months. Soils are particularly fragile and very sensitive to erosion, a situation aggravated by the considerable slopes. A particularity of the area is the development of the counter season maize and vegetables because of the proximity to the capital Antananarivo (130 km). The diffusion of conservation agriculture in the area is fairly recent and therefore the impact on yields is not perceptible yet. 110 ha of CA are diffused in 2008/2009 with 427 farmers, and the systems are at best in 2nd year of CA.

Table 19 summarizes the main diffused systems which are dominated by:

- The system [maize + voluble legumes]//rain fed rice. The voluble legumes are *Vigna umbellata*, *Dolicos labalab*, and mucuna ;
- The system [cassava + stylo]//stylo//rain fed rice;
- Rain fed rice in pure stand that will be followed by inter season legumes (vetch, Dolicos lablab) or vegetables.

Table 19 : Crop Associations in the Itasy Area, Commune of Ampary in 2008/2009

Main Systems (crop associations)	*Year under CA and acreage (ha)*			
	Y_0	Y_1	Y_2	*Total*
Maize + Vigna umbellata	22,3	1,1	0,0	***23,4***
Maize+ Dolicos lablab	4,5	0,1		***4,6***
Maize + mucuna	12,2	1,8	0,2	***14,3***
Maize +Stylosanthes	2,0	0,9	0,3	***3,2***
Maize + Eleusine coracana	0,4	0,5	0,0	***0,9***
Cassava + Stylosanthes	3,6	0,4	0,3	***4,3***
Cassava + brachiaria	1,6	0,7		***2,3***
Vegetables+live cover crops				***2,6***
Vegetable on mulch of cover crops				***0,5***
Fodders and legumes in pure stand				***4,4***
Fruit tress+Live cover crops				***1,4***
Rain fed rice in pure stand	29,9	0,2	0,8	***30,9***
Rain fed rice on mulch of cover crops				***0,5***
Rain fed rice +Stylosanthes	1,7	0,5		***2,1***
TOTAL	***78,2***	***6,2***	***1,6***	***95,3***

Y_0 is under tillage, Y_1 and more is under CA

(BRL , 2009)

4.3. Humid Tropical Area (lower than 500 m): South East

4.3.1. Soil and Climatic Characteristics and Systems Proposed in Humid tropical Area on the East Coast of Madagascar

The hot and humid climate all over the year enables a very high biomass production. Rainfall is higher than 1,500 mm per year with an average temperature of 25°C. In such conditions, the very high mineralization of organic matter contributes to the fact that the biomass required for a proper functionning of CA systems is very important. What is necessary therefore is to produce as much as possible, all along the year. The relatively low pressure on the land and the low development of livestock contribute to the fact that pressure on biomass is relatively low, which enables easily conserving the biomass to cover the soil. It is also very important to protect the soils on slopes, which are very sensitive to erosion under such a climate that is particularly aggressive.

The systems that are the most adapted on the various agronomic units are the following:

4.3.1.1. Perennial Arachis under Perennial Plants (coffee trees, banana trees, etc.)

Planting perennial Arachis (*Arachis pintoï* or *Arachis repens*) in tree plantations enables at the same time protecting the soil against erosion, bringing nitrogen to trees, considerably reducing the maintenance of plantations (weed control by Arachis, a species growing with rhizome and therefore does not compete with perennial plants), and producing a fodder that may be grazed by animals without risk of deterioration . For such set of interests, such system is currently in full spontaneous expansion in the Malagasy South East.

4.3.1.2. Cassava or bambara bean + brachiaria // cassava + brachiaria on the steep slopes of degraded tanety

Yield of cassava associated with Brachiaria may be twice or three times that of cassava in pure stand straight from the year of implantation; this is due to its rapid effect in the soil structure, beneficial for cassava few months only after installation of this graminacea (which develops very rapidly in such environment). The agronomic and economic interest of such system is immediate, which makes it particularly attracting.

Brachiaria may also be replaced by Stylosanthes, which is easier to control without herbicide, and which is more appropriate for soil improvement (nitrogen fixation) which thereafter enables producing rain fed rice (on Stylosanthes residues, which reseeds naturally).

4.3.1.3. Rice + Stylosanthes//rice + Stylosanthes or rice + Stylosanthes//Stylosanthes//rice + Stylosanthes on hydromorphic *tanety*

The **hydromorphic** *tanety* on the east coast are very little cultivated because of their considerable agronomic constraints. Cultivation is little profitable in that area with the traditional practices, whereas a system in CA enable obtaining very interesting productions, with very little investment in cultivation or in capital : the association rice + Stylosanthes in year « zero » enables installing a system in which the cover crop recovered by itself (natural reseeding of Stylosanthes) and which produces each year some rice and at the same time improve the soil, perfectly controlling weeds by the woody plant cover that is produced in counter season by Stylosanthes. Weed control is considerably easier this way, ploughing is no longer done, and rice production is secured at a lower cost and therefore with very limited risks. Smoldering (« slow burning» of soil),by means of strong oxidation and by raising pH, makes available to plant the nutrient accumulated in the organic matter. Such technique is particularly interesting in such very organic environments. By making it possible to produce rice on soils that are not traditionally cultivated, such system enables reducing pressure on forests that are traditionally cultivated in the slash and burn system (*tavy*) to provide rice production, which is highly deficient in the area (which results in the fact that farmers are often ready to produce non profitable rice!).

4.3.1.4. Rice/ cowpea (or bean) in the Drained Lowlands

The drainage of waterlogged lowlands enables reducing iron toxicity by oxidation, and thus increase very considerably rice production (not profitable without drainage). After the cyclone period it is interesting to implant a legume crop like cowpea (or bean) on such drained soils, which provides additional income and reduces weed pressure (extremely high in such rich environments). On the following cycle, rice benefits from the fixed nitrogen by the legume.
Drainage however takes several years to oxide the excess organic matter and to contribute to soil evolution. For the first years nutritional problems are frequent and they entail a high bio aggressor pressure. The varieties used have to tolerate such pest and diseases pressure.

4.3.2. Conservation Agriculture in the South East of Madagascar, Region Atsimo Atsinanana (or Farafangana region)

The region of Farafangana benefits of many retention dams which enable farmers to practice irrigated rice in the lowlands in counter season[13] when the overflow of water is discarded somewhere in May. Soils on the hillsides are very poor, and it is nearly impossible in there to grow food crops with the traditional methods: for this reason, the BVPI-SEHP Project attempted to improve the situation by implanting cover crops.

The total surface area under CA on *tanety* in the Farafangana region (or Region South East) in 2008/2009 was 254 ha for about 600 farmers. Among the achievements the systems that dominate the most are brachiaria based systems and Stylosanthes based systems (table 20). Such systems nearly all come from dressing (e.g. intercropping existing traditional crops with cover crops) of farmer crops of cassava with brachiaria or Stylosanthes.

[13] Season rice is impossible in such lowlands because the latter are flooded in January and February.

Table 20 : Crop Associations on *tanety* in the Area of Farafangana on Low Altitude Areas in 2008/2009

Main Systems (crop associations)		*Year under CA and acreage (ha)*				
Main crops	***Associated crops***	Y_0	Y_1	Y_2	Y_3	***Total***
Arachis	***Pure stand***		0,2	0,1	0,0	0,3
Brachiaria	***Brachiaria***	0,3				0,3
Brachiaria	***Manioc***		0,3			0,3
Brachiaria	***Stylosanthes***	0,3	0,2			0,5
Brachiaria	***en pure***	9,5	43,7	13,1	2,5	68,8
Cassava	***Brachiaria***	40,5	14,7	1,4	0,0	56,6
Cassava	***Stylosanthes***	56,8	15,5	0,8		73,1
Cowpea	***Pure stand***	0,6	0,5			1,1
Sweet potatoes	***Pure stand***	0,4				0,4
Bambara bean	***Stylosanthes***	0,2				0,2
Bambara bean	***Pure stand***	3,5	0,2	0,0		3,7
Rain fed rice	***Stylosanthès***	0,1	0,1			0,2
Rain fed rice	***Pure stand***	0,1	0,2	0,1		0,4
Stylosanthès	***Pure stand***	18,0	29,7	1,2		48,9
	TOTAL	130,4	105,2	16,7	2,6	254,8

Y_0 is under tillage, Y_1 and more is under CA
(BVPI-SEHP, 2009)

4.3.3. Conservation Agriculture in the South East of Madagascar, Region Vatovavy Fitovinany (or Manakara region), Low Altitude Areas

The Region of Vatovavy Fitovinany (or Manakara region), in the low altitude areas (lower than 500 m) includes, in addition to degraded *tanety*, many hydromorphic lowlands which were not cultivated before the intervention by the BVPI-Project because of prevailing high iron toxicity.

The total area of *tanety* under CA in such low altitude areas account for 319 ha for 490 farmers. Besides the *tanety* systems there are 160 ha of drained lowlands for 290 farmers, in which there is succession of cowpea/rice[14] after drainage.

In the achievements on *tanety*, the systems that dominate most, like in Farafangana, are the brachiaria based systems and the Stylosanthes based systems (table 21). Such systems nearly all come from dressing of farmer cultivation of cassava with brachiaria or Stylosanthes. What is also especially noted is the implantation of Stylosanthes and brachiaria directly without tillage in the Aristida which has been killed with herbicide (glyphosate) in the hydromorphic peneplains. The other system that dominates is the implantation of cassava in Stylosanthes.

[14] After lowlands are drained they are cultivated in counter season with legumes (cowpea) which will be followed by *vatomandry* rice (photoperiodic rice that withstands flooding) in rain season.

Table 21 : Crop Associations on *tanety* in the Manakara region on Low Altitude Areas in 2008/2009

Main Systems (crop associations)		*Year under CA and acreage (ha)*					
Main crops	***Associated crops***	Y_0	Y_1	Y_2	Y_3	Y_4	***Total***
Pineapple	***Brachiaria***		0,8				0,8
Arachis	***Pure stand***		0,6				0,6
Brachiaria	***manioc***		2,5	0,5			3,0
Brachiaria	***Pure stand***	16,3	48,0	4,4	12,6	1,6	82,9
Coffe	***Arachis***	0,0	5,5	0,1			5,6
Cassava	***Brachiaria***	7,0					7,0
Cassava	***Stylosanthes***	8,2					8,2
Mucuna	***Pure stand***	0,2					0,2
Cowpea	***Pure stand***	15,7	4,2	1,1	1,5		22,4
Cowpea	***Pure stand***	0,4	0,2		2,7		3,3
Bambara bean	***Pure stand***	3,1	0,6				3,6
Rain fed Rice	***Stylosanthes***	1,3	0,0				1,4
Rice fed Rice	***Pure stand***	2,8	0,1	0,1			3,0
Stylosanthes	***Cassava***		5,5	4,1	0,3		10,0
Stylosanthes	***Rain fed Rice***		1,1	0,3	0,1		1,5
Stylosanthes	***Pure stand***	62,9	85,2	3,5	13,9	0,2	165,6
TOTAL		118,6	156,3	14,4	31,1	1,8	319,1

Y_0 is under tillage, Y_1 and more is under CA

(BVPI-SEHP, 2009)

4.3.4. Conservation Agriculture in the South East of Madagascar, Region Vatovavy Fitovinany (Manakara region), High Altitude Areas

The high altitude areas in the Manakara region correspond to the high watershed buttresses and consist in forest regrowth with many crops under slush and burn (*tavy)* on steep slopes. There are very few lowlands for rice cultivation. The objective of conservation agriculture in such areas is to intensify rain fed crops and to reduce crops on *tavy* in such steep slopes.

The total achievements on *tanety* are140 ha with 600 farmers; even though total area under CA is relatively low, some plots are already at the 6th year under CA . The farmers in such area also practice some cattle breeding and therefore are interested in fodder.

The main systems in such areas of forest regrowth can be found in table 22. What is especially noted is the interest of farmers for brachiaria based systems, stylosanthes based systems, and Arachis under coffee tree:

- Brachiaria in pure stand, largely *Brachiaria humidicola*, very effective against erosion in such steep slopes. Brachiaria is first used for fodders, then used again in association with cassava (e.g. cassava is pl anted on Brachiaria without any tillage) or with bambara bean with very interesting results (RAKOTONDRAMANANA, 2009) ;
- Stylosanthes in pure stand with a view for production of high biomass to be able to grow rain fed rice;
- Cassava + Stylosanthes: such system is very interesting because stylo reseeds naturally and farmers no longer need to make seeding;
- Cassava + brachiaria: Brachiaria effect on yield is now well known by farmers;

- Arachis under coffee tree is certainly the future for such farmers: absence of weeding at the foot of the coffee tree, good development of coffee tree because of the nitrogen input by Arachis.

Table 22 : Crop Associations in Manakara region, on the Upper Parts of Watersheds in 2008/2009

Main Systems (crop associations)		*Year under CA and acreage (ha)*							
Main crops	***Associated crops***	Y_0	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6	***Total***
Arachis	***Pure stand***	0,0	0,3	0,0	0,4	0,5			1,2
Brachiaria	***Cassava***	0,0	0,9		0,1	0,2			1,2
Brachiaria	***Pure stand***	7,8	9,2	0,4	5,3	9,6	1,2	1,4	40,1
Coffee	***Arachis***	0,9	3,9	0,6					5,4
Cassava	***Brachiaria***	5,9		0,0		0,2			6,2
Cassava	***Stylosanthes***	27,2	0,2	0,3	0,2				28,3
Mucuna	***Pure stand***		0,3	0,3	0,7				1,4
Cowpea	***Pure stand***	0,8	0,1		0,3	0,1	0,1		1,4
Sweet potatoes	***Pure stand***	0,7							0,7
Bambara bean	***Stylosanthes***	0,7							0,7
Bambara bean	***Pure stand***	1,1			0,0	0,1	0,2		1,4
Rain fed rice	***Stylosanthes***	2,1			0,2				2,3
Rain fed rice	***Pure stand***	0,2			0,3	0,1			0,6
Stylosanthes	***Cassava***		2,4		0,1				2,5
Stylosanthes	***Pure stand***	16,9	9,3	1,7	7,0	0,3	0,1		49,6
	TOTAL	***65,6***	***43,6***	***4,7***	***15,5***	***11,8***	***1,7***	***1,4***	***142,7***

Y_0 is under tillage, Y_1 and more is under CA

(BVPI-SEHP, 2009)

4.4. Semi arid Area (300 to 600 mm rainfall): Androy, South West

4.4.1. Soil and Climatic Characteristics and Systems Proposed in Semi arid Area

Very low rainfall environments with long dry season considerably restrict biomass production. It is fundamental in such environments to make the best use of infiltrated underground water using plants that are capable of extending their growth during the dry season by catching water from the deep water table. Long dry season considerably reduces mineralization, which results in the relatively low biomass quantity required for the correct functioning of systems in direct seeding. Moreover, the effect of mulch on infiltration and on reduction of evaporation results in higher water efficiency in direct seeding compared to conventional tillage.

In the Androy region where wind erosion is very high from September to November, implanting wind break is indispensable to protect the soil but also to protect the accumulated biomass (crop residues).

The following systems are proposed in such dry areas:

4.4.1.1. Maize + cowpea // cotton tree on tropical ferruginous soils (alfisols)

The association maize + Dolicos lablab (or cowpea or *Vigna umbellata*) enables high biomass production with, in particular Dolicos lablab for its aptitude to continue to grow during the dry season. The nitrogen input from these legumes also benefits the following crop, in particular cotton tree. Such system is therefore very interesting for the whole Malagasy South West region. It contributes to a considerable production earning on the cotton tree the following year, besides providing a double production on the first year.

4.4.1.2. Maize + Brachiaria + Cajanus

Such a system contributes to a high biomass production, rapidly recharging the soil in organic matter. Brachiaria and Cajanus may be used as pasture on the following years (preference is then for *Brachiaria brizantha*) or recultivated with food crops (preferably *B. ruziziensis*). This is in particular an excellent precedent for cotton tree. Recultivation for food crops , however, requires the use of herbicide (or a long scratching work with an *angady (spade)*), contrarily to the system with Dolicos lablab.

4.4.1.3. Maize + Dolicos lablab//rice on hydromorphic sols in the wetland of the watershed

The system Maize + Dolicos lablab is also an excellent precedent to rain fed rice (maintenance of macro-porosity, nitrogen input, weed control). It is particularly interesting on hydromorphic wetland of the watershed (vertisols), which are rare locations where rain fed rice may be grown. The same system may be used in counter season in irrigated areas, reducing needs in water for cultivating poly aptitude rice in season.

4.4.1.4. Maize + mixture (*konoke*, Dolicos lablab, millet, etc.) in the very dry area of Androy

To ensure a high biomass production in the Deep South (e.g. Androy region) that is extremely dry, it is preferable to use maize, sorghum, or millet in association with other crops, of which *Konoke* (indigenous legume drought resistant with big grains). It is to be noted that in such very dry areas, millet has to be favored (it is very tolerant to drought) against sorghum, and sorghum against maize. Biomass mixture is very beneficial because it has buffer effect against rainfall hazards, and the diversity of plants species may limit damage by insects (sorghum and maize stem borers, caterpillars …) which proliferate in such erratic rainfall areas. Windbreaks are indispensable to protect crops and the produced biomass against the violent winds from September to December

4.4.2. Conservation Agriculture in the deep South, Androy region

The area of Androy is divided into two essential areas: the sedimentary area and the crystalline area. Overall the sedimentary area is more populated and used as crop area, whereas the crystalline area with very low population density serves especially as grazing area (common land) and is made up of dry forests. Lucien Séguy, expert from CIRAD based in Brazil, in his 2008 report calls such area «the country of Cynodon, wind, cactus, and sand » (Séguy, 2008). In addition to what is listed there may also be added the country of insects. It is a semi desert area with 200 to 600 mm rain, characterized by dominant sandy soils: coastline dune ridges, rubefied red sands, locally clayish soils. CAs present a considerable stake in dry periods in such areas. But what is needed is a good choice of cover crops and appropriate CA systems. Implanting living hedges is indispensable because of considerable wind erosions, in addition to gully erosion.

CA in such semi desert area are still at the demonstration step with pilote farmers (about fifty farmers during the FASARA Project) in diverse environments but diffusible results are already available. Indeed, following the capitalization of the results of the FASARA Project (2005 to 2008), the species recommended depending on the environments (RAKOTONDRAMANANA & RAZAFINTSALAMA H., 2008) are as follows:

- Legumes:
  - *konoke* : a semi perennial voluble legume close to bean, the botanic identification of which remains to be found, but the grains of which are consumed by man in the Androy area. It is a cover plant adapted to the sedimentary area, which appropriately covers the soil at the 2nd year.
  - *Dolicos lablab* has been cultivated by the local population for long. Its major interest lies in its capacity of catching water from deep water table and in its stems that are more lignified than those of cowpea, for instance.
  - *Alysicarpus* : a creeping legume found in natural status on red sand in sedimentary area in natural vegetation
  - Cowpea, cultivated in the area, but considerably attacked by insects, does not present much interest as cover crop because of its low biomass

- Stylosanthes did not indicate a good performance except for some relatively watered areas.

- Cereals:
  - Millet is by far the most adapted in the area and provides better yield than sorghum
  - Sorghum that is largely grown is considerably attacked by stem borers (*Chilo partellus*).
  - Short cycle maize is largely grown but yields are very low as a function of rain.
- Tuber plants are dominated by sweet potato followed by cassava.
- Shrubs:
  - Cajanus is by far the species most adapted to all environments in the Androy area. Therefore it may be used as windbreak on the edges of plots or inside plots at regular intervals that are perpendicular to the wind direction.
  - Among the other species, there may be quoted crotalaria, Acacia (mangium and auriculiformis), *Morenga oleifera* and pennisetum, as well as *Jatropha curcas*
- Perennial grass
  - Cynodon is by far the most widespread and serves as fodder in sedimentary area
  - *Dactyloctenium aegyptium* (or *drematse*) is also a grass that is well known by farmers in the Androy; it is largely used as fodder on both red sand and dune sand.

Based on the results acquired from the previous seasons, the cropping systems in CA likely to be diffused are mainly based on the following associations:

- millet + Cajanus + *konoke* with millet + Cajanus in hedges or completely in field;
- Cajanus + brachiaria ;
- Cynodon/legumes ;
- Dressing of traditional maize or cassava crops with brachiaria implanted by cuttings.
- etc.

It may be confirmed that the systematic basic frame of entry into CA is the association Cajanus + millet that produces both grains and a biomass likely to cover the soil and which is likely to respond to the main strategy of farmer's land reclamation. Cajanus, which grows in such difficult conditions and which, in addition to wind barrier, provides production of grains used in food, is found satisfactory by farmers.

The greatest diversification possible soil coverage and selection of adapted species and varieties is essential. The following species as cover plant or auxiliary plants (cajanus, brachiaria, konoke, millet, Dolicos lablab, Cenchrus, ricinus, black mucuna...) are used to precede, to accompany, and to succeed to the usual crops by farmers. As maize is the main crop, the soils have to be particularly improved to receive such fertility demanding crop.

The principle for implanting hedges is now demonstrated in view of their effectiveness against wind erosion. Their success is conditioned by the diversity and density of species plantation to create an even plantation although it may be necessary to thin later. The species considered interesting for hedges were mentioned: Cajanus, Leuceana, *Acacia auriculiformis*, millet. It is quite possible to associate with them local species such as Flacourtia, Moringa, *varo* for wood, jatropha, Parkinsonia, Ziziphus, Pennisetum as fodder, it being understood that the most rapid species enable stabilizing the environment for a probable development of local species.

4.4.3. Conservation Agriculture in the South West

4.4.3.1. Conservation Agriculture within the PACA Project

The area of Ankililoaka – corridor of Antseva is known for water availability all along the year in many locations with good soils (vertisols). Besides, it is one of the main cotton areas in the South West of Madagascar. But most soils consist in very compact tropical ferruginous soils.

The PACA Project in the South West focused its actions in the Commune of Ankililoaka. The essential objective of actions is to develop CA systems for a rotation with cotton and to develop the diffusion with the HASYMA Company. The most developed system is the (maize + cowpea)//cotton based system that may be practiced in rainy season and in irrigable areas. Apart from the maize + cowpea system, the project also developed pure cowpea based systems, which provides less biomass. On the opposite, high biomass systems such as maize + Dolicos lablab or sorghum + Dolicos lablab were not much adopted. The maize + cowpea system followed by cotton is a system that contributes to significant improvement of cotton yield on such red sandy soil which account for large surface areas in the region. The system may be practiced in rainy season and in counter season in irrigable areas but the big issue lies in the conservation of crop residues in such area with a lot of cattle breeding. (RAKOTONDRAMANANA, 2007). In 2008/2009, 120 ha of maize + cowpea were supervised by the PACA Project for 126 farmers. Training sessions for HASYMA technicians were provided by the PACA project but the diffusion within HASYMA network did not start because of internal probems in this company.

4.4.3.2. Conservation Agriculture within the Mahafaly Plateau Project, an Area of the South West

The climate in the Mahafaly plateau is very close to that of the Androy but the soil, of low thickness, developed on calcairous rock. Like in the Androy, apart from the gully erosion that is very devastating, there is also wind erosion with violent winds transporting the biomass (DOMAS, 2007). The area as a whole is covered by spiny forests, at least in the non cleared parts. It contains a lot of *Jatropha mahaliensis* which draws its name from the Mahafaly plateau. The big issue for the area is slash and burn maize cultivation by nomadic herder coming from the coastline area.

At the end of the FFEM/AFD I Project, there were 35 ha of CA with 160 farmers : maize + cowpea, sorghum + cowpea, Brachiaria + Cajanus, groundnut or bambara bean on mulching etc.. There were also implantations of fodder especially brachiaria.

4.5. Other Areas

4.5.1. The PLAE Project

The PLAE Project (Anti erosion project) funded by the german bank KfW conducts anti erosion actions in the sensitive sites of the irrigated areas of Marovoay, Soavina, Bezaha, Andapa, and Ambanja. In 2006, the project made a request to GSDM to study the possibilities for diffusing CA in the areas of Marovoay, Soavina, and Bezaha. Following such studies and thanks to the support from GSDM and TAFA, reference sites and demonstration plots were implemented. Trainings were provided to the PLAE staff and visits /exchanges were conducted for the benefit of the staff and the pilot farmers of PLAE. Reference sites of Marovoay and Soavina were implemented in 2006/2007 and that of Bezaha in 2007/2008 along with demonstration plots. In 2008/2009, 17 ha of CA plots were recorded in Marovoay with 70 farmers and 35 ha in Soavina with 174 farmers, mainly Barchiaria and Stylosanthes based systems.

4.5.2. The Cashnew Nut Plantation Project (VERAMA Company) in the peninsula of Masiloka

VERAMA Company invested in cashew nut tree plantation in the peninsula of the bay of NARINDA around the Lac MASILOKA. Its actions account for an example of development of large spaces of savannah with very poor soils that are considerably compacted and in low accessibility locations subject to repetitive bushfires. In addition to compacted soils (red sand) and very poor in organic matter and in mineral elements, the dry season is very long (7 months) and the rains are very violent (high intensity). The solution adopted consists in subsoiling the compact soil layer and implanting legumes crops the most adapted to such environments (*Macroptilium atropurpureum* and *Callopogonium muconoides*) between rows of the cashew nut trees in order to cover the soil and to protect against erosion and providing nitrogen for trees.

4.6. Synthetic Diffusion Rules

The following table presents a summary of the difficulties as a function of the main criteria to be taken into account: the length of growing season, the intensity of land use, the needs in fodder, the soil degradation status, the available space or time, and the investment possibilities.

Table 23 : Difficulty in CA Management as a Function of Various Criteria

Environnement			Land use intensity and forrage needs		
			Low	Medium	High
Length of the growing season (rainfall + water availability) x Temperature	Long (> 9 months)	No cold season Eastern coast	Intra-annual and inter-annual successions (and associations) **Easy to implement**	Intra-annual and inter-annual successions (and associations) **Rather easy to implement**	Associations, intra-annual and inter-annual successions **Rather difficult to implement**
		Cold season High lands	Inter-annual successions , associations (and intra-annual successions) **Rather easy to implement**	Associations, inter-annual (and intra-annual) successions **Rather difficult to implement***	Associations, inter-annual (and intra-annual) successions **Difficult to implement***
	Medium (5 to 9 months)	Middle-West and Alaotra Lac	Inter-annual successions and associations **Easy to implement**	Associations and inter-annual successions **Rather easy to implement**	Associations and inter-annual successions **Rather difficult to implement***
	short (< 5 months)	South West and South	Inter-annual successions (and associations) **Rather easy to implement**	Associations and inter-annual successions **Rather difficult to implement***	Associations and inter-annual successions **Difficult to implement***

**: "Rather difficult to implement": Implementation requires a good technical skills. Soil improvement by CA is slow (moreover, soils are highly degraded). CA Diffusion in such zone requires support to farmers for many years (learning period and implementation of CA), protection of biomasse (non free grazing, fences required…), and eventual subsidies for some inputs (fertilizers for instance) to speed up the entry to CA*

Such conditions have to be taken into account right from the start of any diffusion action, in order to achieve consistency between the project ambitions and the means available and the fixed deadlines.

5. Monitoring and Capitalization Aspects (GSDM)

Monitoring and evaluation of CA by GSDM within various diffusion operators is done through field missions conducted within these operators and projects in the framework of convention and partnership or through methodological support and in particular the provision of two agricultural engineers in the two main projects: BVPI-SEHP and BV Lac.

In total for all projects, these monitoring and evaluation require 200 man-day per year for GSDM executive staff of which the main part is committed to BVPI-SEHP and BV Lac projects.

In order to improve the monitoring of the activities and to use the large quantity of information on the systems that are provided by the diffusion operations on a large scale (identification of the systems that are the most diffused per zone, economic evaluation, etc.), GSDM is developing with the main projects and partners a mutualized database that will enable simplifying data collection and processing in time. As a matter of fact, currently the operators have various procedures and

tools for collecting data until their validation and their transfer to the project units. The template is a paper medium indicating the matrices of the data to be collected, the different pages of which are stuck one after the other in order to better verify the continuity in each record (line by line). The collected data are afterwards transferred on computerand the agronomist in charge consolidates the base as a whole. The Excel sheets for the storage of data may differ as a function of operators of the same project, which makes complex the consolidation and analysis work. Such process for collecting – keyboarding – validating data indicates:

- multiple transcriptions with many operations (field book – register – computer keyboarding – verification – back and forth movement between executive and technician – validation of data – subsequent analysis) which generate errors;
- that the work load is displaced from the keyboarding operating technician to the executive who verifies the data on an enormous table made up of lines x columns;
- that there are risks of errors in transcription and difficulties in analysis and consolidation at the higher levels;
- that the risk of destruction of file (computer virus) is considerable with heterogeneous management of saving.

The complexity of Excel sheets does not enable access to data by users other than the operators and the units of projects and does not enable inter annual monitoring, not more than the completion of operating reports on agricultural practices.
In view of the analysis of what exists and the expression of needs of users as a whole, it is planned to create and set up a common database (BDD), which is user friendly and enabling monitoring the achievements, analyzing the results, producing consolidated figures per zone and at national level. Such database that is managed on a WEB server will enable compiling, managing, analyzing, and consolidating the data available at various required levels, from the rural development operator to political decision makers via the units of the projects and the donors. The general principle consists of a set of centralized and mutualized database, itself interfaced to external tools. The whole enables a high number of applications: operation reports and decision making tools, a system of extracting data on request, monitoring of field tours by operators, GIS applications…

As far as capitalization is concerned, it relates to both drafting technical referentials and implementing initiatives in favor of diffusion and information exchange:

- Creation and regular updating of a bibliographical database on conservation agriculture in Madagascar. It currently includes more than 950 documents (in pdf format) only on Madagascar, and 450 documents on conservation agriculture in general. Such base is shared with the various projects and actors involved in conservation agriculture in Madagascar.

- Writing out, edition and diffusion of technical leaflets: Stylosanthes, Brachiaria, Vetch grass, Striga etc.

- Writing out of a manual on integrating agriculture/ livestock in partnership with Cirad, the region of La Réunion, FIFAMANOR, …

Writing out and edition of a « Practical Manual of Direct Seeding in Madagascar ». Such manual will include 6 volumes over time:

- **Volume I. Principles and Interests of Direct Seeding.**

The first two chapters are available:

Chapter I.1. Principles and functioning of ecosystems cultivated in direct seeding on permanent cover crops (32 pages, 5.9Mo): http://agroecologie.cirad.fr/content/download/7763/39450/file/(2)%20Manuel%20SCV%20Mada%20Vol%20I-Chap%201%20v%20finale.pdf

Chapter I.2. The management of ecosystems cultivated in direct seeding on permanent cover crops (32 pages, 3.6 Mo): http://agroecologie.cirad.fr/content/download/7765/39460/file/(2)%20Manuel%20SCV%20Mada%20Vol%20I-Chap%202%20v%20finale.pdf

The third Chapter will present a bibliographical synthesis of the effects of direct seeding on soils, water, production, etc.

- **Volume II. The implementation of husbandry techniques in direct seeding**

All this volume is now available:

Chapter II.1. The choice for crops, associations and successions adapted to the agricultural and climatic constraints (24 pages, 2.9 Mo):

http://agroecologie.cirad.fr/content/download/7766/39467/file/(2)%20Manuel%20SCV%20Mada%20Vol%20II-%20Chap%201%20v%20finale.pdf

Chapter II.2. The choice for technical itineraries (76 pages, 7.8 Mo)

http://agroecologie.cirad.fr/content/download/7781/39550/file/Manuel%20SCV%20Mada%20Vol%20II-%20Chap%202%20v%20finale.pdf:

Chapter II.3. How to propose to farmers, systems in direct seeding on permanent cover crops, adapted to their needs and constraints (20 pages, 1.5 Mo).

http://agroecologie.cirad.fr/content/download/7768/39481/file/Manuel%20SCV%20Mada%20Vol%20II-%20Chap%203%20v%20finale.pdf:

These two volumes present the set of principles and decision criteria for choosing the cropping systems and the technical itineraries that are the most adapted for a given farming.

The following volumes are under completion:

- **Volume III. The « tools » of the direct seeding on permanent cover crops,** which will in particular present the various plants species used in CA
- **Volume IV. The cropping systems to be proposed to Malagasy farmers**, with a chapter for each major agro ecological zone
- **Volume V. Data sheets per cropping system** (for about forty systems that are the most diffused)
- **Volume VI. The landscape based approach for diffusing the CA systems**

❖ design and completion of posters serving as training media during the interventions by technicians with farmers

❖ organization of a workshop «The tropical soils in direct seeding under plant covers » in partnership with the University of Antananarivo, Cirad, IRD, TAFA, and FOFIFA from December 3 to 8, 2007 which resulted in the edition of a booklet « tropical soils, CA practices, and ecosystemic services » and of one special number of the periodical of the Faculty of Agronomy «Terre Malgache ».

6. Synthesis and Perspectives

Despite the structural difficulties in rural development in Madagascar, conservation agriculture is relatively well advanced in view of the numerous development operations, and achievements.

As a matter of fact, about twenty operational stakeholders intervene in the 4 major agro ecological zones in Madagascar and participate in the good implementation of many rural development projects. Such activities rely on a network of field operations, experimental fields, farmer groupings, and materialize through the achievement in 2009 rain season of about 5,200 ha of plots under CA (GSDM, 2009) and in counter season, in succession with rice, some 550 ha under cover crops, essentially vetch or crop associations with vetch, Dolicos lablab and vegetables (GSDM, 2009) .

The major motivations among farmers for conservation agriculture techniques are essentially related to three strategies: rice production, livestock, and regenerating degraded soils. To each of such strategies that are the most frequently indicated by farmers, there is an entry way in CA matching it. They correspond to:

- Rice cultivation, irrigated or rain fed according to the agronomic period and the period of the year considered. It is noticed overall that farmers that are the most motivated to invest in conservation agriculture on *tanety* are those who have no or few irrigated paddies fields (Lac Alaotra East bank, Middle West). Rice is the unavoidable cultural and traditional staple diet even if the work productivity remains low. Hence all cropping systems on cover crops that tend, or result in regular rice production are the ones that diffuse most.
- Cattle breeding with the omnipresent presence of zebus in considerable number in farming. It is a structuring component of the rural population and the rural culture. The cropping systems that are the most easily adopted are those based on « dressing» of traditional crops with fodder oriented cover crops in areas highly dominated by livestock. Implanting fodder crops with Brachiaria sp. meets the constant concern among farmers about feeding their animals. However, taking account of fodder shortage in dry season, there is a high tendency to over graze the cover crops and the crop residues.
- Soil regeneration . This third way is observed in various areas especially in difficult zones. For instance in the Androy region, it is confirmed and manifest that the major interest among farmers for CA is its capacity to regenerate soils. It is therefore a potential entry in CA for farmers oriented on land improvement strategies, but also an increased difficulty for extension staff. . Indeed, they are faced with particularly degraded soils and, at the end of their use, the best plots remain cultivated traditionally. Such soil regeneration process is therefore more difficult and requires more time.

The experience acquired for the past years of large scale CA diffusion indicates two fundamental aspects to be taken into account during diffusion operations:

- CA systems require a learning period and the training aspects are fundamental. 2 to 4 years have to be required to train a team capable of appropriately supervising farmers, accompanying them over change. The diffusion projects imperatively need time to build teams, and require continuity in actions and actors.
- The difficulty and the speed for diffusing such systems considerably vary as a function of climatic, soil, and socio economic environments.

The general balance sheet indicates the existence of many initiatives and achievements in conservation agriculture in Madagascar and the presence of many operators involved in rural development or in the protection of the environment. Such achievements rely on the experience acquired by some operators, especially the TAFA NGO, on the network of various sites in diverse area of Madagascar and their magnitude was relatively limited by the low availability of skills in agro ecology. Such skills and such experience slowly diffused among professionals through practical training sessions for technical staff.

From such balance sheet which, all things considered, is positive in view of the magnitude of stakes, a number of perspectives can be seen at the technical level, at the organizational level, and at the training level:

At the technical level:
In addition to the strategy recommended by GSDM for a landscape based approach, a number of additional strategies may be proposed to support the diffusion of conservation agriculture techniques:

- Technical support and accompanying of agro forestry, especially with the promotion of crop associations of arborescent and food perennial species, on one hand ; and of techniques for managing the fertility of orchards, such as the insertion of cover crops of perennial species in orchards or coffee plantations, on the other hand;

- Developing hedges to serve as windbreak and to introduce trees in the farm. In addition of introducing diversity in farming types, hedges have very often multiple uses ranging from fuel wood provision to availability of medicinal plants, via fruit and non woody products production , and the strictly physical role of plot demarcation and protection against wind and animals damage to crops;
- Identifying the Malagasy zones and areas that are the most apt to enable large scale development of conservation agriculture. In that respect, the Bongolava region may be mentioned, illustrating large stretches of the Middle West and which may be characterized by the availability of land apt to agricultural production provided that they are managed with conservation agriculture techniques and a correct access to the communication ways and to markets especially of Antananarivo ;
- Identifying the Malagasy zones and regions that are the most sensitive to deterioration of the environment in order to urgently bring a number of solutions likely to meet the stakes for the protection of the environment and natural resources.
- Confirming a holistic approach associating diverse disciplines at various organization levels. It is important to keep and develop the links between technical innovations, especially the ones related to conservation agriculture and socio economic conditions of the environment. Farmers are at the center of such dynamics; the success and the sustainability of a harmonious development depend on their environment and on their skills (their training, their supervision).
- Availability of seeds and cuttings of cover crops at the level of the area of diffusion. The solution kept at such stage is to choose pilot farmers to produce seeds and cuttings locally.

At the organizational level:

- Following the expression of needs from many operators involved in rural development, it is planned to create and set up a common user friendly database (BDD) enabling monitoring the achievements. Such database will be useful to the development of activity reports and will provide a working tool for the various interveners. The implementation of such mutualized database regarding conservation agriculture techniques in Madagascar will facilitate the consolidation of achievements and results. It will also provide an invaluable tool for analyzing the results and indicators likely to orient the development strategies. Furthermore, coupled with a cognitive approach, such database will be a source of information, the analysis and the modeling of which open the way to a reasoned management of rural development and the related projects.
- Consolidating the data from all conservation agriculture operations may associate with an exhaustive inventory of operations achieved by various NGOs and institutions in order to come up with a coordination of methods and strategies before envisaging any coordination of means. The point would be to inventory the operations likely to be able to benefit from the agro ecology techniques in their responses to the stakes in protecting the environment and natural resources.

At the training level:

The training in agro ecology and on conservation agriculture techniques has to be addressed at all levels to support a rural development that is particularly difficult in Madagascar because of various constraints related to production factors.
Such training in conservation agriculture techniques has to be present in all frameworks and at all levels. At the academic level, the initiation should be addressed right from the primary and the secondary schools. Moreover the themes related to conservation agriculture (protection of soils, erosion, management of biomasses, ecological cycles, production and fertility) have to be integrated into the courses of higher education and university level training. It is an important stake which has been postponed many times in Madagascar; training modules, even complete courses (Bachelor, master) integrating conservation agriculture techniques in agronomy, livestock, and forestry have to be established.
A particularly considerable and sustained support is required for professional training with the both logistic and pedagogical boosting of the various training structures in agriculture subjects (high school for agriculture, training center, etc) in order to provide Madagascar with long term professional skills.

BIBLIOGRAPHY

1. AFD, Agence Française de Développement. (2006). *Le semis direct sur couverture végétale permanente (SCV), une solution alternative aux systèmes de culture conventionnels dans les pays du Sud.* PARIS: AFD, 5, rue Rolad Barthes, 75598 Paris Cédex 12.
2. ANAE. (2009). *Diffusion des SCV et appui aux opérateurs dans la région du Bongolava. Rapport final d'exécution de projet. Convention N°04/2009/CONV/GSDM. ANTANANARIVO*. ANAE.BRL . (2009). *Base de données BRL Ampary*. Ampary: BRL.
3. BRL. (2009). *Présentation BRL Lac Alaotra à l'Atelier Riz SCRiD Antsirabe 14 et 15 octobre 2009*. BRL Ambatondrazaka
4. BV LAC. (2009). *Base de données AVSF/ANAE Rive Ouest du Lac.* Ambatondrazaka: BV LAC.
5. BV LAC. (2009). *Base de données BRL Nord Est. Ambatondrazaka: BV LAC*
6. *BV LAC. (2009). Base de données BRL Vallée du Sud Est. Ambatondrazaka: BV LAC.*
7. *BV LAC*. (2009). *Base de données BRL Vallée du Sud Est.* Ambatondrazaka: BV LAC.
8. BVPI-SEHP. (2009). *Base de données AVSF Manakara.* Antsirabe: BVPI-SEHP.
9. BVPI-SEHP. (2009). *Base de données SD MAD. Farafangana*: ANTSIRABE. BVPI-SEHP.
10. BVPI-SEHP. (2009). *Base de données SD MAD Manakara.* ANTSIRABE. BVPI-SEHP.
11. BVPI-SEHP. (2009). *Base de données FAFIALA Moyen Ouest du Vakinankaratra.* ANTSIRABE. BVPI-SEHP.
12. BVPI-SEHP. (2009). *Base de données SD MAD Amoron'i Mania.* Ambositra: ANTSIRABE. BVPI-SEHP.
13. DOMAS R. (2007).*Compte-rendu de la mission d'appui à AVSF Tuléar du 21 janvier au 3 février 2007. ANTANANARIVO. Agronomes et Vétérinaires sans frontières*
14. DOUZET *et al*., (à paraître). *Effets des systèmes de cultures en semis direct avec couverture végétale sur le ruissellement et l'érosion des cultures pluviales des Hautes terres de Madagascar*. Accepted in Etude et gestion des sols.
15. ENJALRIC F. (2008). *Rapport de mission au Lac Alaotra du 20 au 26 avril 2008 dans le cadre du suivi des actions des opérateurs BV LAC*. ANTANANARIVO: GSDM.
16. FELLER C., RABEHARISOA L. éditeurs, (2008). *Les sols tropicaux en semis direct sous couvertures végétales,* Séminaire international Antananarivo 3 - 8 décembre 2007, Terre Malgache N° 26 spécial semis direct, Université d'Antananarivo, Ecole Supérieure des Sciences Agronomiques.
17. FELLER C., RABEHARISOA L. éditeurs, (2008). *Sols tropicaux, pratiques SCV, services écosystémiques*, Collectif "Sol-SCV" GSDM, IRD, CIRAD, TAFA, FOFIFA, Commune Urbaine Antananarivo.
18. FOFIFA - SCRiD (2007). *Rapport d'activités 2006 - 2007*, ANTANANRIVO. FOFIFA
19. FOFIFA - SCRiD (2009). *Rapport général d'exécution du marché N° 08/°6/MAEP/AGROECO: Projet d'appui à la diffusion des techniques agro-écologiques à Madagasca*r, ANTANANRIVO. FOFIFA
20. GRET. (2008). *Agriculture et Développement en pays Antandroy: l'expérience du projet FASARA* (GRET Objectifs Sud). Paris, GRET.
21. GSDM. (2009). *Rapport 3ème trimestre 2009.* ANTANANARIVO: GSDM.
22. GSDM. (2009). *Rapport premier trimestre 2009.* ANTANANARIVO: GSDM.
23. GSDM. (2008). *Rapport annuel 2008.* ANTANANARIVO: GSDM.
24. GSDM. (2009). *Rapport annuel 2009.* ANTANANARIVO: GSDM.
25. HUSSON O., *Rapport de mission auprès du projet BVPI SEHP du 10 au 20 Octobre 2007*. GSDM. ANTANANARIVO.
26. HUSSON O., CHARPENTIER H., NAUDIN K., RAZANAMPARANY C., MOUSSA N., MICHELLON R., ANDRIANASOLO H., RAZAFINTSALAMA H., RAKOTONARIVO C., RAKOTONDRAMANANA, ENJALRIC F., SEGUY L.,. (2009). *Le choix des cultures, associations et successions adaptées aux contraintes agro-climatiques.* Manuel pratique du semis direct à Madagascar, Vol. II, Chap. 1. http://agroecologie.cirad.fr/.
27. HUSSON O., CHARPENTIER H., NAUDIN K., RAZANAMPARANY C., MOUSSA N., MICHELLON R., RAKOTONARIVO C., RAKOTONDRAMANANA, ENJALRIC F., SEGUY L.,. (2009). *Le choix des itinéraires techniques.* Manuel pratique du semis direct à Madagascar, Vol. II, Chap. 2. http://agroecologie.cirad.fr/.
28. HUSSON O., CHARPENTIER H., NAUDIN K., RAZANAMPARANY C., MOUSSA N., MICHELLON R., RAZAFINTSALAMA H., RAKOTONARIVO C., RAKOTONDRAMANANA, ENJALRIC F., SEGUY L.,. (2009). *Comment proposer des systèmes de cultures en semis direct sur couverture végétale permanente adaptés aux besoins et contraintes des agriculteurs.* Manuel pratique du semis direct à Madagascar, Vol. II, Chap. 3. http://agroecologie.cirad.fr/.

29. HUSSON O., BOUTHER R., SEGUY L., RAKOTONDRAMANANA (2008). *Voly rakotra, Le Semis Direct sur Couverture végétale permanente (SCV). Comment ça marche?*. GSDM, CODEV, ANTANANARIVO.
30. . HUSSON O., RAKOTONDRAMANANA, éditeurs, (2006). *Mise au point, évaluation et diffusion des techniques agro-écologiques à Madagascar.* Articles et posters présentés au Congrès mondial d'agriculture de conservation, Nairobi, Kenya, octobre 2005. ANTANANARIVO. GSDM
31. MAEP. (2006). *Lettre de Politique de Développement des Bassins Versants et Périmètres Irrigués.* http://www.maep.gov.mg/lbvpi.htm
32. MOUSSA N., MICHELLON R., ANDRIANAIVO P., (2009). *Amélioration des systèmes de cultures et lutte contre le Striga asiatica dans le Moyen Ouest du Vakinankaratra.* Atelier Riz SCRiD Antsirabe 14 et 15 octobre 2009, TAFA, Antsirabe.
33. NAUDIN K. et al., (2010). *Trade-offs between soil cover and cattle feeding in conservation agriculture cropping systems - Examples from smallholder fields in Madagascar*. Communication submitted to the Agro2010 congress, Montpellier, France, August-September 2010.
34. PENOT E., DOMAS R., DURAND C., NAVE S., ANDRIAMALALA H., HYAC P., DUPIN B., (2010). *Place et rôle du riz pluvial dans les systèmes de production du lac Alaotra. Les systèmes SCV (semis direct avec couverture végétale) : une alternative viable pour une agriculture pluviale durable*. Communication submitted to the African Rice Congress, Bamako, Mali, March 2010.
35. RABARY, B., SALL, S., LETOURMY, P., HUSSON, O., RALAMBOFETRA, E., MOUSSA, N., CHOTTE, J-L., (2008). *Effects of living mulches or residue amendments on soil microbial properties in direct seeded cropping systems of Madagascar*. Appl. Soil Ecol. 39, 236 – 243.
36. RABOIN L.M., RAMANANTSOANIRINA A., DZIDO J.L., RADANIELINA T., AHMADI N., (2010). *Upland (aerobic) rice breeding for the harsh environment of the High Plateau of Madagascar*. Communication submitted to the African Rice Congress, Bamako, Mali, March 2010.
37. RAKOTONDRAMANANA, MOUSSA N., RAVELONARIVO R. (2006). *Possibilités d'adoption et de diffusion de semis direct sur couverture végétale permanente (SCV) dans les actions du PLAE*: Antenne 2 SOAVINA (Amoron'i Mania). ANTANANARIVO. GSDM
38. RAKOTONDRAMANANA (2007). *Rapport de mission dans le Sud Ouest du 6 au 8 mars 2007 dans le cadre du suivi du projet PACA et des activités de TAFA.* ANTANANARIVO. GSDM.
39. RAKOTONDRAMANANA, RAZAFINTSALAMA H. (2008).*Rapport de mission au sein du projet FASARA Ambovombe du 30 juin au 11 juillet 2008.* ANTANANARIVO. GSDM.
40. RAKOTONDRAMANANA. (2009). *Rapport de mission au sein du projet BVPI-SEHP du 24 août au 5 septembre 2009*. ANTANANARIVO: GSDM.
41. RAVONISON L. N. (2009). *Les systèmes de cultures à base de riz pluvial dans le Moyen Ouest du Vakinankaratra*. Atelier Riz SCRiD Antsirabe 14 et 15 octobre 2009. Centre FAFIALA, CVS, ANTSIRABE.
42. RAUNET M. (1998). *Cartes et photographies des paysages de Madagascar, Milieu physique et érosion*. CIRAD Montpellier.
43. RAZAFIMBELO T.M., ALBRECHT A., BASILE I., BORSCHNECK D., BOURGEON G., FELLER C., FERRER H., MICHELLON R., MOUSSA N., MULLER B., OLIVER R., RAZANAMPARANY C., SEGUY L., SWARC M., (2006). *Etude de différents systèmes de culture à couverture végétale sur le stockage du carbone dans un sol argileux des Hautes Terres de Madagascar*. Etudes et Gestion des sols, Volume 13,2. p113-127
44. RAZAFINDRAKOTO C.R., RAKOTOARISOA H. L., RAZAFINDRAKOTOMAMONJY A. (2008). *Evolution de l'entomofaune et de l'abondance d'Heteronychus (Scarabaeidae - Dynastinae) sur riz pluvial sous couverture végétale morte et contrôle biologique de ce ravageur par utilisation de Metharizium anisoplae à Madagascar. séminaire international Antananarivo 3 - 8 décembre 2007*, Terre Malgache N° 26 spécial semis direct, Université d'Antananarivo, Ecole Supérieure des Sciences Agronomiques.
45. RAZAFINDRAKOTO C.R., RAKOTOARISOA H. L., (2009). *Synthèse des résultats sur l'utilisation du Matarhizium anisoplae dans le cadre de la lutte biologique contre Heteronychus plebejus sur les cultures pluviales dans la région d'Alaotra*. AMOHITSILAOZANA, FOFIFA-CALA
46. SEGUY L. (2008). *Rapport de mission à Madagascar du 12 mars au 9 avril 2008: Evaluations des actions et aide à la programmation du GSDM et des projets BV LAC et BVPI et des projets en cofinancements.* CIRAD PERSYST, Montpellier.

47. SEGUY L., HUSSON O., CHARPENTIER H., BOUZINAC S., MICHELLON R., CHABANNE A., BOULAKIA S., TIVET F., NAUDIN K., ENJALRIC F., RAMAROSON I., RAKOTONDRAMANANA. (2009). *Principes et fonctionnement des écosystèmes cultivés en semis direct sur couverture végétale.* Manuel pratique du semis direct à Madagascar, Vol. I, Chap. 1. http://agroecologie.cirad.fr/.
48. SEGUY L., HUSSON O., CHARPENTIER H., BOUZINAC S., MICHELLON R., CHABANNE A., BOULAKIA S., TIVET F., NAUDIN K., ENJALRIC F., CHABIERSKI S., RAKOTONDRALAMBO P., RAKOTONDRAMANANA. (2009). *La gestion des écosystèmes cultivés en semis direct sur couverture permanente.* Manuel pratique du semis direct à Madagascar, Vol. I, Chap. 2. http://agroecologie.cirad.fr/
49. Site internet FAO Grassland: http://www.fao.org/ag/AGP/AGPC/doc/Gbase/data/pf000070.htm
50. TAFA (2010). *Capitalisation des acquis en systèmes de cultures sous couverture végétale permanente (SCV)*, ANTSIRAE, ONG TAFA.

ANNEX I: TAFA MODULES OF TRAINING IN CA

Module 1: INITIATION IN AGROECOLOGY FOR THE EXECUTIVES OF AN INSTITUTION

Audience:
Technical, administrative, and financial executives of an institution, an organization, and a development operator.

Objectives:

- To enable executives /decision makers, and officers of the institution to which they belong, acquiring one first theoretical knowledge and a brief outline of the agro ecological approach and techniques and of the systems of cultivation under cover crops (CA).
- To present the probable advantages of CA; to assess the constraints and to measure the possible impacts of their application.

Length: 3 days

Content:
2 days for theoretical sensitization:

- Status and constraints of the Farming in the Southern Coubtries,. The situation of the Malagasy Agriculture and national strategies to face the major concerns of the Sector.
- History of CA all over the world and in Madagascar: the institutional scheme organized for consolidating and promoting such systems in Madagascar.
- The major principles of agro ecology and of CA.
- Their advantages and constraints: their agronomic, socioeconomic, and ecological impacts.
- The diverse systems proposed in response to the major stakes of development and management of Natural Resources in Madagascar.
- The diffusion of CA in Madagascar: strategies, constraints, and perspectives.

1 field visit day: commented visit of a TAFA Site and of plots/ lands of our partners.

Training Location:
TAFA intervention Zones (Antsirabe, Toliara, Manakara, Lac Alaotra) according to the choice of training takers and during the crop season (best from January to March).

Training Cost: Ariary 105, 000 per participant, for a group of 8 to 15 individuals per session.
Accommodation, catering, and transportation to the training location are paid for by recipients

Module 2: LONG TERM TRAINING FOR ENGINEERS

Audience: Engineers in Agronomy

Objectives:

- To know the basic principles of agro ecology;
- To know a wide range of cropping systems under cover crops (CA) adapted to the various ecologies of Madagascar;
- To identify and complete the technical itineraries of CA systems adapted to the various ecologies of Madagascar and to the various farming constraints;
- To establish a diagnosis of farming and to propose appropriate systems
- To supervise and to coordinate technicians for a diffusion of CA;
- To acquire the capacities for sensitizing and initiating farmers in practicing CA.

Length: 12 months

Content

The module is divided into three distinct units:

The theoretical and practical bases in CA

- History of CA all over the world and in Madagascar, the basic principles of various ecosystemic functions of cover crops, the different cover crops, the different types of CA, the different conditions for success in CA,
- The various cultivation operations required by CA (diagnosis of plots, seeding, crop maintenance, harvest and post harvest)

The various systems in CA

- The various systems adapted to each ecology of Madagascar: in areas with medium altitude climate with long dry season (Lac Alaotra and the Middle West), in areas with sub tropical altitude climate with cold season (on the High Lands), in areas with semi arid climate with long dry season (South West)), and in areas with humid tropical climate (South East).
- The various CA systems adapted to each landscape unit (from tanety to lowlands), and to each initial soil fertility (from rich to poor soil);
- The various CA systems facing the various stakes of Madagascar:
  - Systems without input and intensive systems,
  - Alternatives to *tavy*
  - Management of paddies fields with poor water control,
  - Integration agriculture-livestock,
  - Reclamation of low fertility soils,
  - Fight against plant pests,
  - Small scale mechanization

Approach for diffusing CA

- Land based approach: landscape interpretation, rapid initial diagnosis of plots and landscape before intervention, setting up of demonstration plots, and integration of systems at the level of farming and landscape
- Lanscape management: protection of watersheds, hedges and trees management, tree plantation, stabilization of *lavaka*, installation of pastures …
- Collection and registration of data, data processing and presentation of results.

Pedagogical Methods

The training will combine varied pedagogical situations:

- Alternation of *intra muros* theoretical parts and practices on the field;
- Compared studies and analyses of many concrete cases;
- Field practices of the various cultivation operations required by CA;
- Better use of the experience of recipients;
- Visits of sites, plots, farming, and village landscape in various areas of Madagascar;
- Exchanges and discussions with various structures and professionals on the field.

Training Location
In all the intervention areas of TAFA: Antsirabe, Toliara, Manakara, Lac Alaotra)

Training Cost : Ariary 8, 640, 000 per participant, for a group of maximum 12 individuals per session
Accommodation, catering, and transportation to the training location are paid for by recipients.

Module 3: LONG TERM TRAINING FOR TECHNICIANS

Audience: Technicians in Agriculture

Objectives:

- To know the basic principles of agro ecology and of the cropping systems under cover crops (CA)
- To know a wide range of CA systems adapted to the ecology of Madagascar;
- To acquire the capacity of completing technical itineraries in CA adapted to an ecology of Madagascar;
- To conduct an action for diffusing CA in one's intervention area;
- To be able to sensitize and supervise farmers in CA practice.

Length : 12 months

Content:

The module is divided into three distinct units:

The theoretical and practical bases in CA

- History of CA all over the world and in Madagascar, the basic principles of CA, the various ecosystemic functions of cover plants, the various types of CA, the various conditions of success in CA,
- The various cultivation operations required by CA (diagnosis of plots, seeding, crop maintenance, harvest and post harvest);

The various systems in CA

- The various systems adapted to a well defined ecology of Madagascar: areas with medium altitude climate with long dry season (Lac Alaotra and the Middle West), or in areas with sub tropical climate altitude with cold season (on the High Lands), or in areas with semi arid climate with long dry season (South West), or in areas with humid tropical climate (South East).
- The various CA systems adapted to each landscape unit (from *tanety* to lowlands), and to each initial soil fertility (from rich to poor soil);
- The CA that may be proposed in systems without input and that are intensive
- Small scale mechanization
- The various systems facing the various stakes in the training area.

The approach for diffusing CA

- Landscape based approach: setting up of demonstration plots and integration of systems at the level of farming and landscape
- Lanscape management: protection of watersheds, hedges and trees management, tree plantation, stabilization of *lavaka*, installation of pastures …
- Collection and registration of data (monitoring sheets, survey sheets …)

Pedagogical Methods:

- The training will combine varied pedagogical situations:
- Alternating *intra muros* theoretical parts and field practices;
- Comparative studies and analyses of many concrete cases;
- Field practices of the various cultivation operations required by CA;
- Better use of the recipient experience;
- Visits of sites, plots, farming, and village land in their intervention area;
- Exchanges and discussions with various structures and field professionals.

Training Location:

TAFA Intervention Areas: in Antsirabe or in Toliara or in Manakara or in the Lac Alaotra area

Training Cost : Ariary 5, 040, 000 per participant, for a group of 3 to 5 individuals per session per area in maximum
Accommodation, catering, and transportation to the training location are paid for by recipients

Module 4: SEQUENTIAL TRAINING

Audience: Agricultural Engineers and Technicians

Objectives:

- To know the basic principles of agro ecology and of the cropping systems under cover crops (CA)
- To know a range of CA systems adapted to an ecology of Madagascar;
- To acquire the capacity of setting up technical itineraries in CA;
- To be able to supervise farmers in practicing CA.

Proceeding:

The training consists of 4 sessions in alternation, during one growing season, and according to the availability of recipients.

Session 1: the basic principles of CA; 10 days; from July to September

Objectives: To know the basic working principles of CA

Content:

- The basic principles of CA, the various ecosystemic functions of cover crops, the various cover crops, the various types of CA, the conditions of success in CA,
- The various cultivation operations required by CA (diagnosis of plots, seeding , crop maintenance, harvest and post harvest);
- The diverse systems adapted to a well defined ecology of Madagascar: areas with medium altitude climate with long dry season (Lac Alaotra and the Middle West), or in areas with sub tropical altitude climate with cold season (on the High Lands), or in areas with semi arid climate with long dry season (South West), or in areas with humid tropical climate (South East).

Session 2: Field preparation and setting up; 5 days; from September to October

Objectives: Complete and succeed in setting up the CA.

Content:

- Initial plot diagnosis (indicator plant, cultivation profile, etc…) and choice of cropping systems
- Control of cover crops (schedule and methods used) and weed control;
- Preparation of seeds cuttings (coating, treating with hot water or with acid, inoculation, root or grain coating in a protecting preparation…);
- Manure input (quantity, spreading mode …);
- Seeding modes (preparation of seed bed, density…);
- Handling of diverse materials (seeders, seeding wheel, planting stick, sprayer…).

Session 3: Maintenance and setting up of second cycle crops; 5 days; from January to February.

Objectives:

- Crop maintenance
- Be to able implemente a second cycle crops.

Content:

- Diagnosis of the sanitary status of crops in vegetation;
- Weed control;
- Fertilizer application and nutrient shortage
- Prevention and fight against crop pests and diseases;
- Relay cropping and 2nd cycle crops

Session 4: Counter season crops, harvest of food crops and cover crops; 4 days; from March to May.

Objectives:

- Complete and succeed in the harvest and post harvest activities
- Set up counter season crops

Content:

- Appropriate time of operations;
- Operation for harvest and post harvest of food crops and cover crops;
- Management of crop residues and cover crops during dry season;
- Setting up of counter season crops;
- Yield sampling and calculation of production;
- Economic analyses (Production cost, gross margin, net margin …)

Pedagogical Methods:

- The training will combine varied pedagogical situations:
- Alternating training with TAFA and direct practices by recipients;
- Comparative studies and analyses of many concrete cases;
- Field practices of various cultivation operations required by CA;
- Better use of recipient experience;
- Exchanges and discussions with various structures and field professionals.

Training Location:

TAFA intervention areas: Antsirabe, Toliara, Manakara, Lac Alaotra ; according to the ecology of recipient intervention area.

Training Cost : Ariary 1, 125, 000 per participant, for a group of 5 to 10 individuals per session and per area.
Accommodation, catering, and transportation to the training location are paid for by recipients
It would be beneficent to have periodical support by TAFA, based on a partnership convention, during the various cultivation phases, in recipient intervention areas.

Module 5: PRACTICAL TRAINING FOR FARMERS

Audience:
Farmers, training farmers, animating farmers, pilot farmers….

Objectives:

- To know the CA basic principles
- To know the CA systems and complete main technical itineraries adapted to one's land;
- And to be able to sensitize and initiate other farmers

Length: 2 days; during an agricultural season and according to recipient availability.

Content:

- Understanding of CA principles and working bases
- Knowing the issues in one's land
- Installing and conducting some itineraries

Pedagogical Methods:
The module will combine:

- Field practices of various cultivation operations required by CA
- Better use of farmer experience

Training Location :

- TAFA intervention areas: Antsirabe, Toliara, Manakara, Lac Alaotra
- Or in areas /farming chosen by recipients.

Training Cost: Ariary 82, 000 per participant, for a group of 8 to 15 individuals per session.
Periodical support by TAFA, based on a partnership convention, during the various cultivation phases may be set up in order to consolidate what has been acquired.
Accommodation, catering, and transportation to the training location are paid for by recipients

Module 6: SMOLDERING

Audience:
Engineers, technicians, agricultural advisors, rural leaders, trainers and farmers

Objectives:

- To acquire the general principles of smoldering
- To control smoldering practice

Length: 2 days

Content:

2 intra muros half- days:

- The aim and the general principles of smoldering,
- Choice of fuels and combustion,
- The various systems practiced after smoldering,
- The results acquired from smoldering according to ecologies.

2 field half days: practice of various required operations

Pedagogical Methods:

The module will combine:

- Alternating theoretical parts and field practices;
- Field practices of various operations required by smoldering;
- Better use of recipient experience.

Training Location:

- TAFA Intervention Areas: Antsirabe, Manakara, Lac Alaotra
- Or in areas /farming chosen by recipients.

Training Cost: Ariary 88, 000 per participant, for a group of 8 to 15 individuals per session.
Accommodation, catering, and transportation to the training location are paid for by recipients
It would be beneficent to have periodical support by TAFA, based on a partnership convention, during the various cultivation phases, in recipient intervention areas.

Module 7: FIGHT AGAINST PLANT PESTS

Audience:
Engineers, agricultural technicians and trainers, who have already practiced the cropping systems under cover crops (CA)

Objectives:
To know the main CA systems enabling fighting against plant pests and weeds

Length: 4 days; from October to April according to recipient availability.

Content:

- Identifying the weeds and knowing plant biology « plant pests » (Striga, Imperata, Cyperus…)
- Choice of CA systems according to ecology, environment, and constraints
- The results previously acquired by TAFA according to the various ecological areas.

Pedagogical Methods:
The module will combine:

- Alternating theoretical parts and *intra muros* directed work, and field practices;
- Visits and exchanges with various structures and field professionals
- Enhancement of recipient experience

Training Location:

- TAFA Intervention Areas: Antsirabe, Toliara, Manakara, Lac Alaotra, according to the ecology of recipient intervention area.
- Or in areas /farming chosen by recipients.

Training Cost: Ariary 188, 000 per participant, for a group of 8 to 12 individuals per session.
Accommodation, catering, and transportation to the training location are paid for by recipients
It would be beneficent to have periodical support by TAFA, based on a partnership convention, during the various cultivation phases, in recipient intervention areas.

Module 8: CROP PROTECTION AND CA

Audience:

Engineers, agricultural technicians and trainers, who have already practiced the cropping systems under cover plant (CA)

Objectives:

To know the main CA systems enabling to fight against diseases and crop ravagers

Length: 4 days; during the whole agricultural season, according to recipient availability

Content:

- Identifying the main diseases (blast disease, Helminthosporium…) and the main insects devastating crops (Heteronycus, white worm…) and knowing their biology
- Choice of CA systems according to ecology, environment, and constraints
- Means of fighting diseases and insects (cover crops various treatments…)
- The results previously acquired in the various ecological areas.

Pedagogical Methods:

The module will combine:

- Alternating theoretical parts and *intra muros* directed work, and field practices;
- Visits and exchanges with various structures and field professionals
- Enhancement of recipient experience

Training Location:

- TAFA Intervention Areas: Antsirabe, Toliara, Manakara, Lac Alaotra
- Or in areas /farming chosen by recipients.

Training Cost : Ariary 235, 000 per participant; for a group of 8 to 15 individuals per session.
Accommodation, catering, and transportation to the training location are paid for by recipients
It would be beneficent to have periodical support by TAFA, based on a partnership convention, during the various cultivation phases, in recipient intervention areas.

Module 9: TAVY ALTERNATIVE METHODS

Audience:
Engineers, agricultural technicians and trainers, who have already practiced the CA

Objectives:
To know the main CA systems enabling reducing itinerant agriculture and settling it

Length: 4 days; from January to April

Content:

- Clearing without burning
- Soil protection
- Dressing of crops under tavy
- Reclamation of deteriorated soils after tavy
- The results acquired according to ecologies.

Pedagogical Methods:
The module will combine:

- Alternating theoretical parts and *intra muros* directed work, and field practices;
- Visits and exchanges with various structures and field professionals
- Enhancement of recipient experience

Training Location:

- TAFA Intervention Areas: Antsirabe, Toliara, Manakara, Lac Alaotra
- Or in areas /farming chosen by recipients.

Training Cost: Ariary 160, 000 per participant; for a group of 8 to 12 individuals per session.
Accommodation, catering, and transportation to the training location are paid for by recipients
It would be beneficent to have periodical support by TAFA, based on a partnership convention, during the various cultivation phases, in recipient intervention areas

Module 10: RECLAMATION OF DETERIORATED SOIL

Audience:
Engineers, agricultural technicians and trainers, who have already practiced the CA

Objectives:
To identify the constraints in various soils and to know the main systems of cultivation under cover crops (CA) enabling reclaiming the deteriorated and abandoned spaces

Length: 4 days; from January to April

Content:
Smoldering

- Improvement of fallow by cover plants
- Improvement of cultivation profiles in organic matter
- Integrating tree – cover plant
- The cropping systems in CA with the various manure levels
- The results acquired according to the various ecological areas.

Pedagogical Methods:
The module will combine:

- Alternating theoretical parts and *intra muros* directed work, and field practices;
- Visits and exchanges with various structures and field professionals
- Enhancement of recipient experience

Training Location:

- TAFA Intervention Areas: Antsirabe, Toliara, Manakara, Lac Alaotra
- Or in areas /farming chosen by recipients.

Training Cost: Ariary 160, 000 per participant, for a group of 8 to 12 individuals per session.
Accommodation, catering, and transportation to the training location are paid for by recipients
It would be beneficent to have periodical support by TAFA, based on a partnership convention, during the various cultivation phases, in recipient intervention areas.

Module 11: CA AND LIVESTOCK

Audience:

Engineers, agricultural technicians and trainers, who have already practiced the CA

Objectives:

- To integrate agriculture with livestock and appraise the management of biomasses;
- To improve food crop and fodder production;
- To enhance fodder cover crops

Length: 4 days; from January to April

Content:

- The various fodder cover plants
- Fodder production in CA
- The results acquired according to ecologies
- Improvement of cover crops as fodder
- Relationship between composting and manure pits with the management of organic matter in CA

Pedagogical Methods:

The module will combine:

- Alternating theoretical parts and *intra muros* directed work, and field practices;
- Visits and exchanges with various structures and field professionals
- Enhancement of recipient experience

Training Location :

- TAFA Intervention Areas: Antsirabe, Toliara, Manakara, Lac Alaotra
- Or in areas /farming chosen by recipients.

Training Cost: Ariary 172, 000 per participant, for a group of 8 to 12 individuals per session
Accommodation, catering, and transportation to the training location are paid for by recipients
It would be beneficent to have periodical support by TAFA, based on a partnership convention, during the various cultivation phases, in recipient intervention areas.

Module 12: RICE CULTIVATION

Audience:
Engineers, agricultural technicians and trainers, who have already practiced the CA

Objectives:
To consolidate the agronomic knowledge in rice cultivation on *tanety* and in lowlands

Length: 5 days; from November to April

Content:

- Irrigated rice cultivation: systems of intensive rice cultivation (SRI) and improved rice cropping systems (SRA);
- Improvement of paddies fields with poor water control (RMME);
- Rain fed rice and CA;
- The results acquired by TAFA according to the ecological areas.

Pedagogical Methods:
The module will combine:

- Comparative studies and analyses of many concrete cases;
- Enhancement of recipient experience;
- Field visits and practices ;
- Discussions with field professionals.

Training Location:

- TAFA Intervention Areas: Antsirabe, Toliara, Manakara, Lac Alaotra
- Or in areas /farming chosen by recipients.

Training Cost: Ariary 205, 000 per participant, for a group of 8 to 12 individuals per session.
Accommodation, catering, and transportation to the training location are paid for by recipients
It would be beneficent to have periodical support by TAFA, based on a partnership convention, during the various cultivation phases, in recipient intervention areas.

Module 13: SEED PRODUCTION IN CA

Audience:

Engineers, agricultural technicians and trainers, who have already practiced the CA

Objectives:

- To build the capacity of recipients on quality seed production by using the systems on plant cover (CA):
- To produce food crop seeds and cover plants
- To control the CA techniques required for the production of quality seeds;
- To propose seed conservation methods.

Length: 4 days ; all along the year

Content:

- Definition and interest of good quality seeds;
- The components of the quality of seeds;
- The techniques required for the production of quality seeds (choice of plots, conduct, monitoring and harvest);
- The post harvest treatments;
- The storage of seeds;
- The CA systems adapted to the various agro ecological conditions.

Pedagogical Methods:

The module will combine:

- Comparative studies and analyses of many concrete cases;
- Enhancement of recipient experience;
- Field visits and practices.

Training Location:

- TAFA Intervention Areas: Antsirabe, Toliara, Manakara, Lac Alaotra
- Or in areas /farming chosen by recipients.

Training Cost: Ariary 205, 000 per participant, for a group of 8 to 12 individuals per session
Accommodation, catering, and transportation to the training location are paid for by recipients
It would be beneficent to have periodical support by TAFA, based on a partnership convention, during the various cultivation phases, in recipient intervention areas.

Module 14: Vegetable growing under CA

Audience:
Engineers, agricultural technicians and trainers, who have already practiced the CA

Objectives
To consolidate the agronomic knowledge in vegetable (tomato, cabbage, bean, peas, potato, leafy vegetables, onion…)

Length: 5 days, all over the year.

Content:

- Recall of agroecology principles
- Vegetables
- Smoldering;
- Mulching (crop residue, cover plant)
- The results acquired according to ecologies

Pedagogical Methods:
The module will combine:

- Comparative studies and analyses of many concrete cases;
- Enhancement of recipient experience;
- Field visits and practices.

Training Location:
TAFA Intervention Areas: Vakinankaratra (Antsirabe)

Training Cost: Ariary 235, 000 per participant, for a group of 8 to 12 individuals per session.
Accommodation, catering, and transportation to the training location are paid for by recipients
It would be beneficent to have periodical support by TAFA, based on a partnership convention, during the various cultivation phases, in recipient intervention areas.

Module 15: CULTIVATION OF FRUIT TREES

Audience:
Engineers, technicians and trainers, farmers

Objectives:
To consolidate one's agronomic knowledge in cultivation of fruit trees (apple tree, plum tree, orange tree…)

Length: 3 days, all over the year

Content:

- Recall of agro ecology with plant interactions
- Cultivation of fruit trees
- Smoldering;
- Cover plants, auxiliary plants and/ or related plants
- The results acquired according to ecologies

Pedagogical Methods:

- Comparative studies and analyses of many concrete cases;
- Enhancement of recipient experience;
- Field visits and practices.
- The module will combine:

Training Location:
TAFA Intervention Areas: Vakinankaratra (Antsirabe)

Training Cost: Ariary 165, 000 per participant, for a group of 8 to 12 individuals per session
Accommodation, catering, and transportation to the training location are paid for by recipients
It would be beneficent to have periodical support by TAFA, based on a partnership convention, during the various cultivation phases, in recipient intervention areas.

CUSTOMIZED TRAINING

Training sessions may also be organized according to specific lengths and themes depending on recipient needs.

Cost:
Ariary 350, 000 per day
Accommodation, catering, and transportation to the training location are paid for by recipients
In case of training outside of TAFA agency areas, the Trainer Per Diem is Ariary 50, 000 per day and the travel expense is Ariary 1,000 /Km.

POST TRAINING MONITORING AND SUPPORT

All training may be subject to post training monitoring with probable refreshing sessions adjusted to the identified needs, and organization of support.

Cost:
Ariary 350, 000 per day
In case of training outside of TAFA agency areas, the Trainer Per Diem is Ariary 50, 000 per day and the traval expense is Ariary 1,000 /Km.

OTHER SERVICE PROVISIONS BY TAFA
EXPERTISE AND SUPPORT –ADVICE

Through its teams, TAFA proposes in addition a support for the following interventions:

- Environment diagnosis, identification of issues and stakes,
- identification and preparation of technical itineraries,
- identification of sites and operational field partners,
- programming of the multiplication of the necessary plant material and of the supply of specific input
- programming of the development of field devices
- identification and programming of required training
- planning of periodical monitoring for supporting and accompanying activities.

Expertise will be made in keeping with a partnership convention.

Cost:
Ariary 350, 000 per day
In case of training outside of TAFA agency areas, the Trainer Per Diem is Ariary 50, 000 per day and the travel expense is Ariary 1,000 /Km.

DEVELOPMENT OF CROPPING SYSTEMS
TAFA creates cropping systems under plant cover and in direct seeding, the objective of which is a productivity that is higher, more stable, and more diversified; at lesser cost compatible with the practice of a sustainable and profitable agriculture.

In collaboration with the research or development organizations, TAFA may test, research or adapt in CA various crops (food or cash crops) with diverse intensification methods and diverse systems:

TO CONTACT TAFA NGO

HEAD OFFICE
ONG TAny sy FAmpandrosoana
Lot: 906 B 335 Ampihaviana
BP 266 -110 ANTSIRABE - Madagascar
Tel: (+261) 20 44 496 30
(+261) 20 44 491 59
Email: tafaantsirabe@moov.mg

Agency of Vakinankaratra
Narcisse MOUSSA
Lot: 906 A 165 Ampihaviana BP 266
110 ANTSIRABE - Madagascar
Tel: (+261) 20 44 496 30
tafaantsirabe@moov.mg

Agency of Manakara
Martin RANDRIAMITANTSOA
Lot: 3 H 107 Ambalakazaha Sud
316 MANAKARA - Madagascar
Tel: (+261) 20 72 216 71
tafamanakara@moov.mg

Agency of Toliara
Hubert RAZAFINTSALAMA
Lot: Villa Cécile route de Manombo
(Anketa Bas), BP 252
601 TOLIARY - Madagascar
Tel: (+261) 20 94 413 40
tafatoliara@moov.mg

Agency of Lac Alaotra
Céléstin RAZANAMPARANY
Lot :10 208 Ambohimasina
503 Ambatondrazaka - Madagascar
Tel: (+261) 20 54 815 52
tafaambato@moov.mg

ANNEX II: CODE FOR DESCRIBING CA SYSTEMS

A text code enables defining with precision the various systems:

- crop associations are indicated by a "+", whether seeding of the main crop and the associated is made at the same time or delayed (crop "with a time interval": seed of the cover crop or the related crop some weeks after seeding the main crop);
- the various crop years (inter annual successions) are separated by "//";
- the successions of intra annual crops are indicated by a "/", the second crop being sowed some days or some weeks after the harvest of the first one (or some weeks before, in "relay"), but during the same year.

For example, "Maize + cowpea // rice / Dolicos lablab" indicates crop successions with maize associated with cowpea that is followed the following year by rice followed by Dolicos lablab in the same year.

- In the case of very intensive systems (case of volcanic soils of high lands) in which a crop succession takes place in association with a longer cycle crop, the succession is indicated between square brackets: "Maize + [bean/potato + oat]" for example indicates a system in which maize is planted with bean. On the harvest of bean, potato is associated with oat, in the maize still in place;
- The systems on live covers are indicated as such ("Bean on kikuyu" for example), except in case of implantation of live cover in year "zero", that will be considered as a plant association ("Maize + desmodium" for example, that will be followed in year 1 by "Maize on desmodium");

ANNEX III: CONDITIONS OF THE AGREEMENT BETWEEN FAO AND GSDM

ORGANISATION DES NATIONS UNIES
POUR L'ALIMENTATION ET L'AGRICULTURE

FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS

epresentation in Madagascar, in the Comoros,
in Mauritius Island and in the Seychelles

159, Route Circulaire (Ankorahotra), Facsimile: +(261 20) 22 343 88 Telephone: +(261 20) 22 288 31/ 22 283 12
B.P. 3971 – Antananarivo, MADAGASCAR E-mail : FAO-MG@fao.org / 22 621 51

1. **Context**

The OSRO/RAF/904/USA Project will support the documentation and the evaluation of the previous and ongoing activities on conservation agriculture de. Desk and field visit works will be combined in completing the present documentation work. Knowing the ongoing activities, the practices and approaches used will be essential to define an appropriate intervention in the future.
The social and economic context will be taken into account during the analysis of such practices and approaches.
The synthesis at the national level will be consolidated with the documents of the other countries at the regional level. Sessions for diffusing the lessons learnt and the best practices to the various stakeholders including the farmers, the interveners and the decision makers will be organized.

2. **Mandate**

2.1 Description of Activities/Services

1- Review and analysis of Conservation Agriculture in Madagascar :
   a) *The roles and capacities of stakeholders in promoting conservation agriculture*
   b) *Extent of the practice of Conservation Agriculture techniques*
      i. *Geographical coverage (previous and ongoing activities)*
      ii. *Number of targeted beneficiaries*
      iii. *Financial resources (past and present)*
      iv. Performances of Conservation agriculture techniques against with the biophysical conditions, in particular the precipitations and the soils.
      v. Performances of CA techniques against the socioeconomic conditions, in particular genders and HIV/AIDS
      vi. *Type and performance of conservation agriculture techniques practiced in the past and currently for the small and average scale farmers;*

vii. *Impact of conservation agriculture at the level of household and that of community*
viii. *Opportunities and constraints encountered by interveners in using the various techniques developed.*

c) Adequacy of the various models or approaches used to promote the AC techniques by diverse interveners.
d) *Policy and socioeconomic environment and institutionalization of conservation agriculture*

2- Synthesis and Writing out;
3- Consultation with stakeholders: diffusion operators and partners
4- Presentation to the Task Force and validation of report;
5- Correction and edition of report: amendment of report as a function of the conclusions by the presentation workshop.

Writing out Reports

The main reports to be produced are:

- The midterm report recalling the detailed drafting plan of the document,
- The detailed statement of expenses (certified by the head accountant or by an analogous functionary of the recipient institution).

2.2 Definition of the Products

The synthesis document produced in 10 copies
Electronic file of such document

2.3 Length and Schedule

Activités	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	TOTAL
1. Revue et analyse de la documentation sur le CA																																														8 jours
2. Synthèse et rédaction																																														20 jours
3. Concertation																																														4 jours
4. Validation du rapport																																														1 jour
5. Correction et édition du rapport final																																														12 jours
																																											TOTAL	**45 jours**