RICE SECTOR SUPPORT PROJECT

(RSSP)

Republic of Ghana

Ministry of Food and Agriculture

Support mission to the R&D program for a transfer and adaptation

to the Northern regions of Ghana

of Direct Seeding Mulch based Cropping systems

18/06 – 6/07/2014

Mission Report on R&D component of the Rice Sector Support Project
Savanna Agricultural Research Institute

Stéphane Boulakia - CIRAD UR AÏDA
Equipe CSIA

Contents

Schedule of the mission

Wednesday 18th June

S. Boulakia flight from Paris to Accra (arrival 8:00 pm) – night in Accra

Thursday 19th

am Flight to Tamale (arrival 7:15 am)

pm Sowing Community's demonstration plot – upland in Nwodua

Meeting with Dr W. Dogbe (mission objectives and planning)

Friday 20th

am Visit of the 3 experimental lay outs at Nyangpala station. Discussion and adjustment of design

pm + Sowing Community's demonstration plot – upland in Jantong

Saturday 21st

am Sowing Community's demonstration plot – upland in Zugu

pm Design of Midland's demonstration plot in Zugu

Sunday 22nd

Documentation

Monday 23rd

am Field design of Upland experimentation at Nyangpala station

pm Field design of Midland-up experimentation at Nyangpala station

+ Sowing Community's demonstration plot – midland in Zugu

Tuesday 24th

am Field design of Midland-up experimentation at Nyangpala station

pm + Sowing Community's demonstration plot – midland in Nwodua

Wednesday 25th

am Harrowing and design of Community's demonstration plot – midland in Jantong

pm Sowing Community's demonstration plot – midland in Jantong

Thursday 26th

am Presentation preparation

pm Presentation and discussion with SARI's staff in charge of DMC component (technology and methodology)

Friday 27th

am Meeting with Wienco Cotton and Arima Farms Ghana Limited

pm Finalization of protocols and monitoring forms

(fields operations suspended – no rain for 8 days)

Saturday 28th

Reporting

Sunday 29th

Reporting
(some rainfall)

Monday 30th

am Manual sowing of Upland experimentation at Nyangpala station
pm (cont.) + complement and control of Community's demonstration plot – midland in Zugu

Tuesday 1st July (Ghana National Day)

am Manual sowing of Upland experimentation at Nyangpala station (end of crops' sowing)
pm Manual sowing of Midland-up experimentation at Nyangpala station

Wednesday 2nd

am Control and complement sowing of Community's demonstration plot – upland in Jantong
Manual sowing of Midland-up experimentation at Nyangpala station (end of crops' sowing)
pm Meeting with Director of SARI (evolution of the R&D programme on CA)

Thursday 3rd

am Manual sowing of Midland-low experimentation at Nyangpala station
pm Presentation (technology and R&D methodology) for USAID and IFAD's projects management teams; discussion around implementation of joint R&D program, possibly on private - public partnership

Friday 4th

am Control and complement sowing of Community's demonstration plot – upland/ midland in Zugu
pm Control and complement sowing of Community's demonstration plot – upland / midland in Nwodua
Manual sowing of Midland-low experimentation at Nyangpala station (end of rice sowing)

Saturday 5th

am Tamale – Accra
pm reporting
Accra - Amsterdam

Sunday 6th

am Amsterdam – Paris
pm Paris - Montpellier

Met persons

SARI

Dr S.K. NUTSUGAH	Director of SARI
Dr Wilson DOGBE	Director of the Rice section
Michael MAWUNYA	Scientist in charge of DMC experimentation (Station)
Elsie SARKODEE ADDO	Scientist in charge of DMC experimentation (Communities)
Sampson ALHASSAN	Technician on DMC experimentation (Station)
Dela KUADUGAH SAVIOUR	Technician on DMC experimentation (communities)
Anne PERINELLE	RSSP-SARI Junior expert – support in DMC R&D program

PCU of the RSSP

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Abbreviations and Acronyms

AFD	Agence Française de Développement
a.i.	active ingredient
AÏDA	CIRAD-Persyst's Research Unit
Brach	*Brachiaria ruziziensis*
c.c.	cover crop
CIRAD	Centre de Coopération International en Recherche Agronomique pour le Développement
Crot	*Crotalaria sp.* (*C. juncea*, *C. retusa*, *C. spectabilis, …*)
e.p.	elementary plot
IFAD	International Fund for Agriculture Development
IRAD	Institut de Recherche Agronomique pour le Développement (Cameroon)
IWAD®	Integrated Water and Agricultural Department (Wienco® Ghana Ltd.)
NRGP	Northern Region Growth Project (IFAD)
MoFA	Ministry of Food and Agriculture
RSSP	Rice Sector Support Project
SADA	Savanna Accelerated Development Authority
SARI	Savanna Agricultural Research Institute
SOC	Soil Organic Carbon
Stylo	*Stylosanthes guianensis*
TSP	Triple Super Phosphate

Sincere thanks to SARI's and PCU teams for the good organization of the mission and their warm welcome all along the stay.

Introduction

Background

This support mission to the RSSP R&D component on DMC adaptation-transfer is part of the backstopping plan established during the mission of Oumarou Balarabé and Stéphane Boulakia in October 2013. It came after the mission of Mr Abakar Madam Diogo (April 2014) that has focused on the implementation of the part of the R&D methodology conducted with and for the communities (finalization of the rapid diagnosis, establishment of village committee, discussion and programming of fields activities, programming of information, exchange and training …).

Objectives

The principal aims of the mission planned at the beginning of the rainy season consist in

- Providing direct practical advice for the experimentation implementation (based on protocols established in October 2013 for on Station and after exchanges with communities) and crops management in initial phase
- Recalling key points of the programme to be imperatively implemented in prevision of its further evolutions in 2015's cropping season
- Providing information on technology (DMC) and R&D methodology (DATE x territory participative development –cf Balarabe et Boulakia, 2013) to SARI staff newly involved in this Research-Action work
- Initiating prospective on the programme evolution and new public and private partnership to prolong on longer term and sustainable basis (after the end of the RSSP) and share the current RSSP R&D component ; in these views,
    - a short seminar has been organized during the mission to share experiences in CA fields with 2 major Rural and Ag. development projects acting in the Northern regions of Ghana (NRGP funded by IFAD and XXXX – USAID)
    - contacts have been taken with private companies acting in the regions and willing to develop agricultural production via the support to Farmers Organizations

The initially intended, during last mission, focus on large bottom valley and lake side (prospective for cropping systems design on this specific agro-ecosystem) hasn't been implemented due to time constrains.

This mission being mostly oriented on practical support to SARI's fields operation, the present report will be short and mostly consists in (i) a synthetic reminder of the key points for the on-station experimentation and on-community based tests and (ii) a prospective on operation and institutional arrangements for the prolongation, coordination and evolution of CA based R&D programme

I- Comments and recommendations on R&D programme implementation

This chapter proposes

(i) a rapid return on the overall proposed R&D methodology as it has proposed and explained during the mission Boulakia and Balarabé, (October 2013) and later on more explicitly detailed by Abakar Madam Dogo, (April, 2014) for the participation and consultation with farmers around various fields works at community's level,

(ii) some comments and protocols' adjustments for the experimentations and fields' tests implemented at Nyangpala station and on the 3 selected communities,

(iii) a reminder on 2 emergencies : seeds production and some equipment's to be locally built

I-1 Reminder on the overall methodology and practical consequence in implementation

The proposed methodology is largely based on the R&D experience conducted in North Cameroon since early 2000's.

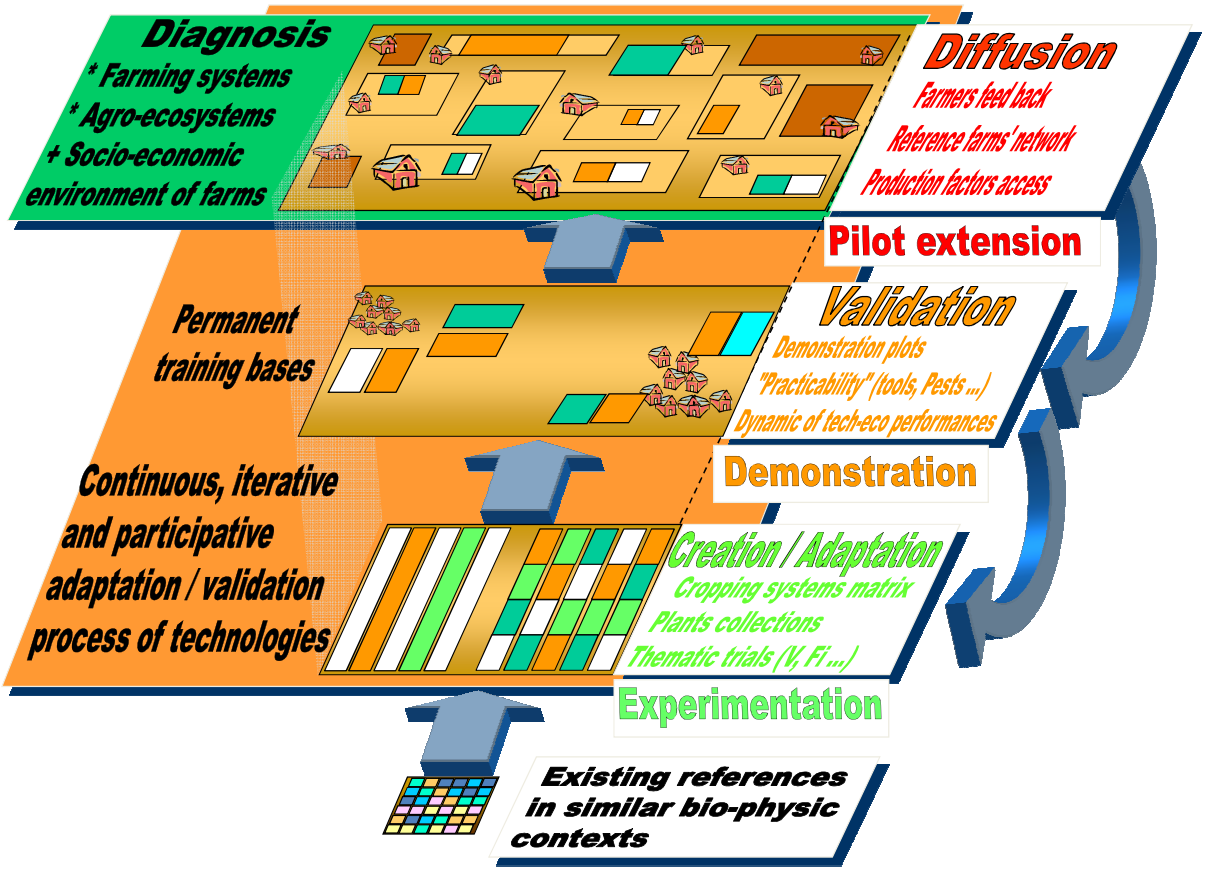


Figure 1: Organization of the DATE in an iterative process between experimentation Demonstration and pilot extension network

It can be considered as a coupling of the DATE approach (Diagnosis, Design, Assessment, Training and Extension - **Figure 1**) with a progressive concerted territory development at community level. These two works are lead jointly to induce a close interaction, an "entanglement" by crossed, mutual causalities, between

- the cropping systems introduction, adaptation and forms of adoption combined with the identification of proposals to ease the production factors (+ possibly market) access for farmers and farmers organization (identification of support measures to be taken for dissemination and up-scaling process – **Figure 2**)

- and the progressive evolution of the village territory use through consultation and negotiation between stakeholders (farmers, herders, authorities …) that are both triggered and requested by the territorial extension of the DMC based innovations (crops and fodder/ biomass production).

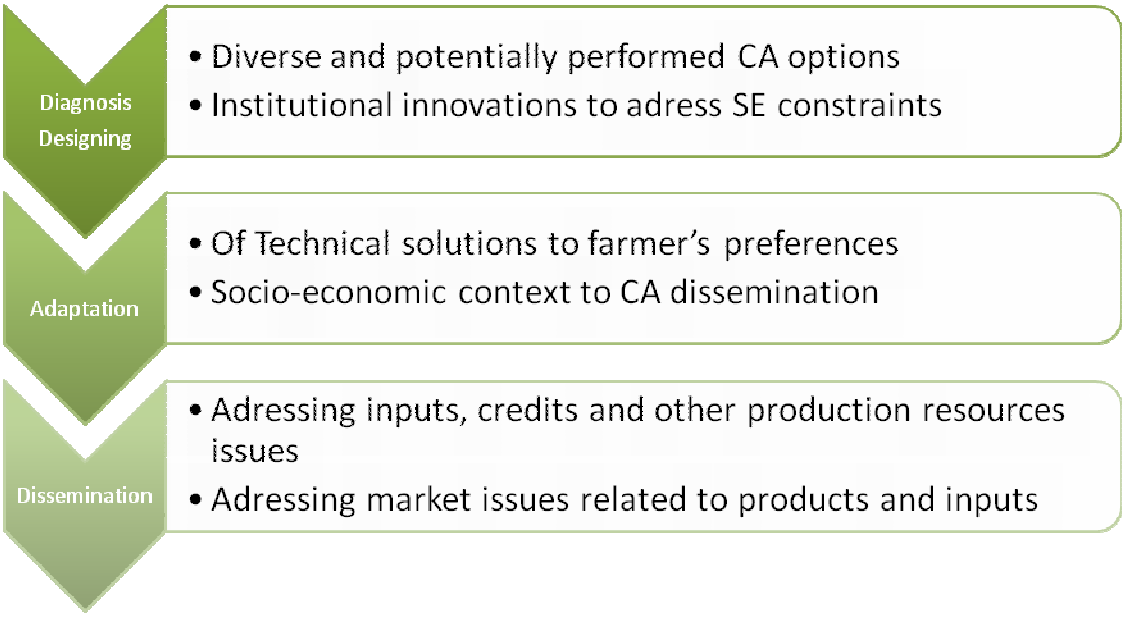


Figure 2: DATE implementation process

This Research – Action proposal eases and melts the co-construction of practices (cropping systems, livestock management), farmers organizations (production factors and market access), and new arrangements between stakeholders[1] (accrued production/ productivity opening negotiations to solve conflicts of interest via new arrangements around space allocation and natural resources management).

By plunging the collective Invention / Innovation process conducted at plot and farm level through the DATE approach into the different bio-physical (agro-ecosystems) and landuse units of the community territory (**Figure 4**), the overall method allows to address simultaneously the different scales questioned by deep, systemic changes (**Figure 3**).

[1] Inside households (men and women, young / holder), between households and farm's types

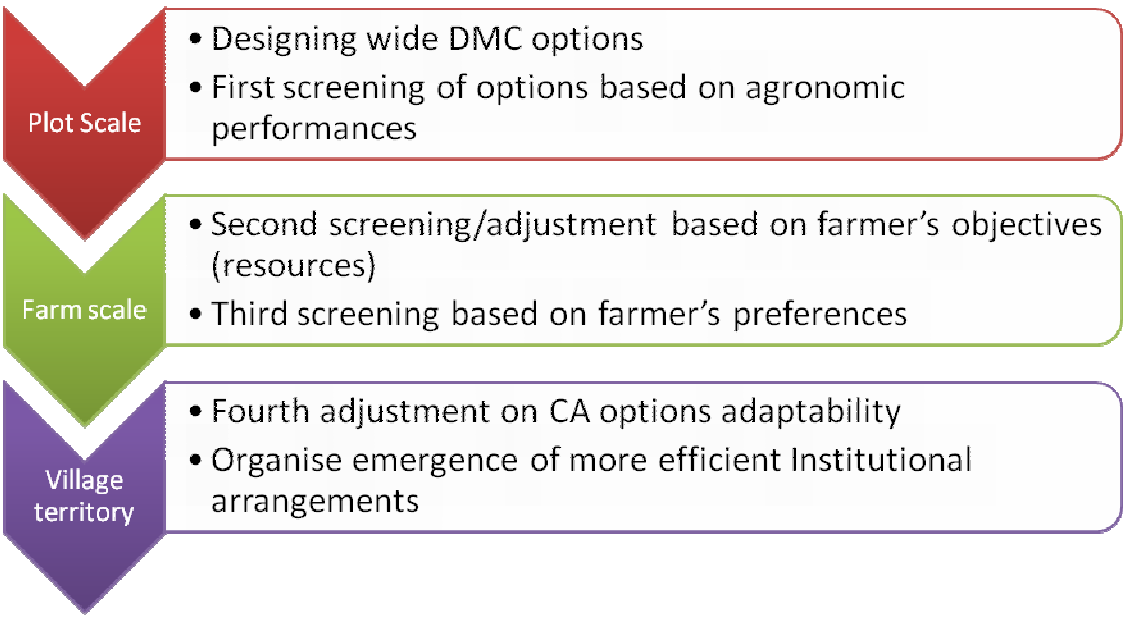


Figure3: Distribution of concomitant R & D activities according to different scales

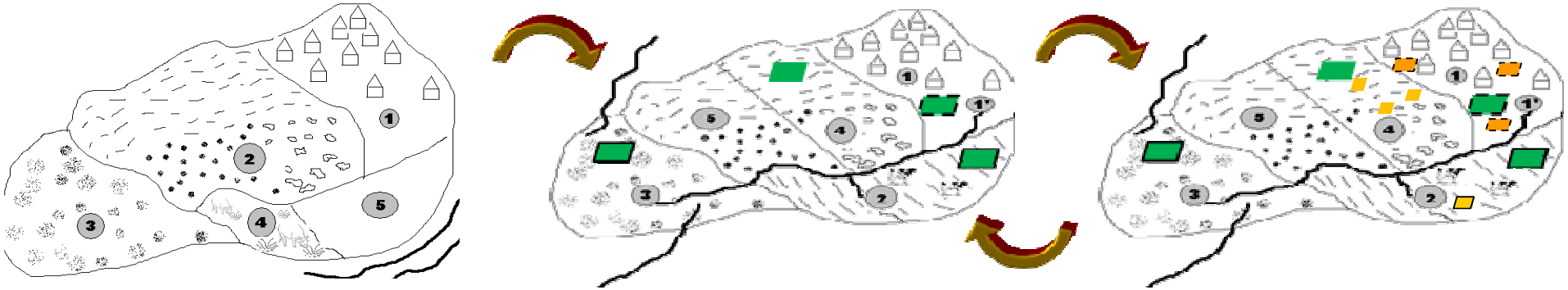
Major steps	Current state of achievement
• Field description and pilot village identification	• 3 pilot communities chosen around Tamale (< 25 km distance)
• Socio-economic diagnosis (including agricultural and livestock systems) and identification of farm household typology	• RRA carried out / gross indicator assessed (cf. Anne Perinelle et al. in Abakar report) + participatory mapping of the village's territory • Preliminary typology proposed … to be completed and précised along interaction and work with communities
• Consultative committee setting and new collective rules for negotiation	• 3 Committees set
• Pilot farmers identification and quantitative and qualitative DMC activities' programming	• 2 collective plots (upland and midland) implemented with committees in each village (Rice and Maize based systems + pure fodder/ cover crops) • No on-farm plots implemented due to lack of cover-crop seeds
• Agricultural input and technical advises providing	• First information and training sessions done for each community – programme for 2014 established
• Participative Monitoring & evaluation	• Planned along and at the end of the 2014's cropping season

Table 1: Reminder on the 6 structuring steps of the proposed methodology and current achievement stage

Figure n° 4. Coupling DATE with community's territory planning

1- village
2- Crops area
3- uncleared bush
4- grazing area
5- lowland

1- village
1'- Corral
2- pastureland
3- uncleared bush
4- crop area with strict residue control
5- crop area open to grazing
track - corridor for cattle

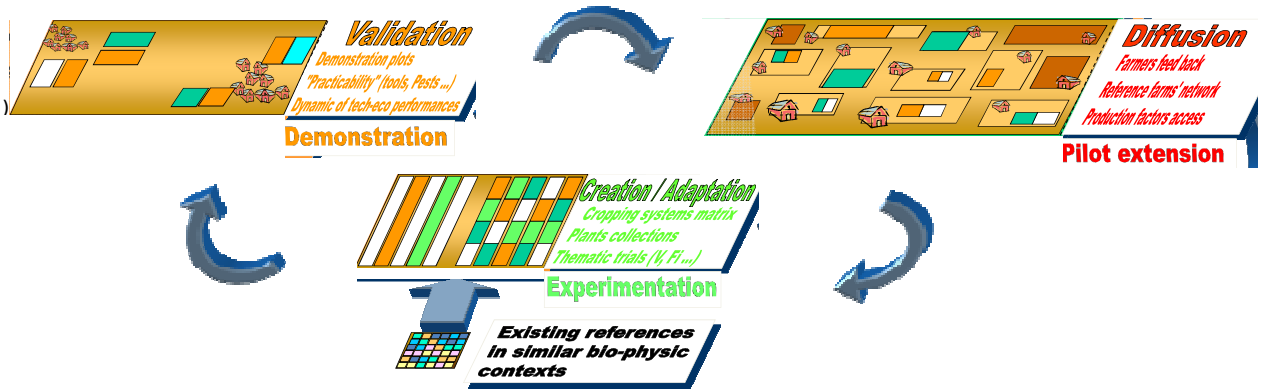


Diagnosis

Territory, Community	Agreements systems (in community, trad. Chief, State ...) rules driving space sharing, Natural Resource allocation
	Functionnal mapping (cf. methodo ZADA*)
Farm-Concession-household	Typology
	Intra rules for space allocation, labour org. ...
	Production system
Plot	Cropping systems
Herd (farmer anc	Livestocks systems
Farm economic environment	Market, Credit, Inputs, State support syst., contractor for mechanization access ...

*: ZADA - Zonage à dire d'Acteur (Y. Clouet)

*cf. **Appendix 6** on results for simple Cattle



Simple & evolutive demo. plots
on new opportunities brought by
DMC based technology
*e.g. 1/ Fodder production coupled to soil restoration**
2/ DMC of food crop after 2 years of fodder/cover

- New perspective on agro-ecosystem potential production needing concertations around space
- Sharing the production "surplus" bought by DMC triggers communities land planning and collective

Intra community negociation

On-farm - concession pilot extension
Dynamic adoption and adaptation by farmers and herders of the first technical proposals
Evolution of the demo. plots according to DMC chosen tech. orientations by farmers in the adoption process

- Differentiation and evolution of the crop + livestock systems under the "umbrella" of the agreed land allocation plan
- Progressive involvement of upper and/or external agents (paramount chief, State) allow to couple longer and more secure landuse right against higher investment (trees, lowland devpt, basal fertilizers ...)

Negociation community(ies) with external stakeholders

I-2 Nyangpala station experimentation

Preliminary remarks

The 3 protocols / lay-outs proposed during the last mission have been slightly modified; updated designs are presented in the figures 5, 6 and 7.

Fertilizers levels have been simplified due to difficulties to find Triple Super Phosphate (TSP), to be now based on the sole application of NPK 15-15-15, KCl and Ammonium Sulfate (cf. Table 2).

Due to late rain arrival no sowing had been realized prior mission arrival (19/6) in Nyangpala station; following limited precipitations (from the 23rd/6) it has been possible to sow all crops on the 3 trials. At departure (5th/7), only cover crops remained to be sown; this should be done within the best delays to increase chance to get flowering and seeds production in 2014, at the end of the rainy season (November – December). Too late sowings will postpone reproduction of the perennial species to late 2015.

It is advised for all experimentations dispatched along the topo-sequence

- to set corner stones to fix, on the long term, the limit of all elementary plots (except for treatment based on soil plowing)
- to rapidly initiate fencing with bush / trees species (Jatropha, Ziziphus sp., Cassia sp. …) and enclose some supplementary surface compare to 2014 programme in anticipation of the future activities developments (seeds production, new trials, demonstrations …)
- to have a monitoring systems to systematically record and plan all technical operations ; monitoring sheets have been proposed

I-2-1 Preliminary practical reminders (from appendix 1 of Boulakia et Balarabé, 2013)

Land preparation and site management

Take opportunity of the quasi total absence of cover crop to re-decompact profile and even surface of soil; for that make 2 passages of chisel plow, crossing each other with an angle of # 20°; keep a coarse soil surface to delay run-off.

The plow based treatment is only "chiseled" in 2014; in 2015, elementary plots are plowed in the same direction, *i.e.* tractor plow in only one way to avoid the creation of furrow (and the 3,5 m alley between blocks doesn't allow to turn without rolling on DMC plots).

The erosion gullies must be totally controlled on the experimental site (demonstration):

- implementation of cover-crop on the bund (e.g. *Brachiaria humidicola* in Midland and *B. ruziziensis* in Lowland)
- transitory small "dams" with wood sticks and cut grasses to slow down water flows in gullies between blocks and allow development of cover crops to be sown or set up by cuttings
- with arrival of new funds source, planning and implementation of a global anti-erosive plan through complete station land development and Conservation Agriculture adoption : hedges, anti-fire walls, permanent contour bunds fixed by cover (high values timber trees, bushes –fire woods, fodder-, perennial cover-fodder crops, … - cf Raunet, Seguy report, 1993).

All elementary plots (except for plow based system) are permanently delimited by concrete stones (size e.g. 60 cm high, 50 cm buried in soil, 10 cm square section).

Recommended methodology to *control large biomass (> 10 t/ha of dry matter) of Stylosanthes guianensis* prior to crops' sowing:

- the cover is rolled once or twice (according biomass) by a power tiller-draught "Rolo faca" with cutting discs (Cambodian adaptation – cf. Appendix 2 for pictures) about 30 to 40 days prior to the 1st "wished" sowing date
- a mix of 900 g/ha glyphosate + 720 g/ha 2,4 D amin is spread 10 to 15 days after rolling (after some rains)
- a complement spraying (540 g/ha + 540 g/ha of the same mix) is done within 24h right after the crop's sowing if weeds have germinated, notably in the track of the roller's cutting discs.

Seeds treatment and quality control

Dormancy alleviation of cover crop species

There is no universal seeds treatment and not all species need a treatment; in fact, mainly small legumes seeds (in the current list of manipulated species, this recommendation concerns only Stylosanthes guianensis) with thick teguments request hot water treatment. If observed problem of low germination rate after test, compare 2 treatment methodologies using "boiling" water

- the one recommended in the report of Mahamat Alifa
- 10' in "sub-boiling water" and transfer in normal temperature water (put the seeds in a piece of mosquito net for easy transfer)

Fertilizers applications

Proposition for contrasted fertilizers application are detailed in the **Table 2**

3 levels		
F0 = low, representing farmers' current practises	**F1 = # current recommandation of extension**	**F2 = "no" mineral limitation of the production** (evolutive with progressive soil improvment)
a/ basal fertilizer b/ apport en couverture (top dressing)	a/ basal fertilizer c/ apport en couverture (top dressing)	a/ basal fertilizer c/ apport en couverture (top dressing)
Maize 75 kg/ha 15-15-15 at 25 DAS 11-11-11	**Maize** 150 kg/ha 15-15-15 at 0 DAS 45-30-30 + S 50 kg/ha 15-15-15 at 25 DAS 75 kg/ha ammon. Sulf at 25 DAS	**Maize** 150 kg/ha 15-15-15 at 0 DAS 84-53-53 + S 200 kg/ha 15-15-15 at 25 DAS 75 kg/ha ammon. Sulf at 25 DAS 75 kg/ha ammon. Sulf at 40 DAS
Soybean 75 kg/ha 15-15-15 at 25 DAS 11-11-11	**Soybean** 150 kg/ha 15-15-15 at 0 DAS 30-30-45 50 kg/ha 15-15-15 at 25 DAS 25 kg/ha KCl at 25 DAS	**Soybean** 150 kg/ha 15-15-15 at 0 DAS 45-45-60 150 kg/ha 15-15-15 at 25 DAS 25 kg/ha KCl at 25 DAS
Rice 75 kg/ha 15-15-15 at 25 DAS 11-11-11	**Rice** 150 kg/ha 15-15-15 at 0 DAS 40-30-30 + S 50 kg/ha 15-15-15 at 25 DAS 50 kg/ha ammon. Sulf at 25 DAS	**Rice** 150 kg/ha 15-15-15 at 0 DAS 74-53-53 + S 200 kg/ha 15-15-15 at 25 DAS 50 kg/ha ammon. Sulf at 25 DAS 50 kg/ha ammon. Sulf at 40 DAS
	d/micro nutrient application on **F2 only** as seed treatment or along line (mix with fertilizers at 25 DAS)	
	Soybean 1 kg NeoB + 0,5 kg CuSO4 at 30 DAS - See Mo on seeds	
	Maize 2 kg ZnSO4 + 1 kg MnSO4 + 0,5 kg CuSO4 at 25 DAS 2 kg ZnSO4 + 1 kg NeoB + 1 kg MnSO4 + 0,5 kg CuSO4 at 40 DAS	
	Rice 2 kg ZnSO4 + 1 kg NeoB + 2 kg MnSO4 + 0,5 kg CuSO4 at 25 DAS	

Table 2: Mineral fertilizers application levels for on Station cropping systems experimentation

If "pure" micro-nutrients' source is not available, work with available commercial product; liquid fertilizers with micro-nutrients seen on market … arrange then 2 spraying at 25 and 40 DAS (F2 only)

Fungicide and insecticide

The only seen product for seeds treatment on market was *Insector*, a powder with 350 g/kg of Imidacloprid + 100 kg/kg of Thirame, sold in small bag of 20 g

Legumes species, only fungicide treatment is preferable (Thirame, Thiabendazole …)
+ Mo on Soybean seeds (find some molybdenum source)
+ Rhizobium inoculation on Soybean (on already treated and dry seeds), right before sowing

Grass species, fungicide and insecticide treatment
Use 500 g of *Insector* per 100 kg of seeds + 150 g Thirame a.i. / 100 kg seeds

N.B. With progressive "ecologization" of the agro-system, after 2-3 years of DMC, the seeds treatment for fungi disease will be based on organic product (bio control by fungi of the genus Trichoderma, Metharizhium, Beauveria … Start to check availability on Ghanaian market)

In DMC … like for any crops sowing, germination power (rate and vigor) control prior to all sowing is essential to adjust sowing rate and avoid insufficient crop's initial stand

I-2-2 Upland

In spite of recommendation made in the previous report (and above reminded), no preliminary soil decompaction with chisel plow and surface leveling (former ridges) have been achieved during the dry season. Thus most of the DMC based treatment had been sown in the worth conditions, i.e. on compacted profile, crusted surface with very limited amount of 2013 crops residues (and no cover crops) ; with such initial conditions, crops performances will be low and, of course, no conclusion can be drawn from this first year test on the systems.

Thus the principal goal of this cropping season is the correct implementation of the cover crops sown in association (treatments 2, 6, 8, 10, 11, 12, 14, 16, 17, 18) or out of association with crops (treatments 1, 5, 7, 13). General guidelines for crops and cover crops management presented in the previous mission's report (Boulakia and Balarabe, 2013) remain unchanged.

Comments on the proposed systems (reminder)

Stripe 3, 9, 15 Plow based reference – modeling of the dominant crop systems practices for maize production – 3 replications

Maize is sown at 80 x 20 cm; no livestock grazing during dry season (approximate modeling!)

Stripe 1, 2, 7, 8, 13, 14
DMC based bi-annual rotation Maize + Stylo // Stylo – Simple DMC proposal for rapid transfer and adaptation to farmers' communities – 3 replications

Maize is sown at 80 x 20 cm; Stylo is sown on 2 lines at 20 x 20 in the middle of the interrow, at 20 DAS of the maize and after complete weeds control (hand or Post selective weedicide application)

Stripe 4 — No Tillage based maize mono-cropping - this treatment aims at creating a "counter-demonstration" on this system that some farmers may adopt to make a fast, flexible and cheaper implementation of their maize

Stripe 10 — DMC mono-cropping based on annual association between Maize short cycle (≤ 100 days) and Cowpea long cycle (# 130 days), producing grain and biomass

Cowpea is sown on one line in the middle of the interrow, at 20 DAS of the maize and after complete weeds control

Stripe 16 — DMC mono-cropping based on annual association between Maize and Stylo, producing grain and biomass

Challenging attempt to get enough Stylo biomass to create a good cover in the Guinean savanna conditions of Tamale region; Stylo is sown on 2 lines at 20 x 20 in the middle of the interrow, in the same time than the maize. Weeds control rely on Pre-emergent selective weedicide application (Pendimethalin or preferently Alachlore – this type of a.i. is used only in this first year; hand weeding operation needs a close monitoring of the working team who may destroy the stylo plantlets.

Stripe 5, 6 — DMC based bi-annual rotation Maize + Brach + Stylo // Brach + Stylo – Simple DMC proposal for rapid transfer and adaptation to farmers' communities

Maize is sown at 80 x 20 cm; Stylo and Brach are sown on 2 lines at 20 x 20 in the middle of the inter-row (alternatively, 1 inter-r. Brach, 1 inter-r Stylo), at 20 DAS of the maize and after complete weeds control (hand or Post selective weedicide application)
The mix cover is kept during the following rainy season – 1 "reasonable", allowing a rapid regrowth of the cover is done in August (the exported dry biomass is measured – modeling a cut and carry fodder system)

Stripe 11, 12 — DMC based bi annual rotation Maize + Stylo // Soybean + Sorghum + Stylo

Maize + Stylo like on stripe 16
Soybean is sown with

- *a medium cycle variety (115-120 days) if sown before 20/6*
- *a short cycle variety (95-105 days) if sown after 25/6*

Sorghum (non-photosensitive variety) and Stylosanthes guianensis are sown in soybean at the beginning of the defoliation (30% of yellow leaves) by broadcasting seeds at 15 kg/h and 4 kg/ha respectively ; soybean crop must be clean (use post selective herbicides fomesafen and fop family at 20 – 25 DAS)

Stripe 17, 18 — DMC based bi annual rotation Maize + Crotalaria retusa // Rice + Stylo

Maize is sown at 80 x 20 cm; Crotalaria is sown on 2 lines at 20 x 20 in the middle of the interrow, at 20 DAS of the maize and after complete weeds control (hand or Post selective weedicide application)
Rice is sown at 40 x 20 cm with a short cycle variety (e.g. SBT 68 or 69); Stylo is sown in the in the middle of the inter-row at 25 DAS of the rice and after complete weeds control (hand and/or Post selective weedicide application)

I-2-3 Upper Midland

No major changes; just minor redesign of the fields implementation to properly fit with the protocol lay-out; implementing perennial experimentation (at least several years), it is of utmost importance to realize a correct initial design.

All rice plots have been sown and sole cover crop remained to be sown, as soon as possible, at mission departure. Similarly to upland, no cover crops and limited amount of crops residues from previous cycle in 2013; this cropping season must thus also be considered as a transition oriented on biomass production.

I-2-4 lower Midland

Implementation of lay out has been adapted to the plot state: rice has been sown only where significant amount of cover crop (dried biomass of Stylo # 3 to 5 t DM/h); these surfaces of about 3-4 000 m² can be considered as the only "true" DMC (even if soil conditions are still under transition) implemented by the R&D component in 2014.

This experimental position offers large surface to multiply seeds of Stylosanthes g., Centrosema p. and -in lesser extent- Sesbania sp.

Figure 5: updated lay out for upland rainfed cropping systems

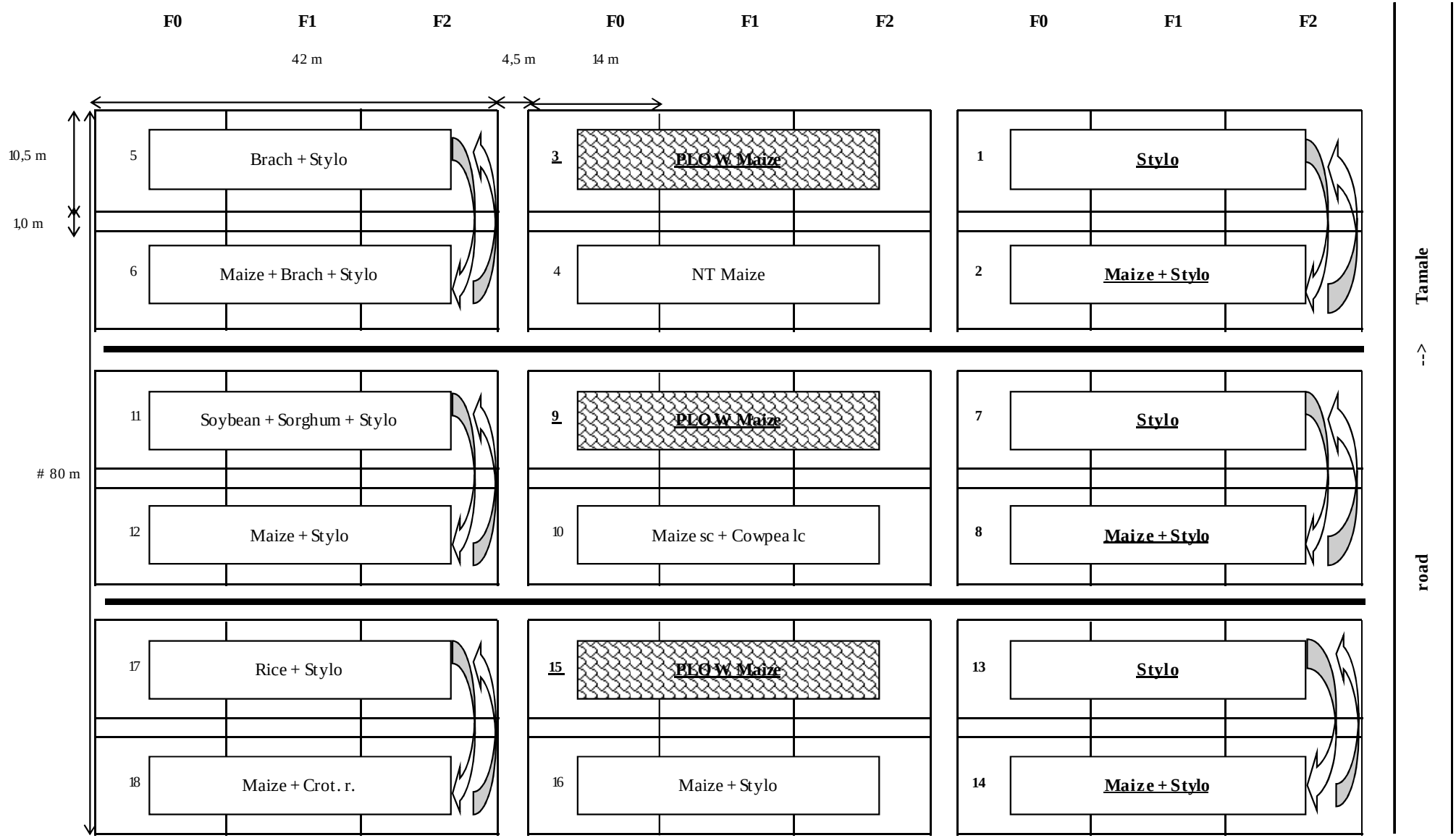


Figure 6: updated lay out for upper midland cropping systems

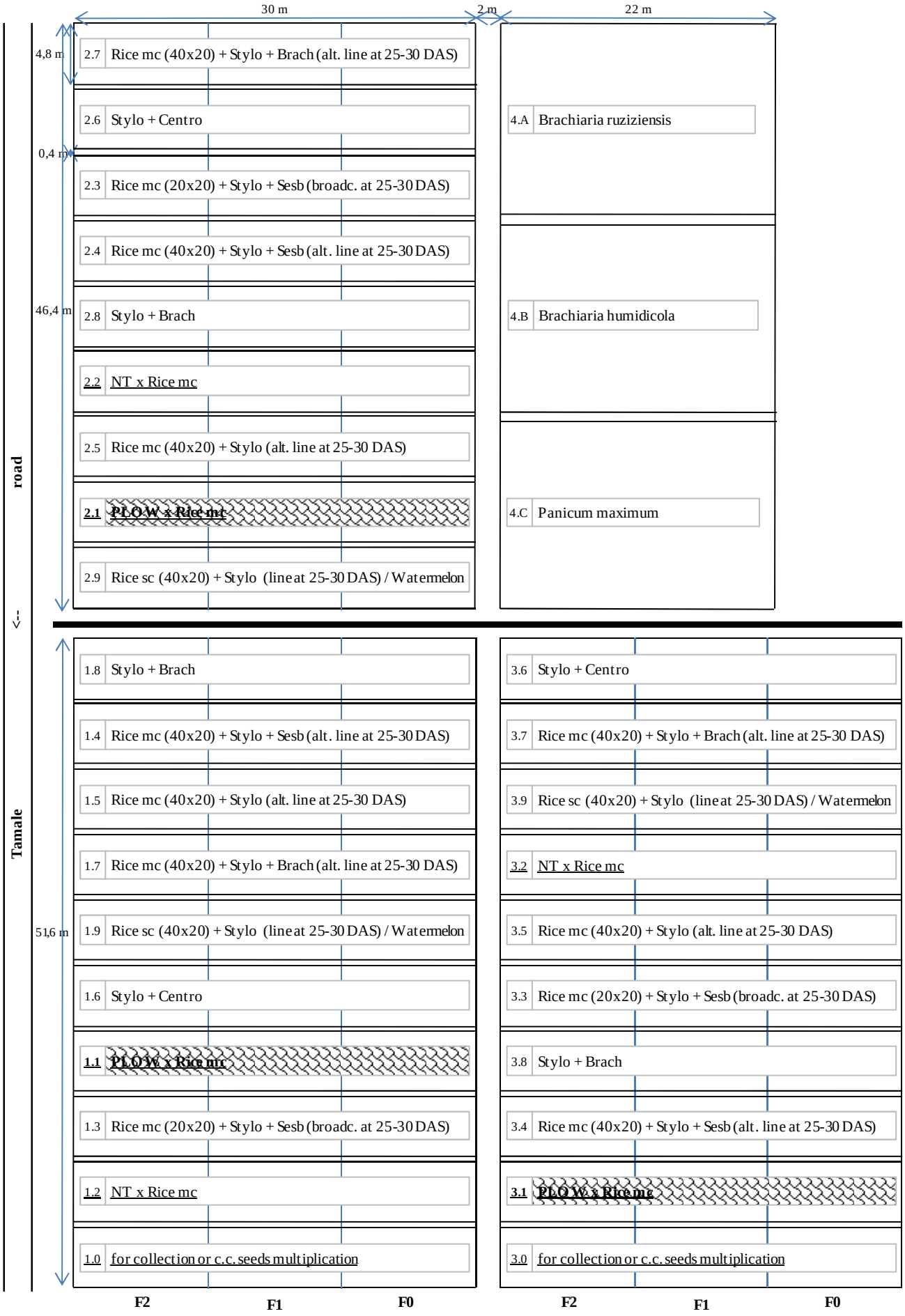
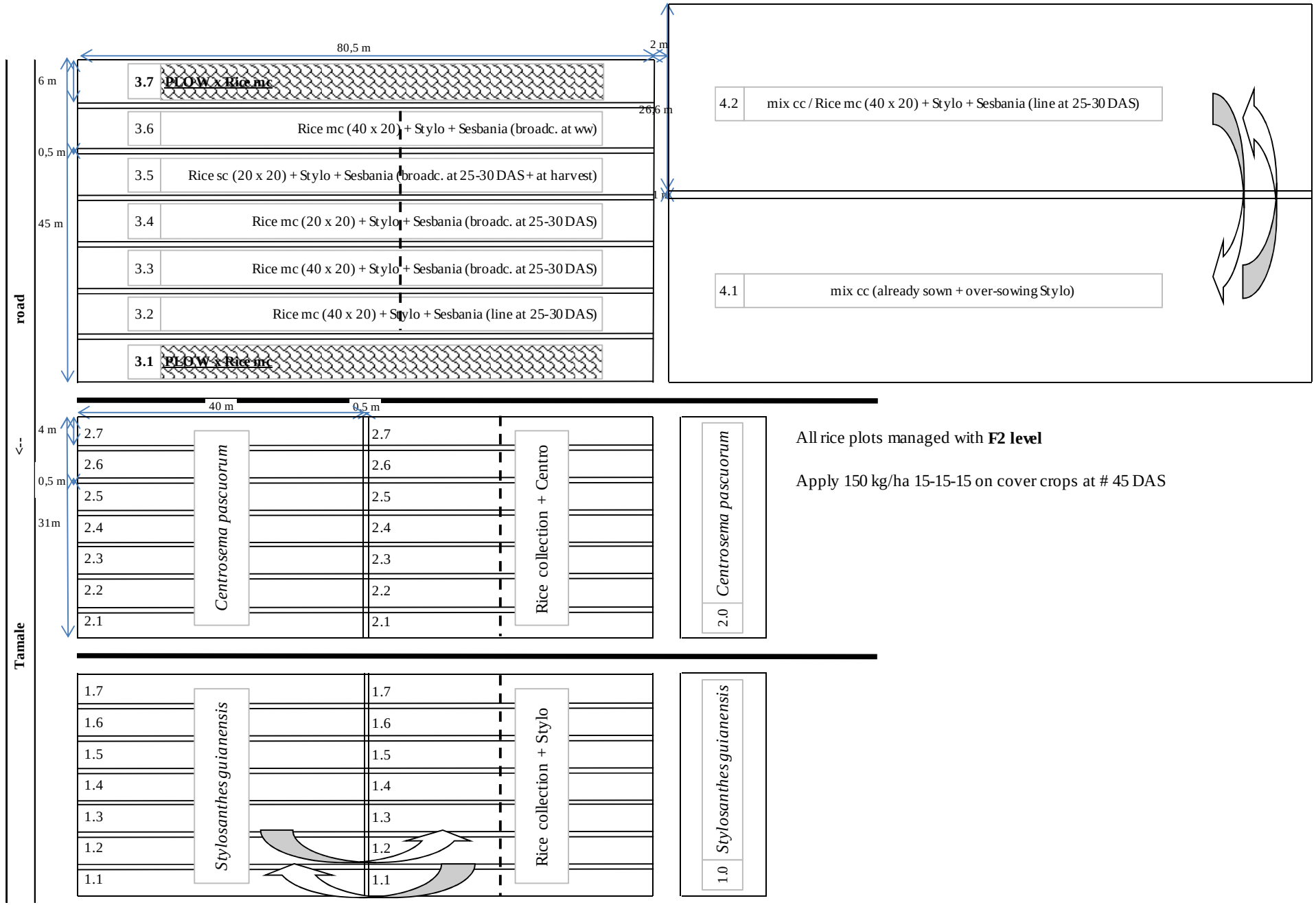


Figure 7: updated lay out for low midland cropping systems.



I-3 On Communities fields works

Fields works and organizations conducted in the 3 selected communities (Nwodua, Zugu and Jantong) have been defined during the mission of Abakar Madam Diogo (April 2014). This preparation phase has been done in dialogue with created ad hoc committees; during this preparation phase, visits have been organized in Nyangpala station (mulch, cover/fodder crops collection …).

The in-community programme has been limited to the sole collective demonstration sites set on both upland and midland positions ; due to lack of seeds it has been possible to answer some farmers requests on fodder / cover production.

Sites are implemented by farmers in coordination with the committee and research; each of them gathers on 2-3 000 m² (cf **Table 3**):

- 2 DMC systems compared to NT (No Till on crops residues without cover crops) and dominant farmers' practices
- 3 cover and/or fodder crops and cover – grains production species

UPLAND	CC1 *Brachiaria ruziziensis*	MIDLAND	CC1 *Stylosanthes guianensis*
	CC2 *Crotalaria retusa*		CC2 Sorghum
	CC3 Cowpea		CC3 *Brachiaria ruziziensis*
	DMC1 Maize + Brachiaria		DMC1 Rice + Stylosanthes
	DMC2 Maize + Crotalaria		DMC2 Maize + rice + Stylosanthes
	Direct seeding Maize		Direct seeding Maize + rice
	Farmer practices		Farmer practices

Table 3: Contains of the demonstration sites conducted in communities

All sites have been sown during the mission time and initial germinations looked promising despite few noticed problems related to cropping systems manangement:

- Weeds control sometimes insufficient (limited efficiency of pendimethalin on some sp -*e.g.* Commelina + dicot., efficiency also limited sometimes due to poor water quality -colloids-, late application and method -*cf.* provided advice on work organization)
- Soil preparation ; last soil tillage prior to NT and DMC based management must pay attention to obtain a sufficiently levelled surface state … especially for rice crops and in prospective of future use of hand tractor draught planter ; thus extremely uneven surface after poor quality disc plowing (the norm) must be properly corrected by at least 2 crossed passages of disc (or vibrant prong) harrow (angle of 30° between the successive passages as practiced in Jantong midland). Ideally, this last tillage should be done with Chisel plow (2 passages –see previous report and above).

<u>Remark.</u> In Jantong (community with the lowest anthropic pressure), It seems that large fallow surface (to be confirmed with farmers) are covered by an association between *Imperata cylindrica* and a legumes sp. (**Photo 4.**). This type of cover, if well developed, can offer an easy and direct "entry point" into DMC based management (Imperata indicating very favorable soil structure). It is thus suggested to discuss and propose to the committee to mark limits and protect from bush fire (and over grazing) some

significant areas covered with this association in order to (1) observe its behavior and potentialities (biomass and seeds production, fodder value of the legumes …) and (2) convert them directly (no soil tillage) into DMC systems (Maize, Rice …). If the proposition raises interest of the village committee, technical steps for implementation will be proposed during the next mission.

I-4 Seeds collection and multiplication

Initiating a significant seeds production must be a top priority for the R&D component in order to allow the progressive development of the current and future programmes (cf. farmers plots limitation during this cropping season due to lack of seeds) … and extent capacities to interact with other R&D and D programmes willing to integrate Conservation Agriculture and fodder extension in their "portfolio" of activities.

A priority focus must be given on the following species:

- *Stylosanthes guianensis*
- *Brachiaria ruziziensis*
- *Centrosema pascuorum* (if seeds remain after sowing trials, sow some areas with 0,8 m interrow in order to set tarpaulin or plastic mulch between lines at the beginning of the flowering)
- *Sesbania sp.* (multiplication and collect)

In this line, largest surfaces as possible must be sown, as soon as possible (to increase chance of flowering at the end of year of the perennial species), in the station fields.

It can be proposed that harvests on part of these station areas can be operated directly by farmers of the 3 communities, according to their objectives for the 2015 season.

Practical training on harvest methods for these key species will be one of the objectives of the next mission (October 2015).

Conduct a continuous plants collections development and assessment is a central action to allow DMC cropping systems progression (performance of systems, "emergence" of new systems). This work concerns both cover and/or fodder crops species (and var.) as well as food crops (DMC for cotton production could be developed later, according market / project attractiveness).

I-4-1 Cover and fodder crops

For upland

- Fodder crops
  - legumes sp.
    - ***Stylosanthes guianensis*** (cv. CIAT 184, Nina, …), *S. hamata*, *Macroptilium atropurpureum*, ***Centrosema pascuorum*** (var. Cavalcade, Bundey), *Chamaecrista rotundifolia* (seen on the side of Tamale road in Nyangpala station), Calopogonium mucunoides, *Dolichos lablab*, *Macrotyloma axillare* (cv. Jade), *Arachis pintoi* …

        - See also some species present in the communities : *Alysicarpus sp.*, *Indigofera* and / or *Tephrosia sp.* (cf. **Photo 1 to 4**)
    - grass sp.
        - *Brachiaria ruziziensis*, *B. humidicola*, *B. decumbens*, *B. brizantha* (cv. Marandu, MG4, MG5), Brachiaria hybrid (B. ruz x B. briz. , var. Mulato I, M. II, M. III), Panicum maximum (var. Tanzania, Mombasa, + eco-type from North Cameroon), Pennisetum purpureum (var. Paraiso), Bana grass (hyb P. typhoides x P. purpureum – by cutting)
- biomass production coupled by secondary grain production in an annual succession or association
    - legumes sp.
        - Cajanus cajan (collection of var.), Vigna umbellata (rice-bean), Vigna unguiculata (cowpea cv. of long cycle, > 120 days)
    - grass sp.
        - Eleusine coracana (collection of var. already introduced), Pennisetum typhoides (see local ecotype), Sorghum bicolor (collection to be regularly enriched and maintained), Sorghum guineensis (photosensitive)
- strict biomass production without any complement outputs for the production systems
    - legumes sp.
        - Crotalaria retusa, C. spectabilis, C. juncea, C. zanzibarica, C. ochroleuca, Mucuna sp.
    - grass sp.
        - Bamboo species (introduced from southern regions of Ghana → to be used for fencing and "hot spot" for erosion control, stabilization of gullies and rivers' banks)

<u>*For Midland and lowland*</u>

Aeschynomene sp.
Sesbania rostrata and other sp.
Macroptilium lathyroides (maybe already present in wetland)
Sorghum sp. (Muskwari type → collection)
Brachiaria mutica

+ local species to be collected and assessed in collection : *Tephrosia sp.*, *Aeschynomene sp.* and *Sesbania sp.* (cf. **Photo 5 to 10**.)

<u>*I-4-2 Collection for food crops and other annual crops*</u>

- Legumes sp.
    - Cowpea, soybean, mungbean, rice-bean, pigeon-pea, groundnut, voandzu, …
- Grass sp.
    - Rice Sebota – Polyaptitude
        - The following varieties has been passed to SARI and should be pre-multiply to be able to conduct multi-local assessment and selection under conventional and DMC management, in lowlands and upland

        - → Sebota 1, 4, 33, 36, 41, 47-12, 48, 63, 65, 68, 69, 70, 87, 147, 200, 254, 265, 270, 281, 330, 337-1, 399 (ex INT 146),
        - → Other varieties of interest, Priamvera, Fofifa 3737, B 22, Sen Pidao, Pkha Rumduol (photosensitive - ps and aromatic -ar), P. Rumlong (ps-ar), P. Rumchang (ps-ar), P. Mlis (ps-ar), ACD 2526, ACD 2528, ACD 2540, Fedearroz 50, Coprosem 304, Espadon, Basmati 113, Basmati 122, Basmati 123, Basmati 370, Nerica 1, N.2, N.3, N.4, N.9, N.14
    - Maize (in breed var. –attention to isolation), sorghum, finger millet, …
- Other
    - Cotton, sunflower, cassava, yam, …

I-4-3 Ligneous species

- Legumes
    - Acacia auriculiformis, A. nilotica, Faidherbia albida, Cassia siamea, …
- Others

Ziziphus sp., Eucaplyptus sp., Tectona grandis … Could be multiply with Nwodua community.

II- Prospective elements on DMC R&D programme evolution

II-1 RSSP and short term evolution

As previously reminded the purposes of the present R&D programme are multiple and arranged in coherent holistic approache coupling:

- transfer / adaptation and creation of technologies (centered on cropping systems)
- identification of needed support and organizational / institutional pathways to address them (production factors access) → up-scaling
- raise of ordered (hierarchized) questions related to regional / national ag. and rural development (strategies) while suggesting orientations and tracks to answer them (tactics) → out-scaling

Proposals are set on reasonable operational basis in line with the progressive capacity building of the SARI's team and training of the first 3 pilot communities. This realistic and moderate ambition is also anticipating the coming end of RSSP funds; the targeted volume of activity being sized to be able to be maintained during few months by SARI -if needed- before to get relay resources from new project / partnership.

SARI should take benefit of this remaining RSSP support period to

(i) strengthen the human resource in charge of the programme

a. team composed of 2 scientists + 2 permanent technicians ; at SARI's level, the team must gather a group of regular workers under the coordination of a corresponding leader ; in this team, 3 to 4 persons must be trained and properly equipped for pesticides treatments
b. clear appointment on medium-long term basis with well-defined role and functions taking into account personally wished trajectory
c. coordination mechanisms and regular (weekly basis) exchange (verbal and through commented visits) and communication between groups implementing station and community based activities

d. training and information visit in North Cameroon to be prepared in coordination with the Agronomy team of SODECOTON (contacts persons MM. Oumarou Balarabe and Abakar Madam Dogo.

(ii) prepare data collection for future scientific capitalization (which can be seriously initiate on performing systems, i.e. once adapted and dominated by implementers)

a. soil sampling and storage (T0) in upland and upper midland experimentations ; 3 bulk sample / elementary plots for [0-5 cm], [5-10 cm], [10-20 cm], [20-40 cm] and [40-60 cm] ; for study on SOC and assessment of C storage capacity, measure of the bulk density in the same time.

b. Data / samples collection plan must be progressively established according type of developed topics (comparative performances and impacts of CT / NT / DMC systems, analysis and comprehension of processes triggered by DMC –e.g. SOC dynamics, soil biology and functions, bio-aggressors regulations, R&D methodology x territory development and articulation with development)

(iii) continue training of the pilot communities through continuous exchanges with local committees with a specific emphasis brought on seeds production development (Stylosanthes, Brachiaria as likely first targeted species)

(iv) initiate regular exchanges and communications and experience sharing with regional development projects …

In order to allow the programme to reach these objectives and increase its chance of prolongation through new partnerships, the extension of RSSP until mid-2016 (if agreed between MOFA and AFD) should include the prolongation of the R&D component lead by SARI. In term of short term operations, this prolongation by one supplementary cropping season will allow to work on scale representative of farmers' dynamics, notably after arrival of power tiller draught planter, increased seeds availability, test on direct conversion of "natural" cover (upland of Jantong).

On its side, SARI should "in return" try to aggregate new resources from other development partners (USAID \ International Lab for Sustainable Intensification – new name of SANREM CRSP, that will start a new 5 year phase in 2015, JIRCA, Foundations …, R&D components of regional Development projects) around the prolongation and development of R&D programme initiated under RSSP; building of coherence and continuity upon holistic approach with (despite) segmented and dispersed funds sources can only be enforced by SARI. Such continuity combined with participatory method (on-farm, with and for farmers) will set capacities to practically address, at community and territory levels, development problem … a red line to put back research in Development process and also a way to Reconnect Research on Development.

II-2 Exchanges with some Rural and Agricultural development projects active in Northern regions

A conference and exchanges with 2 major Rural and Agricultural programmes in Northern regions of Ghana (NRGP financed by IFAD and Advance program financed by USAID) has been organized during the mission. Presentation focused on (i) DMC technologies for smallholders based on experiences in North Cameroon and Cambodia and (ii) the R&D methodology and (iii) what could / should be its place and articulation with development projects set on territorial basis to trigger and support profound changes in production and agrarian systems.

Following exchanges have clearly shown interests in the DMC technology and R&D methodology initiated by SARI with CIRAD support. Both programmes are beginning and intend to initiate actions, still in a designed phase, in the domain of Conservation Agriculture.

Based on multiple experiences on R&D for CA implemented by CIRAD and AFD in contrasted contexts, projects and programmes triggering and supporting deep changes of production and agrarian systems sustained by CA must be conceived on long term (10 to 15 years); in such approaches, R&D must act as a continuous nucleus, at the heart of the targeted areas, working with communities that are representative of the bio-physic and socio-economic diversities. This nucleus can thus feed development actions carried out on the "plasma zones" with adapted technologies and related measures to accompany their up-scaling for the larger number of beneficiaries; these measures aim at easing access to the needed production factors and imply farmers' organizations development. In this construction of continuum between R&D and D, R&D nucleus provides also permanent information and training bases for farmers and their structures, organizations in charge of extension (public services, NGO and private sector – up-scaling) and toward traditional power and policy makers (out-scaling).

The R&D platform on CA of SARI should already initiate regular exchanges with interested programmes in the region of Tamale; beside the share of information, SARI with the pilot communities have to play a central role in the initiation of a local seeds supply for cover / fodder crops species. The SARI's capacity to render these services will largely conditioned possibilities of relay support funding after the end of RSSP.

II-3 Private sector involvement

Private sector has to play a key role in smallholders agricultural development ; it can be even said that there will be no large scale actions set on long term and sustainable economic basis without strong and central commitments of the private sector.

From limited discussions and exchanges with the agribusiness developing projects in the Northern regions (IWAD project of Wienco, Wienco Cotton, Arima farms), it appears that all of them includes the development of relations with smallholders around services supply and / or collect and transformation of productions.

Projects based on large land concessions like IWAD and Arima farms claim to intend to contribute to local development and operate a technology transfer towards neighboring communities notably via services provision; but they appear in need of methodology to progressively build mutual comprehension, confidence and efficient collaborations.

Other types don't include land access; they can be based on the development of special crops, like cotton (sector based approach) or conceived on the development of mutual beneficial support to large farmers associations, as it seems the case with Mazara N'arziki (Maize for prosperity, http://www.wienco.com/pages/partner_content/7); in this project, Wienco supports small and medium holder farmers in maize production by combining technology support (inputs, mechanization and training) with credit offer and market access.

If intermediate model, based on a limited land concession for a nucleus production and active technology development / adaptation (sustainable cropping systems and contract mechanization), doesn't seem to exist, it also appear an apparent lack of deep prospection on private-public partnership development, that should integrate the variety of agribusiness projects. Thinking, through collaborations, on what type of public R&D and D

projects should be implemented, and under which conditionality, in preparation and support of private development for a better, more efficient and fairer inclusion of farmers' communities; reorienting a significant share of the public investment in rural and agricultural development in this direction should contribute to generate coordinate and more coherent evolutions for sustainable territory, communities and economic development

Conclusion

Next Cirad missions

A possible and optimized allocation of the remaining budget for support missions to the SARI's R&D component of the RSSP has been discussed with the PCU and SARI's direction during the debriefing meetings of the mission. The following schedule, taking into account the project closure in November 2014, has been agreed:

Period and duration	Expert	Topic and specific goals
2 x 12 days October 2014	Oumarou Balarabé Stephane Boulakia	Analysis of the cropping season and first year of territory development at pilot communities' scale Program design for 2015 cropping systems (continuation after the end of RSSP) Coordination proposals for insertion of the initiated agro-ecology program within existing or new projects' opportunities (USAID: new phase of SANREM, Africa Rising …; collaboration with Africa Rice) Prospective on prolongation of the CIRAD and North Cameroon expertise

In case of agreement on an 18 months prolongation of some RSSP activities, including the R&D component implemented by SARI, the above schedule could be amended as follow: 12 days backstopping mission of one expert in October 2014, 12 days mission in May-June 2015 (cropping season implementation) ; complementary means -if wished by partners- could then allow to extent CIRAD \ UR AÏDA's support and review possibility to set it on prolonged term, from its operation regional basis (currently studied or starting in the sub-region).

Further possible evolution

AÏDA Research Unit is currently looking for means to implement a long term basis R&D and R platform, with clear orientation on development dynamics' backstopping for dry farming ("Soudano-Sahelian" and "Soudano-Guinean" areas) in West Africa. As above recalled, the R&D approaches progress by establishing a permanent links between DMC based technology transfer/ adaptation, support to -and via- farmers' organizations for training and productions factors access within the progressive implementation of a participatory and shared land use plan (a central necessity to notably address the questions of fire bush and biomass allocation / management). Such a platform should be implemented in region(s) offering good representativeness of the West African dry farming areas ; to operate, on medium to long term basis, all its components on a significant scale, especially the pilot extension network, the intended programme will have to pool funds (and human resources) from different development partners on shared and unified methodology. This multi-donors investment in large R&D programme could be accepted if clearly understood as a first step for concentric development project set on territory approach.

This sequence R&D and D organized at the scale of large and diversified production basin (“DMC schemes”, similar by numerous aspects to holistic approach triggered by irrigation development) could be an innovative way to pave an attractive ground for a progressive and relay commitment of the private sector.

Appendix 1

Local weeds and cover of potential interest for DMC based systems

Photo 1.
Alysicarpus sp. on upland

Photo 2 and 3. Legumes species (*Tephrosia sp.* -?-) on upland ; soil macrofauna activities.

Photo 4. Upland fallow covered by a mixture of Imperata cylindrica and a legumes (*Tephrosia sp., Indigofera sp.* -?-) on upland (Jantong community)

Photo 5 and 6. Legumes (*Tephrosia linearis* -?-) on Lowland

Photo 7 and 8. Legumes (*Sesbania pachycarpa* -?-) on lowland

Photo 9 and 10. Legumes (*Aeschynomene sp.* -?-) on lowland