INITIATIVE ON
Agroecology

Working Package 1- Transdisciplinary co-creation of innovations in Agricultural Living Landscapes (ALLs)

Generic framework for the agronomic assessment of codesigned agroecological technologies and trials

(Initial proposal)

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Purpose

This framework aims to facilitate the collective assessment of results and lessons learned from the codesigned agroecological trials conducted in different ALLs participating in the CGIAR initiative on agroecology (AE). The purpose of this assessment is to understand approaches and methods used for the design and evaluation of these trials (protocols, measurements performed, etc) and contribute to the performance analysis of the agroecological technologies tested.

While each trial within the initiative may be unique due to the context-specific codesign process, the framework aims to analyze them in a generic and structured way to facilitate cross-comparisons. Although agronomic in nature, the framework's assessment integrates the productive, environmental, and socioeconomic dimensions of the trials to compare agroecological technologies with current practices in each ALL.

Additionally, the framework assesses contributions to the agroecological transition for each technology tested in the trials. This document serves as a guideline, to be enriched through interactions with country teams, with a final version potentially included as part of the codesign guidelines for the AE initiative.

Objectives

Documenting codesigned agroecological technologies in the ALLs of the AE initiative.

Facilitating the comparative performance analysis of AE technologies and “current” (non-AE) practices.

Engaging with country teams to develop the comparative performance analysis and assess the codesigned agroecological technologies.

Considerations

- ✓ The process will be primarily based on the information already generated in trials conducted in the ALLs.
- ✓ The assessment could provide an opportunity for the local and global teams in the initiative to identify areas for further improvement and offer recommendations for the way forward.
- ✓ Authorship and data ownership belong to the country teams. The global team will only assist with data analysis if requested by the country team, and will only report summary statistics (not primary data) in its analysis after consent from the country teams has been provided.
- ✓ The scope of the assessment will be highly dependent on the implementation trajectories at each ALL. This generic framework includes aspects that may not always be relevant for the AE technologies tested in the trials.
- ✓ The framework is under construction. Consequently, interaction with local teams is expected to improve the framework, and shape it into the final operational version.

General structure of the assessment

The assessment will be done for each trial in the ALLs. It is structured in four main components. The first two components seek to gather information about the context of the trial and the agronomic performance of the technologies tested in the trial. The third component analyses the information collected to compare the performance of AE technologies against the current practice, focusing on the AE principles addressed by each innovation. Furthermore, a general assessment of AE transition is developed in this component. The last component will develop recommendations for improvements in the trials on different aspects.

Component 1: Trial description

General description of the AE technologies and current practices being tested in the trial, as well as the context in which the trial is being developed. Besides, this section includes a brief description of the codesign process followed in the ALLs and the experimental setup.

Section 1.1- Codesign process:
Overview of the codesign process (Participants, Workshops held, etc)

Section 1.2- Description of practices:
Technical description of AE technologies tested in the trial. This section seeks to document the **local knowledge about each technology tested** and their key differences.

Section 1.3 – Experimental setup:
Materials and Methods section of the trial

Figure 1- Sections included in the component about the trial description

Component 2: Agronomic performance

The component on agronomic performance aims to compare the performance of AE technologies with current practices, as tested in the trial. While the framework attempts to identify common variables to document the performance in agroecosystems, some variables may not be relevant to all trials, and some pertinent variables may be excluded. In such cases, there is a section available to include relevant variables specific to the innovations tested in the trial.

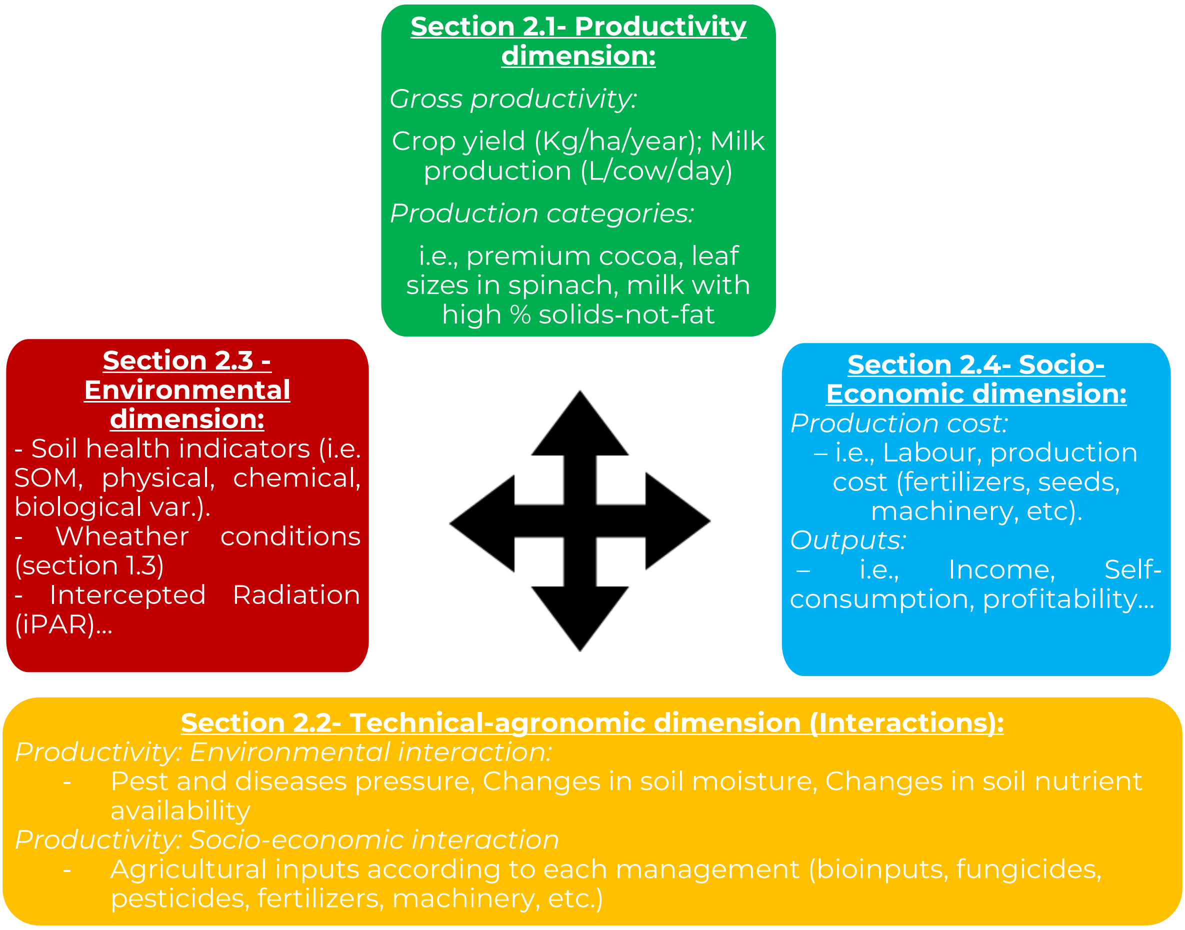

Figure 2- Sections included in the agronomic performance component of the trial

Component 3: Agroecology assessment

This component includes two sections: A specific and a general assessment of the AE transition in each trial. In the specific assessment, based on information collected in previous components, an assessment of the AE principles addressed by each innovation is conducted. The specific assessment analyzes the effect of each AE technology against the current practices on the AE principle(s) addressed by each innovation (i.e., input reduction, soil health, economic diversification). In the general assessment, a characterization of the AE transition is done using a modification (simplification) of the TAPE protocol proposed by Mottet et al., (2020). These two assessments will contribute to the cross-analysis of results in the initiative.

Section 3.1- Specific assessment: This section is highly dependent on the information available, and the AE principle(s) addressed by the innovations tested. An illustrative example of potential analyses in this component is presented in the following illustration box:

Agroecological innovation tested: Spinach production using mulch.

***Agroecological principle(s) addressed*:** Soil Health (main), Economic diversification.

Comparative performance analysis (against production of spinach without mulch):

-Soil moisture content during the productive cycle

-Yield components at harvest, such as plant height, number of leaves per plant, leaves size.

- Differential prices of spinach according to their sizes.

Hypothesis tested:

- Spinach produced using mulch increased the soil moisture during the entire productive cycle.
- Spinach produced using mulch significantly increased the number and size of leaves, thus increasing grower income through higher prices for larger leaves in the local market.

Section 3.2- General assessment: This component will be developed by applying scores to selected indices of Characterization of AE transition (CAET) according to the methodology proposed by Mottet et al., (2020). The scoring can be conducted in each ALL by the local staff in charge of the trial, based on the knowledge gained during the trial development. CAET indices proposed by Mottet et al. (2020) cover the ten elements of agroecology according to FAO: diversity, synergies, efficiency, recycling, resilience, culture and food traditions, co-creation of knowledge, human and social values, circular and solidarity economy, and responsible governance. This framework proposes to assess four elements of the transition—diversity, synergies, efficiency, and recycling—as they are directly related to practices developed at the field level in the trials.

Component 4- Recommendations

This component is developed in close coordination with country teams about different aspects in the trials: i.e., protocols, co-design process, analysis of results, etc. This section provides an opportunity for the country and global teams in the initiative to identify areas for further improvement and offer recommendations for the way forward.

Foreword

In order to fully understand the context of the agronomic trials presented in this report, the editorial team would like to remind you of the background to these trials. The Agroecology initiative arrived in Senegal a little later than in the other Living Labs, following the impossibility of running a Living Lab in northern Burkina Faso (security conditions). When the Agroecology Initiative was launched in Senegal, numerous agronomic trials were already underway, mobilizing a large number of local researchers and local partners in the villages concerned. It was therefore decided to build on this ongoing momentum and focus the Initiative's activities on the co-design approach and on strengthening these living labs. Thus, the data presented in this report are the results of the 2021 and 2022 agronomic trials conducted in this living lab in Fatick, Senegal, under the joint support of the FAIR-Sahel project and the Agroecology Initiative project. With the FAIR-Sahel project coming to an end in December 2024, this report highlights the importance of continuing agronomic activities in the second phase of the Initiative, given the promising results raised in the first phase.

Component 1- Trial description

Section 1.1- Codesign process

Please briefly describe the trial's codesign process, addressing the following aspects:

i. <u>Participants: Who was involved in the process?</u>

A wide range of stakeholders were involved in the trial co-design process. Indeed, during the various co-design phases (pre-diagnosis, quick diagnosis, trials, co-assessment, results' presentation to farmers), numerous partners were mobilized to represent the diversity of local stakeholders' viewpoints: village communities (men, women, young people), national research (ISRA-LNRPV) and international research partners (CIRAD), development services (Enda pronat) and technical services (agricultural councils (ANCAR), water and forestry services).

ii. <u>Workshops and Activities: What workshops and activities were held?</u>

Various activities were carried out throughout the co-design process, to ensure that the views of all stakeholders were represented in the conduct of the tests. In chronological order, there were 3 main types of workshop:

- - Pre-diagnosis and quick diagnosis: This phase, carried out in consultation with all local stakeholders, highlighted the main cropping systems in the area, and the main constraints faced by producers. After a phase carried out with the entire group of stakeholders, small-group discussions were held to identify agroecological alternatives to current cropping systems, which would help to identify solutions to the constraints identified. This diagnostic phase also enabled a collective decision to be taken on the most appropriate location for the experimental fields.
- - Co-evaluation of trials during the agricultural season: During the agricultural season, farmers were invited to co-evaluation workshops on two occasions (70 growers in 2021 and 107 in 2022). By conducting the co-evaluation workshops on two separate dates (35 days after sowing and 70 days after sowing), it was possible to assess various agronomic criteria (emergence, pest pressure, etc.).
- - Ideotyping workshop: This workshop only took place in 2022. Its aim was to bring together producers and reflect on the different avenues of innovation for agricultural practices in the region. Bringing together 59 producers, the workshop highlighted the main agricultural constraints in the Fatick region, and proposed technical or organizational levers to overcome these constraints. The idea here was to go beyond the plot level at the heart of agronomic trials and develop more systemic innovation paths on a regional scale (availability of seeds, farm equipment, etc.).

Figure 1 : Trials visit during co-evaluation workshop in Ndiourbel Sine in 2021 (left), ideotyping workshop in Ndiob in 2022 (right)

iii. Outcomes and Challenges: What were the main outcomes and challenges?

In 2021, the main results were (i) very poor soil quality (low organic matter and nutrient (N,P) content); (ii) the groundnut-niebe association was beneficial to groundnuts (+16% yield) without the underlying biophysical processes being clearly identified; (iii) contrasting results with horse manure, which improved groundnut yields in pure cultivation, but reduced groundnut yields associated with cowpeas.

In 2022, the results for central field 2 (Mbatar) showed a negative effect of horse manure on groundnuts sole cropping, in contradiction with the results obtained for central field 1 in 2021, highlighting the importance of considering inter-annual climatic variability in our analyses (2022 being a significantly rainy year in comparison to the average year around 550 mm). The effect of compost on the association cowpea-groundnut positively affected yields despite low application rates.

Another interesting result was the consistency between farmers' perceptions during the co-evaluation workshops and the yield results obtained afterwards. Indeed, in 2021, farmers had noted the good performance of horse manure on groundnuts, and the results had corroborated their assessments. Conversely, the farmers had given a negative assessment of the horse manure trials when it is used on the association (cowpea-groundnut), and the yield results also supported their view. Finally, during these workshops, the growers paid close attention to pest attacks, but the research teams regretted not having any indicators to present to them to measure this dimension. This is certainly an aspect to be improved in the second phase of the Initiative. In addition, indicators of soil moisture following manure application and when the two crops are combined was not monitored during the crop cycle. Research question remained open after this first phase : is the groundnut-niebe combination "effective" on all types of soil? soil types? Is it possible to further boost the performance of this combination with specific spatial arrangement or cowpea seeding density?

If this information is detailed in another document, please provide a reference to that document.

This information is taken from the consolidated report on agronomic trials at Ndiob in 2021 and 2022 (attached to the report, French version).

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Section 1.2- Description des pratiques

In the groundnut basin, the most common practice is groundnut-millet rotation.

On this basis, the trial will explore two main alternatives: the use of horse manure as an organic fertilizer. Horses are very common in the area, and access to mineral fertilizers is extremely limited for farmers.

Another traditional practice was the addition of cowpeas to pure groundnut crops. As cowpeas are harvested earlier than groundnuts, they provide THE household with food for the lean season, which is always the most critical for household food security. We therefore chose to test a groundnut-cowpea association for this experimental set-up. By combining these 3 parameters (association, horse manure, sole cropping), we arrive at the six treatments described below (note that T7, the addition of compost, was not tested until 2022 on the central field of Mbatar).

Conventional practice (treatment control, T1):

The conventional practice in the groundnut basin is to rotate groundnuts and millet. Millet is a cereal adapted to the region's arid conditions and is the main food crop. Groundnut is a key crop in this region, as it (i) produces grain that are important for household food security (rich in nutrients) and household expenditure (important market), and (ii) produce groundnut biomass (quality fodder), (iii) fixes atmospheric nitrogen in soils that are often poorly amended (mineral or organic fertilization), even if this nitrogen contribution can be questioned with regard to the export of the whole plant in the case of groundnuts.

This practice of growing groundnuts as sole cropping, followed by millet the following year, is therefore the conventional practice for this trial.

The groundnut variety used was 55-437 for a 90-day cycle. Groundnuts were sown using an animal-drawn (horse-drawn) seeder, and a 30-hole disc was used for sole cropping groundnut sowing or when it is associated with cowpea (mix of seeds in the seeder). The spacing between 2 rows of groundnuts was 50 cm. Weed management was controlled (mechanical and manual weeding) throughout the crop cycle. The number of groundnut and cowpea plants at emergence and harvest was recorded.

Agroecological technologies 1 (T2) :

Name: cowpea sole cropping with horse manure (C+HM)

Description:

The technical itinerary for this agroecological technique is the same in every respect as for cowpea sole cropping, except for the addition of organic horse manure. Horse manure was broadcast over the entire plot surface at the time of sowing, at a doses of 4 tons per hectare. Three samples of horse manure were taken for laboratory analysis.

Agroecological technologies 2 (T3) :

Name: cowpea-groundnut association (C+G)

Description: Groundnuts and cowpeas were sown at the same date in both fields and both trial years. A 30-hole disc was used with the seeder and animal traction for groundnut and cowpea. Seeding density cannot be accurately assessed. It can simply be noted that a handful of cowpea seed (around 80g) was added to the 5kg of groundnut seed, but the drill was not completely full. Cowpeas were harvested before groundnuts in 2021 (60 days and 108 days after sowing respectively), while both crops were harvested at the same time in 2022 (120 days after sowing).

Agroecological technologies 3 (T4) :

Name: cowpea sole cropping (C)

Description: The cowpea variety used is the 60-day-old Baye Ngagne. It is a semi-erect variety. The spacing between cowpea rows is 100 cm. The technical itinerary (sowing technique, weeding, etc.) is the same as for the other practices.

Agroecological technologies 4 (T5) :

Name: association cowpea-groundnut with horse manure (C+G+HM)

Description: The technical itinerary concerning manure is the same as in T2 and concerning the association the same as in T3.

Agroecological technologies 5 (T6) :

Name: groundnut sole cropping and horse manure (G + HM)

Description: The technical itinerary is the same as for groundnut sole cropping and follows the same protocol as T2 for fertilization with horse manure.

Agroecological technologies 6 (T7) :

Name: association cowpea-groundnut and compost (C+G+Co)

Description: This technology was only tested in 2021 on Mbatar's central field 2. It is important to note that this is not compost stricto sensus, it is simply an accumulation of different sources of manure (horses, small ruminants, donkeys), ash and household and food waste. The pile has not been subjected to any special handling.

Millet cultivation technical mangement

Millet cultivation was carried out on Field 1 Ndiourbel Sine in the second year to study the after-effects of different legume cropping systems. Millet was sown using an animal-drawn seeder with an 8-hole disc, 4 of which were plugged. The millet variety used was Souna 3 for a 90-day cycle. No inputs were applied to the millet. Row spacing was 90 cm.

Section 1.3- Experimental setup:

The ALL of Sénégal trials were carried out in the Fatick region, and more specifically in the commune of Ndiob. This commune covers an area of 127 Km2 and includes 18 villages.

In 2021, the trials were set up in central field 1, in the village of Ndiourbel Sine, located to the east of Ndiob (9-10 km). The previous crop in this field was millet.

In 2022, Ndiourbel Sine central field 1 was sown with millet. That same year, a second central field (2) was installed in the village of Mbatar, also in the commune of Ndiob.

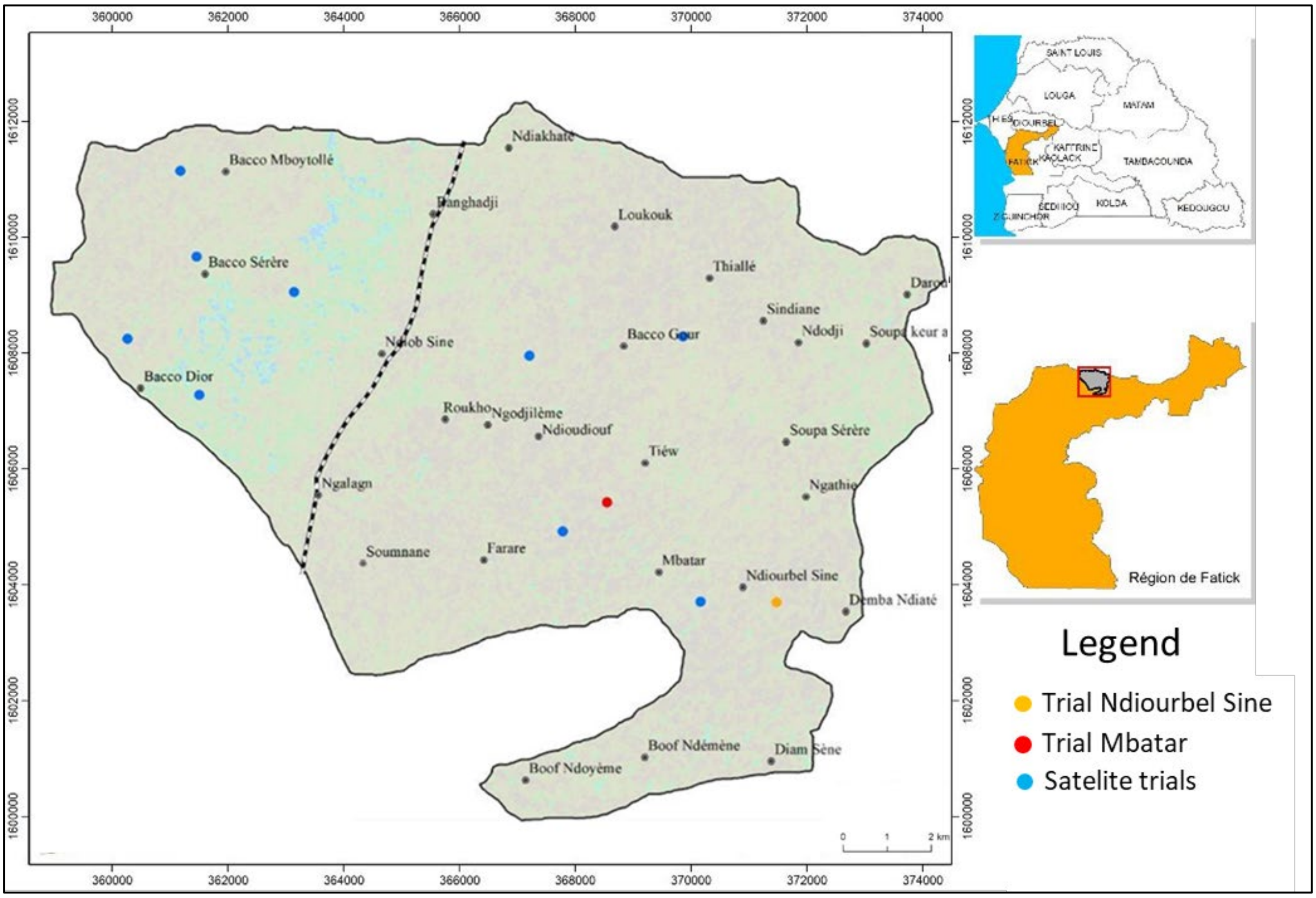

Figure 2 : Location of Fatick region in Senegal, and Ndiob commune within this region. Location of the two triel field in Mbatar and Ndiourbel Sine, along with baby trials (not presented in this report); source : Isidore Birame Diouf

Climate and weather conditions :

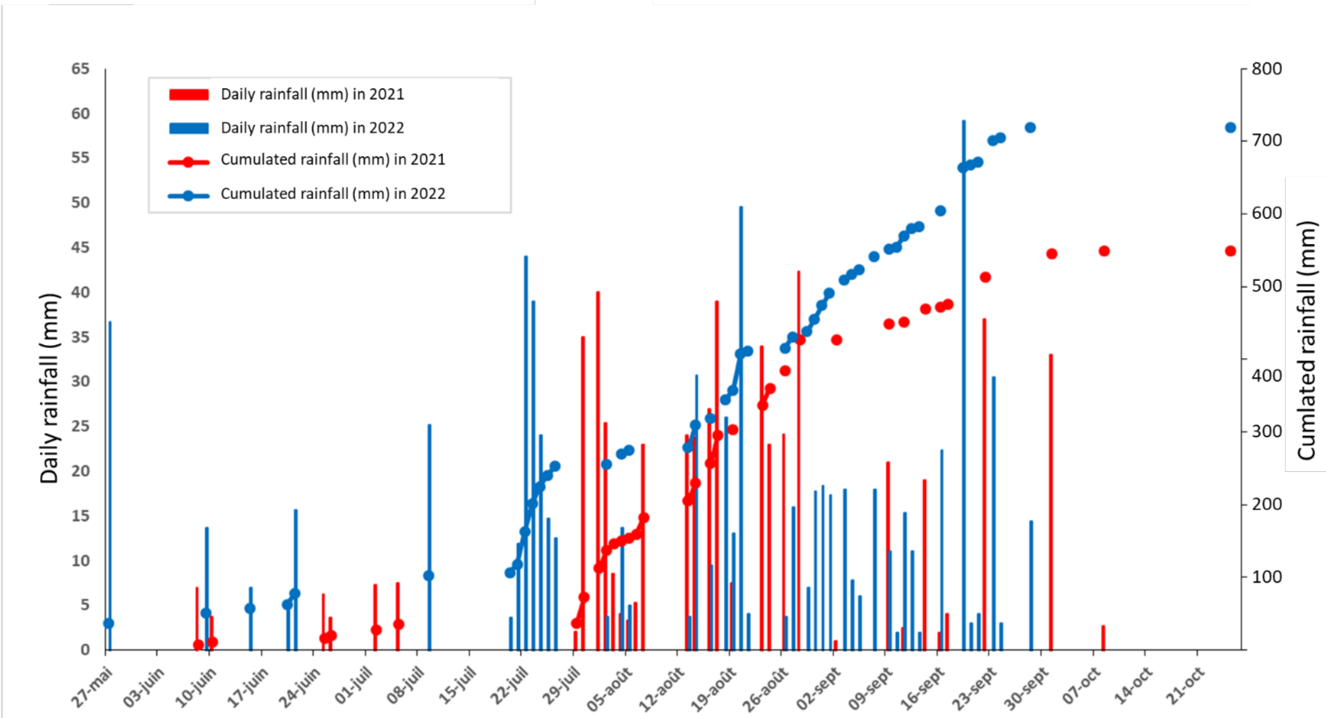

Figure 3 : Daily and Cumulated rainfall in the commune of Ndiob in 2021 and 2022

Figure 3 shows that the two test years presented in this report were significantly different in terms of rainfall. In 2021, rains started late (end of July) and stopped early at the end of September for a total rainfall of 548.8mm. It is important to note that this year was marked by a pocket of drought from July 8 to July 25. The year 2022 began earlier (end of July) and rains continued throughout September for a total rainfall of 719.1mm, i.e. an exceptionally rainy year. These 2 years provide a good illustration of the inter-annual variability of rainfall in the region.

Landscape description (select the option)

The landscape is generally flat throughout, with the exception of a few very local, gently sloping depressions.

Land slope: flat(0-2%)[X] gentle(3-5%)[ ] moderate(6-10%)[ ]

rolling (11-15%)[ ] hilly (16-30%)[ ] steep (31-60%)[ ] Very step(60-100%)[ ]

Slope shape: Concave[ ] Convex[ ] Linear[ ]

Soil texture class: sand [X] loamy sand [X] sandy loam [X]

sandy clay loam [ ] loam [ ] silt loam [ ] silt [ ] silty clay loam [ ] clay [ ] clay loam [ ] sandy clay [ ] silty clay [ ]

Soil classification: Tropical sandy to sandy loam ferruginous soil

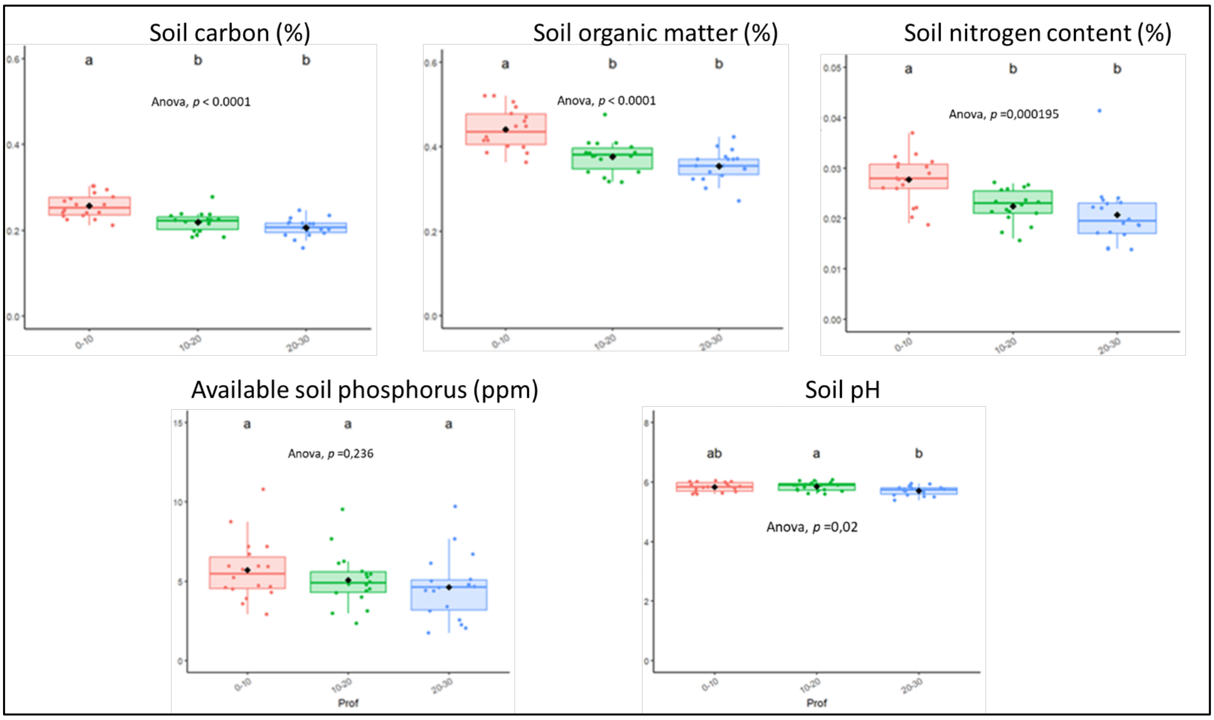

Figure 4 : Main soil characteristics in the field of Ndiourbel

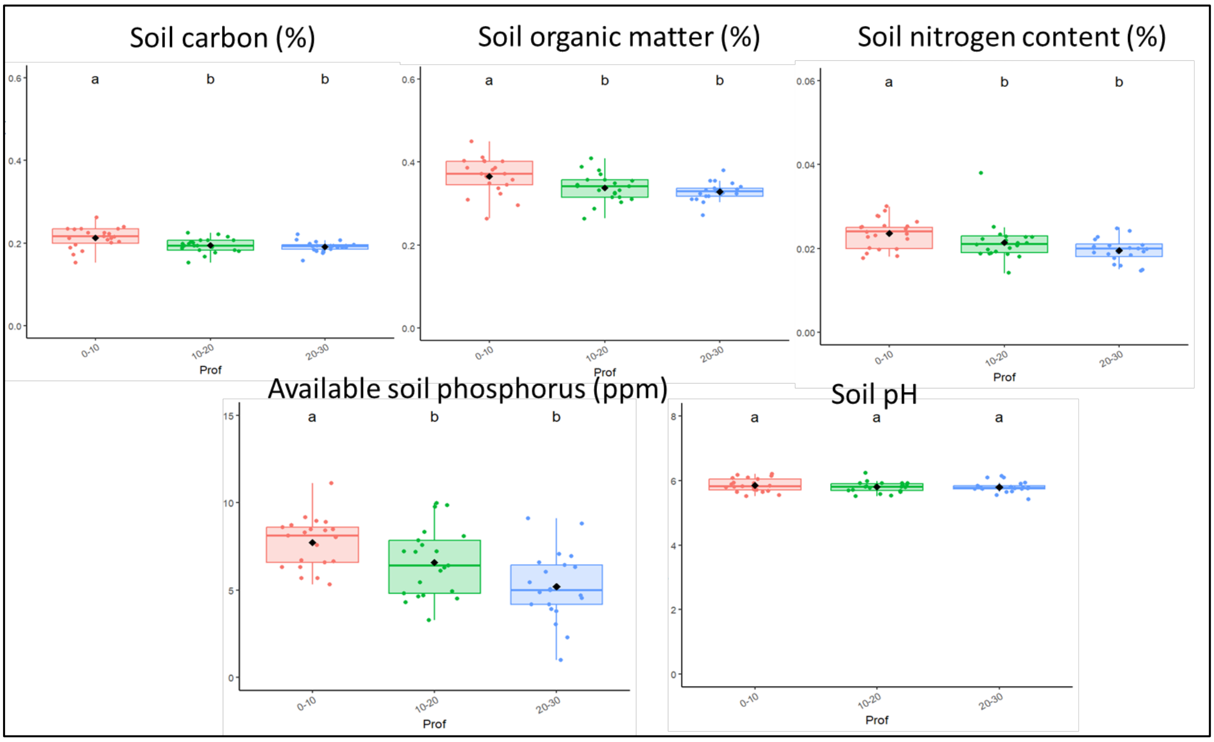

Figure 5 : Main characteristics of the soil in Mbatar

Overall, the soils in both fields are poor in nutrients, organic matter and carbon. Both soils are moderately acidic.

Trial setup

Trials in field 1 of Ndiourbel Sine

In 2021, all the treatments described above were implemented in the central field 1 of Ndiourbel Sine, according to the layout shown in figure 4. Each elementary plot (agroecological technology) measured 12 m by 9 m, for a surface area of 108m2. The distance between treatments was 2 m. The overall design was a Fisher block with 6 treatments and 3 replicates. All elementary plots were installed under Millet in 2022.

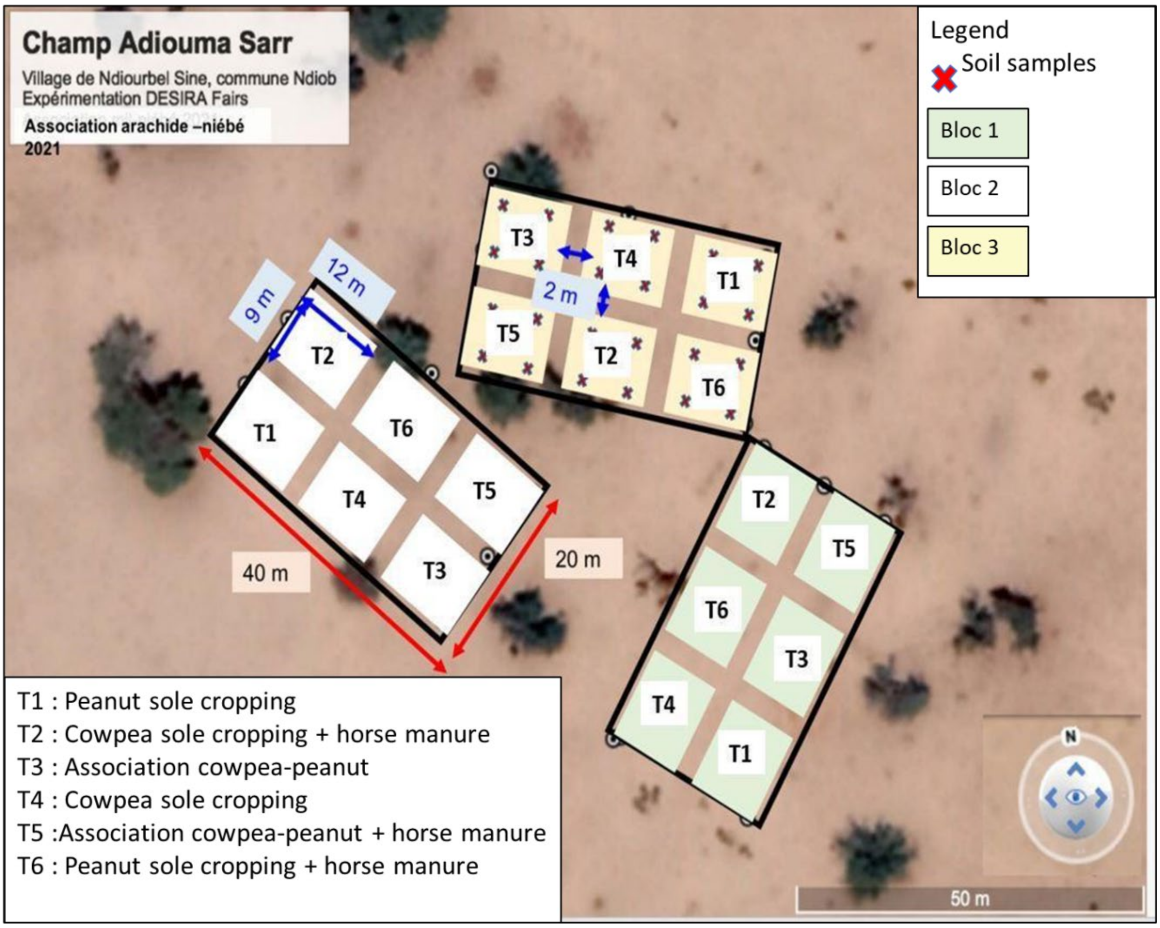

Figure 4 : Experimentation trial in Ndiourbel Sine (2021)

Trials in field 2 of Mbatar

No experiments were carried out in 2021 on the central field of Mbatar, which only entered the co-construction scheme in 2022.

In 2022, the same legume-based cropping systems tested at Ndiourbel Sine in 2021 were installed at Mbatar. The only addition was the compost treatment (T7) described above. Each treatment measures 97.5 m2 (15 m x 6.5 m). The distance between 2 blocks is 2 m and 1 m between treatments. The same varieties were used at Ndiourbel Sine and Mbatar.

It is important to note that in 2022, satellite trials (in farmers' fields) were carried out (9 trials), but they are not presented in this report. These satellite trials were on cowpea-groundnut association with diverse spatial modalities (mixed sowing or in line), diverse varieties, and diverse crop residue mulching.

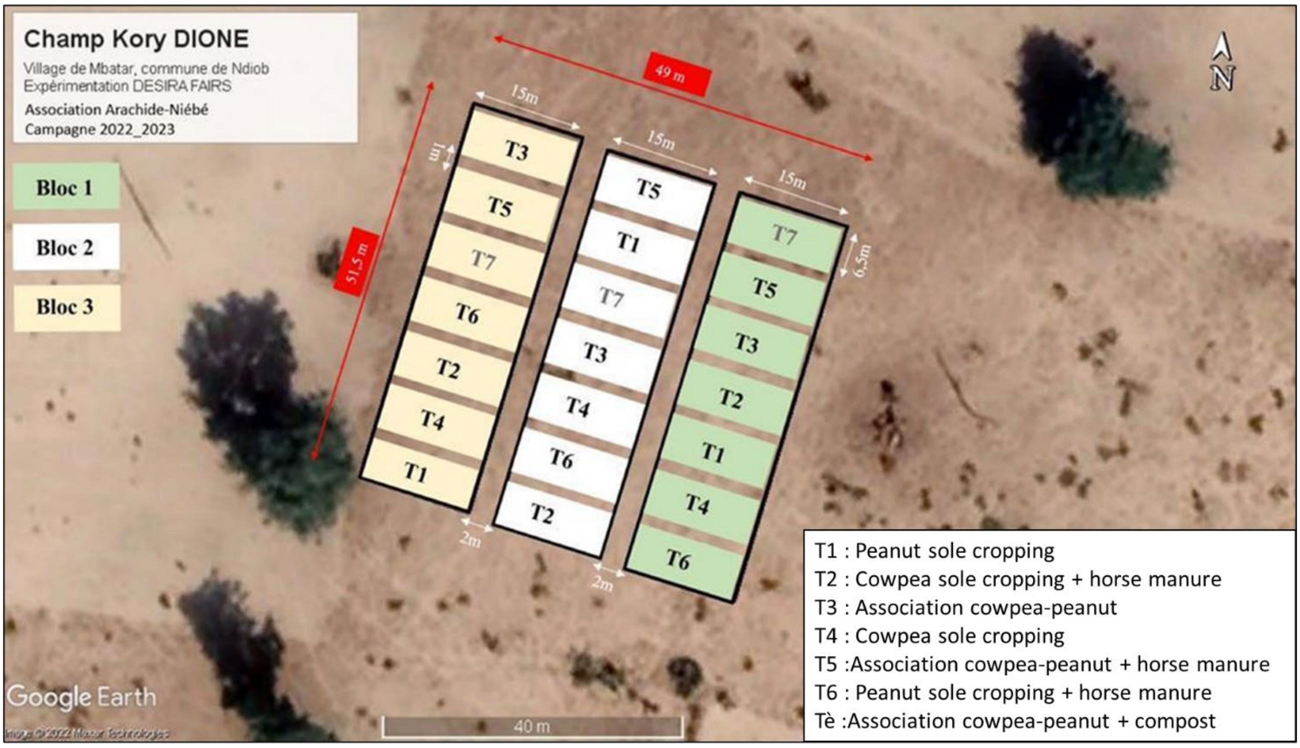

Figure 4 : Experimentation trial in Mbatar (2022)

Table de mesure développé durant l'essai:

Variable	Unités	Methodologie	Fréquence	Responsable
Sol : Total carbon	% C	54 samples (0-10cm; 10-20cm; 20-30cm) before manure deposition	1	Local partners
Sol : Organic matter	% OM	54 samples (0-10cm; 10-20cm; 20-30cm) before manure deposition	1	Local partners
Sol : total nitrogen	% N	54 samples (0-10cm; 10-20cm; 20-30cm) before manure deposition	1	Local partners
Sol : Available phosphorus	% P	54 samples (0-10cm; 10-20cm; 20-30cm) before manure deposition	1	Local partners
Sol : pH	pH	54 samples (0-10cm; 10-20cm; 20-30cm) before manure deposition	1	Local partners
Millet : Plant height	cm	Based on 15 plants	1	Local partners

Millet : numbers of leaves	nb	Based on 15 plants	1	Local partners
Millet : cob weight, grain weight, biomass weight	Kg	Based on 15 plants	1	
legume (cowpea and groundnut) : plant height	cm	Based on 10 plants	1	
legume (cowpea and groundnut) :branches number	nb	Based on 10 plants	1	
legume (cowpea and groundnut) : flowering date	date	Based on 10 plants	1	

Component 2- Agronomic performances agronomique

Section 2.1 : Agronomic performances of groundnut and cowpea in tested technologies (legume, manure, compost)

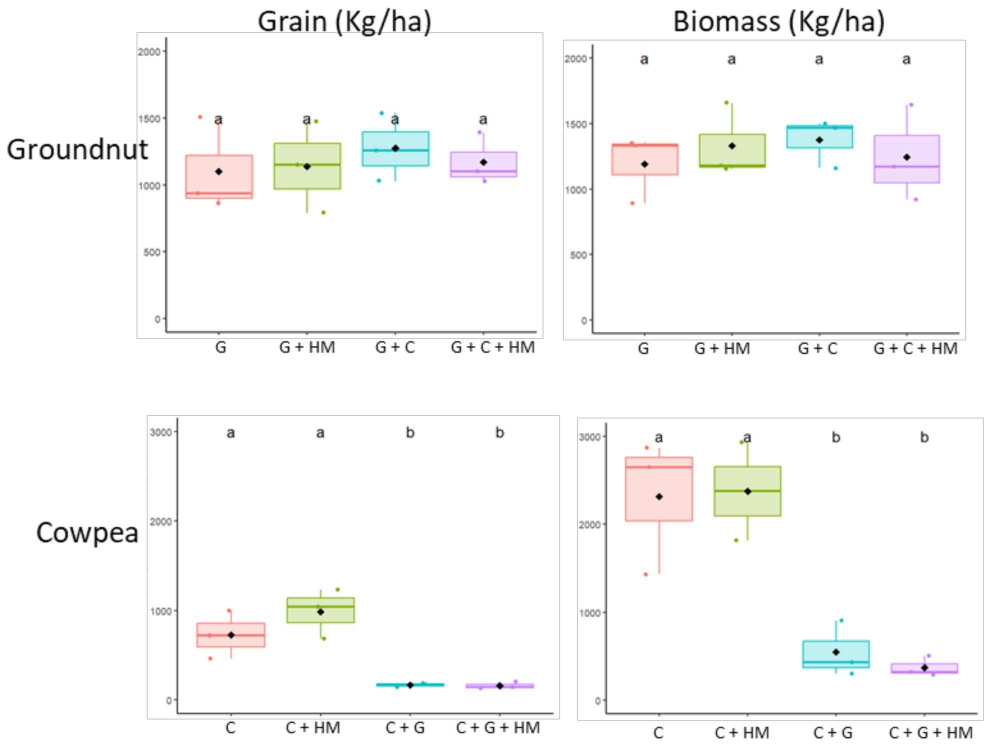

Figure 5 : Grain and biomass production in Ndiourbel Sine in 2021 for groundnut and cowpea and for technologies tested (horse manure, association) (G : groundnut; C : cowpea; HM : Horse manure).

The main results to be retained from these results in 2021 at Ndiourbel are :

- In sole cropping, both groundnut and cowpea yields benefited from organic manure, both on grain (3% and 36% respectively) and biomass (12% for both crops).

- The groundnut-cowpea combination improved both grain and biomass yields (16% and 15% respectively). With an LER of 1.39, this combination seems promising, but the ecophysiological/biological mechanisms involved remain to be understood.

- The combined effect of the association and organic manure showed original results, as manure appeared to reduce the agronomic performance of the association (-5% grain and -32% biomass). This phenomenon were not observed in in the field trial of Mbatar in 2022. One hypothesis is that the manure "inhibited" a physiological process that made the association beneficial. Indeed the field trial in Ndiourbel Sine has significantly more carbon and nitrogen than the field trial in Mbatar. Therefore, we can reflect on the assumption that horse manure input in a soil with sufficient level of nitrogen could reduce the added the value of the association cowpea-groundnut.

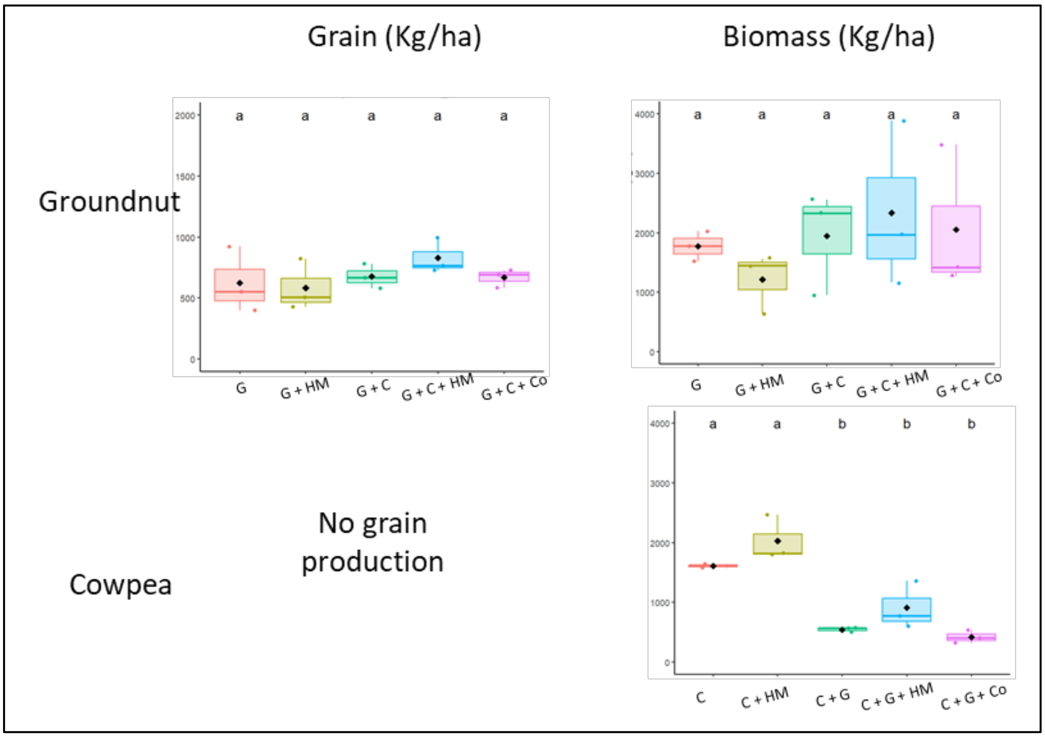

Figure 6 : Grain and biomass production in Mbatar Sine in 2022 for groundnut and cowpea and for technologies tested (horse manure, association) (P : groundnut; C : cowpea; HM : Horse manure).

The main results to be retained from these trials on the Mbatar field in 2022 are :

- In contrast to the Ndiourbel Sine trials, the addition of horse manure to the groundnut-niebe combination increased production by 23% (154 kg/ha). On the other hand, adding compost to the combination did not increase yields (20% loss), raising questions about the quality of the compost.

- Groundnuts in association with cowpeas yielded more pods than sole cropping groundnuts (+8%).

- Surprisingly, horse manure reduced yields on pure groundnuts (-6%), showing both the heterogeneity of performance in this region, and perhaps the difference in manure quality too.

- With regard to cowpeas, an important result is the absence of grain yield on this Mbatar field in 2022, whatever the treatments. The reasons for this need to be investigated, and only the hypotheses of the nature of the soil or an atypical 2022 rainy season (early rains at the start of the season and late rains at the end) can be formulated. Another hypothesis could come from the observation of heavy rainfall combined with hailstorm (called locally “pluie de glace”, i.e. “iced rain”) during flowering of cowpea and groundnut.

Section 2.2 : Agronomic performances of Millet in rotation with distinct legume technologies tested in Ndiourbel Sine in 2022.

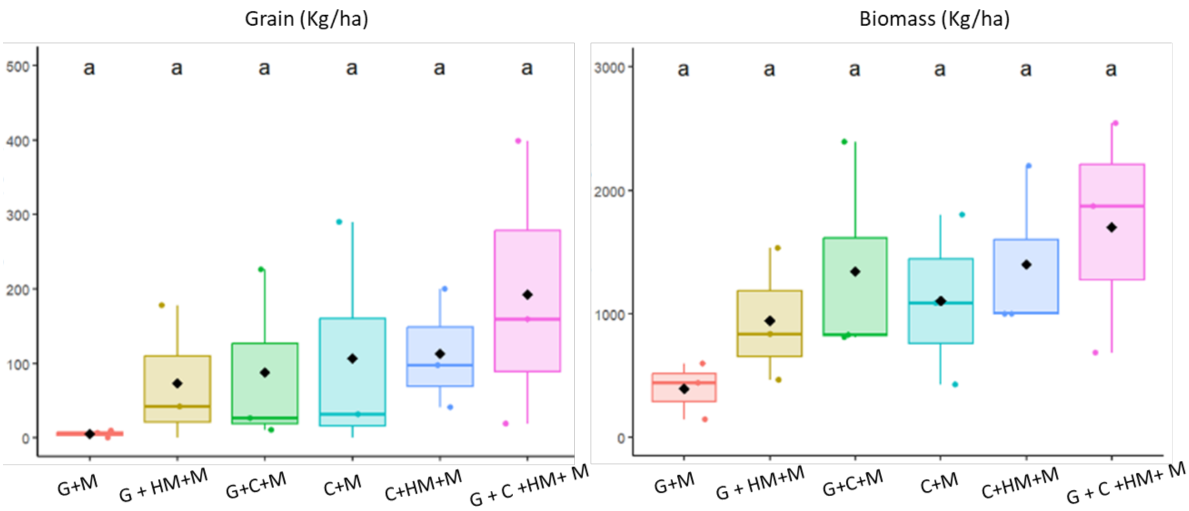

Figure 7 : Grain and biomass production in Ndiourbel Sine in 2022 for Millet in rotation with legume technologies tested (horse manure, association) (G : groundnut; C : cowpea; HM : Horse manure; M : Millet).

Although there were no statistical differences between the treatments and conventional practice (pure groundnut followed by millet in rotation), higher yields were recorded for the cowpea precedent than for the groundnut precedent. The highest millet yield was recorded when the previous crop was groundnuts and cowpeas combined with horse manure. Moreover, the association cowpea-groundnut is a better crop before millet than groundnut in sole cropping, in terms of performances of the millet in year N+1.

		2021				2022	
		Groundnut		Cowpea		Millet	
		Grain	biomass	Grain	biomass	Grain	Biomass
Ndiourbel Sine trial	T1 : Groundnut sole cropping	1102	1190	x	x	6,5	398
	T2 : Cowpea + horse manure	x	x	988	2379	115	1405
	T3 : Association groundnut cowpea	1277	1374	176	547	89	1348
	T4 : Cowpea sole cropping	x	x	731	2315	108	1113
	T5 : Association groundnut cowpea + horse manure	1174	1242	167	366	194	1710
	T6 : Groundnut + horse manure	1142	1328	x	x	74	950

		2021	2022			
			Groundnut		Cowpea	
			Grain	biomass	Grain	biomass
Mbatar	T1 : Groundnut sole cropping	x	624	1763	x	x
	T2 : Cowpea + horse manure	x	x	x	x	2029
	T3 : Association groundnut cowpea	x	676	1941	x	537
	T4 : Cowpea sole cropping	x	x	x	x	1610
	T5 : Association groundnut cowpea + horse manure	x	830	2329	x	910
	T6 : Groundnut + horse manure	x	588	1210	x	x
	T7 : Association groundnut cowpea + compost	x	670	2046	x	419

Table 1 : Synthesis of agronomic results illustrated in boxplots in the reports (no trials in 2021 in Mbatar, no grain yield for cowpea in 2022 in Mbatar).

Section 2.2- Technico-agronomic dimension :

Pest and disease pressure

Few specific measurements were taken for pest and disease attacks. However, during co-assessment workshops, farmers noted that cowpeas without manure were not at all attacked by insects, unlike cowpeas with manure. It remains to be seen whether it was simply the better biomass production (with manure) that attracted insects more, or whether it was the manure itself (e.g. added moisture) that attracted insects.

Agricultural Inputs

None of the technologies tested were treated with mineral fertilizers, in order to remain as close as possible to farming practices, which use relatively little mineral fertilizer, and to respect the agroecology principle of minimizing exogenous inputs. The same principle was applied to the use of pesticides, which were not used on any of the trials.

Section 2.3- Environmental dimension

No environmental variables (greenhouse gas emissions, erosion measurements, soil humidity) were conducted in this first phase, where priority was given to agronomic measurements to test the most promising technologies. In the second phase, we will no doubt be able to deepen our knowledge of these technologies with environmental performance measurements (nitrogen balance, carbon sequestration, etc.). Nonetheless, it is planed to implement soil analysis at the end of the trials in 2024 to evaluate agroecological technology impact on soil health.

Section 2.4 – Socio-economic dimension

Economic data were not collected during this first phase of the project. However, it is vital to examine the economic feasibility of these technologies for producers, and this will be the subject of on-farm trials in the second phase. In addition to conventional economic balances (gross margin, net margin, etc.), particular attention will need to be paid to work constraints, a point that is often the subject of debate in the implementation of agroecological practices.

Component 3- Agroecologic assessment

Section 3.1- Specific analysis

- Biomass supply (horse manure or compost)

Agroecological innovations tested: Addition of manure or compost

***Agroecological principles tested*:** Synergy, soil health, input reduction, recycling

Comparative performance analysis (compared with groundnuts in pure cultivation):

- *Production of* additional grain for household food security and income generation

-Production of additional biomass for animal feed

Hypothesis tested:

- Manure increases production of the two crops tested (groundnut and cowpea) in sole cropping.

- Manure increases production of the two crops tested (groundnuts and cowpeas) in combination.

- Adding compost achieves the same performance as adding manure

- Association du cowpea-groundnut

Agroecological innovations tested: Cowpea association in pure peanut plots

***Agroecological principles tested*:** Economic diversification, synergy

Comparative performance analysis (compared to pure groundnut):

- *Production of* additional grain for household food security and income generation (cowpea is a food crop)

-Production of additional biomass for animal feed

-Production of a crop that can be harvested early in the lean season (cowpea).

Hypothesis tested:

- Cowpeas have a beneficial effect on the peanut plants around them.

- Cowpea production, even if sown at low density, helps the household to meet its needs in the lean season before the millet harvest.

-

Section 3.2- General assessment

3.2.1 Worshop in Ndiob

A 2-day workshop was held in the commune of Ndiob to understand how the 2 technologies tested could improve or reduce performance on the 4 elements of the selected CAET (Diversity, Synergies, Efficiency and Recycling). The first day was devoted to presenting the objectives of the workshop, and the different concepts through powerpoint illustrations. Once the discussions were over (figure 8), the workshop team prepared the blank evaluation sheets, where each dimension was rated from 0 to 4, and each technology represented by a color. The second day was devoted to the actual evaluation by the farmers. It's important to note that the first dimension (diversity) took up almost half the workshop time, as it was important to understand the evaluation process, and explained in particular the conventional practice scores that had been given in advance by the facilitation team.

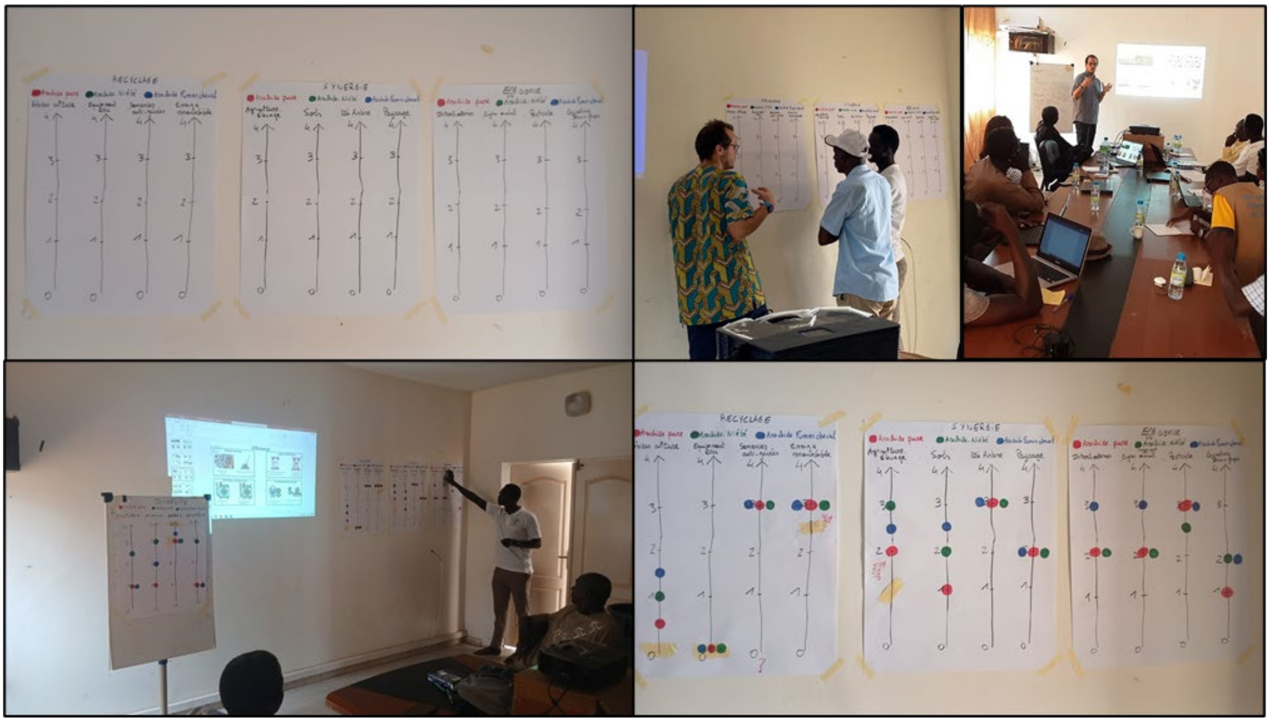

Figure 8 : Worskhop preparation (top), workshop with farmers led by Isidore (lower-left) and results of participatory evaluation (lower-right)

3.2.2 Résultats

Treatment	Element	Index[1]				Element Score[2]	Score
		I	II	III	IV		
Groundnut sole cropping	**Diversity**	1	1	3	1	6	37.5
Association groundnut-cowpea		2,5	3	3	3	11.5	71.9
Horse manure		1	2	3,5	1	7.5	46.9
Groundnut sole cropping	**Synergies**	2	1	3	2	8	50
Association groundnut-cowpea		3	2	3	2	10	62.5
Horse manure		2,5	2,5	3	2	10	62.5
Groundnut sole cropping	**Efficiency**	2	2	3	1	8	50
Association groundnut-cowpea		2	2	2,5	2	8.5	53.1
Horse manure		3	3	3	2	11	68.7
Groundnut sole cropping	**Recycling**	0,5	0	3	3	6.5	40.6
Association groundnut-cowpea		1	0	3	3	7	43.7
Horse manure		1,5	0	3	3	7.5	46.9

Scoring from 0 to 4 for each index as described in the supplementary material (see S1- Page 22). 2 Sum of scores, ranging from 0 to 16. 3 (Item score/16) * 100.

Table 2 : Results of the participatory evaluation of conventional practice and 2 alternative technologies in Fatick for 4 dimension of CAET (diversity, synergies, efficiency, recycling)

Table 2 and figure 8 show that the 2 selected technologies improve performance on all 4 dimensions, with greater improvements for diversity, which can be explained by the addition of a new plant species in the groundnut-cowpea association. Looking in more detail at figure 9, we can also see that the diversity of activities is increased because the new crop associated with groundnuts (cowpea) can be sold and diversify sources of income. The use of horse manure also performs well on the "synergy" component, with better integration of agriculture and livestock farming. Regarding the "recycling" dimension, there is little difference between conventional and agroecological practices, except for the "recycling biomass" sub-category, where both practices optimize biomass production, and reuse it in the case of horse manure. On the "efficiency" component, there is little difference between conventional practices and agroecological alternatives. In fact, this was the only case where an agroecological practice was rated less favourably than the conventional one, as cowpea attracted pests to groundnuts in the case of association. This result shows the importance of studying the trade-offs between the different dimensions of agroecology.

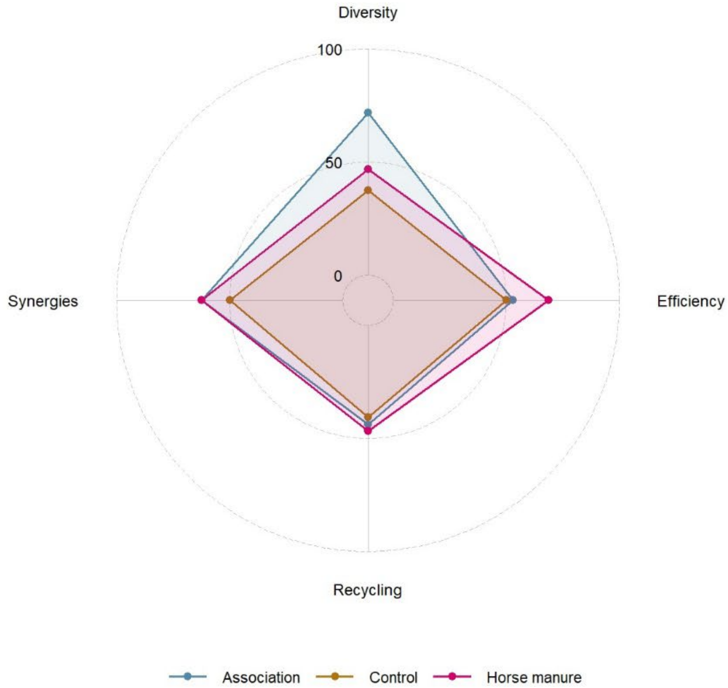

Figure 8 : Radar plot of participatory assessment (CAET) of agroecological technologies in Fatick (horse manure and association cowpea-groundnut) for 4 dimensions (average value)

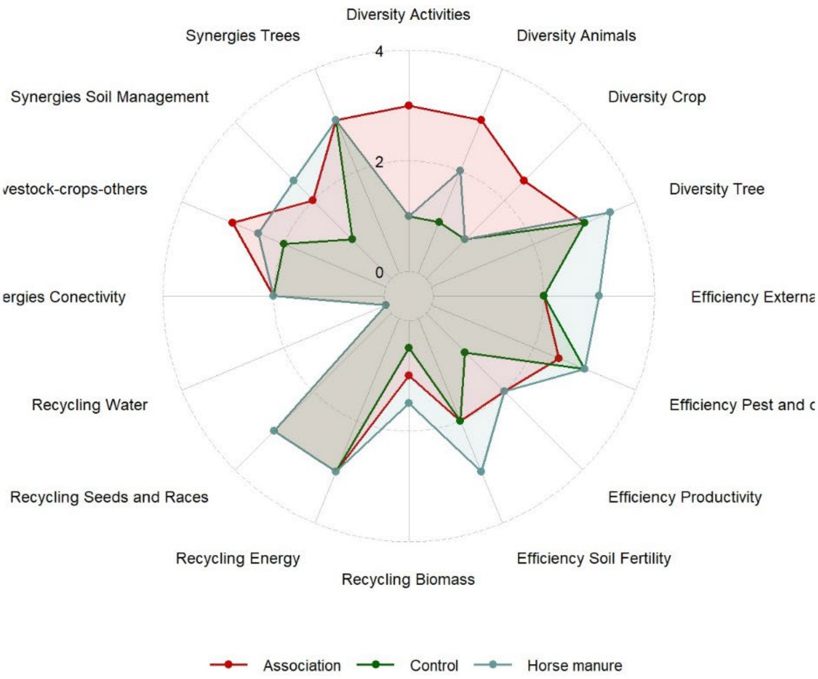

Figure 9 : Radar plot of participatory assessment (CAET) of agroecological technologies in Fatick (horse manure and association cowpea-groundnut) for 4 dimensions and each subcategories .

Recommendations

The technologies tested in this first phase showed promising results and were positively evaluated by farmers. However, we can note avenues to explore to continue to evaluate their performance and thus assess their ability to be adopted on a larger scale:

- The results in farming environments should include multi-criteria analyses including environmental and economic indicators, but also social ones (labor constraints, inequity, etc.). This last point, economic profitability, should be at the heart of the new test phase (cost of transporting manure, economic contribution of cowpea in the association, etc.) in order to demonstrate the ability of these technologies to meet the constraints of producers.
- The legume-legume association is an original innovation tested in this living lab. It is quite innovative and relatively little explored in the literature. It is often found under the name of "double-up" legume

rotations[1]. In the new phase of the initiative, it will be important to equip ourselves with ad hoc experimental trial to continue analysing aout these associations, in particular by determining the effects of competition or synergies between the physiology of the two plants (synergies and trade-off).

- We have seen in this first phase that the effects of horse manure or compost have fairly heterogeneous effects between years or between fields. It is therefore important during the second phase to deepen the analyses of the quality of these biomass sources (sand content, chemical analysis, biochemical content, near infrared spectrometry analysis) with diachronic measurements to study the evolution of quality over time according to different storage methods.

Acknowledgements

The three authors of the report would like to particularly thank the local authorities of the commune of Ndiob, an “agroecological” commune as the mayor rightly says. Also a big thank you to the producers who came to the participatory evaluation workshop, and shared with us all their expertise to evaluate the conventional practice and the 2 agroecological alternatives. Thank you for their trust.

[1] Smith et al., 2016. Doubled-up legume rotations improve soil fertility and maintain productivity under variable conditions in maize-based cropping systems in Malawi. Agricultural Systems, 145, 139-149.