

Evaluation of soil fertility through cropping systems and different soil and climatic conditions

Protocols for ISFM trials in Mali

The collaborative research project between l'Institut d'Economie Rurale (IER) and the African soil information services (AfSIS) proposes to conduct multiple trials to evaluate local effects of the factors limiting the growth and development of sorghum under different soil and climatic conditions. In the long term, this research should lead to the generation of options for integrated soil fertility management (ISFM) for the intensification of agriculture in the Sahelian and Sudano-Sahelian region of Mali and West Africa.

The activities selected as part of this research include:

- Assessing the effect of nutrients on crop growth and development.
- Determining the potential of nutrients available at different levels of soil fertility.
- Determination of the relationship between soil chemical properties and crop productivity.
- Development of techniques for managing soil fertility.

To better link the information above to the real context of the farmer, the work will take into account the agricultural practices in use in the agricultural zones; include the provision for micro-doses of fertilizers and cropping systems including monoculture, intercropping and crop rotation.

1. Objectives

To assess the effects of factors limiting the growth and development of sorghum under different cropping systems, and differing soil and climatic conditions.

2. Sites

In 2010, experimental work will be carried out in two sites. The first is a sentinel site located in Nogossiré in the Kayes region, and the second is a sentinel site located in Koloko in the Segou region (Table 1).

Table 1. Some characteristics of the sentinel sites

Site	Partner	Rainfall (mm)	Agroclimatic zone	Cropping system	Village
Kayes <i>Nogossire</i> ²	IER & DRA	400 - 600	Sahelian	Sorghum and peanuts	<i>Nogossiré</i> , Kandia Sero, Melo, Diajoumbera (5)
Koulikoro <i>Koloko</i> ²	IER & DRA	800 – 1000	Sudano Sahelian	Millet, maize, sorghum and peanuts	<i>Koloko</i> , Seyla, Bankoro Bugula Blendio (5)
Sotuba	IER & AfSIS	850	Sudano Sahelian	Millet, maize, sorghum and peanuts	Sotuba (office)

Selection of field sites

At each sentinel site, the work will be conducted in ten fields selected from those farmers who had previously participated in 2009. Of these ten farmers, five will be under monocropping or continuous cropping of sorghum while the other five will employ cropping systems according to the treatments listed below. However, it must be ensured that the two cropping systems are on the same soil type. The test plots will be located in 10 clusters of each sentinel site in order to allow for a wide range of soil conditions so that the responses are correlated with soil analysis. The choice of fields will cover; fields that are under cultivation, fields under temporary fallow, and fields under permanent fallow. Each field site will be geo referenced.

3. Experimental design

- Trials setup

This year (2010), the trials will consist of two cropping systems based on sorghum, which are;

1. Monocropping or continuous cultivation of sorghum, constituting the first group of treatments.
2. Intercropping of sorghum and cowpea, and rotation sorghum and cowpea, constituting the second group of treatments.

In each case, the trial will consists of six treatments in five replicates in representative clusters (Table 2). Each replicate will be represented by a farmer in the representative cluster. The experimental plot will measure 50m x 20m. The field trial will measure 50m wide by 120m and will comprise of six plots. Sorghum and cowpea spacing will be 80cm x 50cm.

- Crop varieties

Two improved varieties of sorghum of delayed senescence type (stay green) will be selected for experimentation. For Nogossiré, the variety called Séguifa Malisor 92 -1 with a yield

potential of 3 t ha⁻¹ adapted to the Sahelian zone (400-600mm) will be used. In Koloko, the variety called Tiandougou with a potential yield of more than 3t ha⁻¹ and adapted to the Sudano-Sahelian zone (800-1000mm) will be grown. The cowpea variety selected must be a forage variety adapted to the growing area. For Nogossiré, the variety Korobalen (IT89 KD 374, which has proven itself in the region of Kayes) will be planted while for Koloko, a local variety will be used.

Treatments

Two treatment groups will be selected according to the cropping practices practiced in agricultural zones of Mali. These treatments are;

Group 1, sorghum monocropping

T1: Control treatment, pure culture of sorghum following farmers practice.

T2: Mechanical placement of sorghum plus 5 kg/ha of complex fertilizer in a 10 mm diameter hole.

T3: Mechanical placement of sorghum plus 35 kg/ha of complex fertilizer in an 18 mm diameter hole.

T4: Farmers practice plus 5 t/ha of organic manure.

T5: Mechanical placement of sorghum plus 5 kg/ha of fertilizer and 5 t/ha or organic manure in a 10 mm diameter hole.

T6: Mechanical placement of sorghum plus 35 kg/ha of fertilizer and 5 t/ha or organic manure in an 18 mm diameter hole.

Group 2, sorghum association

T1: Control treatment, intercropping of sorghum with cowpea following farmers practice.

T2: Mechanical placement of sorghum plus 5 kg/ha of complex fertilizer in a 10 mm diameter hole. Cowpea is then sown next to a sorghum planting hole after the emergence of sorghum.

T3: Mechanical placement of sorghum plus 35 kg/ha of complex fertilizer in an 18 mm diameter hole. Cowpea is then sown next to a sorghum planting hole after the emergence of sorghum.

T4: Monocropping of cowpea following farmers practice.

Table 2. Treatments arrangement in 2010 and 2011

No	Treatments	1 st Year 2010		2 nd Year 2011	
		Group 1	Group 2	Group 1	Group 2
		Monocropping	Association	Monocropping	Association
1	Absolute control (Farmer practice)	Sorghum	Sorghum/Cowpea	Sorghum	Sorghum/Cowpea
2	Mechanical placement (0.2 g /hole)	Sorghum	Sorghum/Cowpea	Sorghum	Sorghum/Cowpea
3	Mechanical placement (1.42 g /hole)	Sorghum	Sorghum/Cowpea	Sorghum	Sorghum/Cowpea
4	Absolute control (Farmer practice)	Sorghum + OM	Cowpea	Sorghum + OM	Sorghum
5	Mechanical placement (0.2 g /hole)	Sorghum + OM	Cowpea (0.2g/hole)	Sorghum + OM	Sorghum
6	Mechanical placement (1.42 g /hole)	Sorghum + OM	Cowpea (0.2g/hole)	Sorghum + OM	Sorghum

4. Agronomic management

The trials will be run and managed by researchers to ensure consistency of agronomic practices at all sites. Standard agronomic practices are recommended.

- Field preparation

The experimental fields will be plowed to a depth of 0-20 cm.

- Sowing

Sorghum will be sown at the spacing of 80 cm between rows and 50 cm between planting holes. 5 seeds will be sown per hill. These shall be later thinned to two plants per hill ten days (10) after emergence.

- Application of organic and mineral fertilizers

The same quality of organic manure will be used consistently on all trials in one sentinel site. To ensure this, after the collection of organic manure, the pile will be well mixed and five 200g samples will be obtained for analysis in the Sotuba lab. Samples will be labeled by writing the site name, type of manure, replicate number (1 to 5) and the sampling date. The pile of manure will be protected from rain and moisture before field application. Fertilizer for the plot will be weighed, bagged and incorporated during land preparation.

- Weeding

Weeding will be conducted in all experimental fields.

5. Observations

- Soil properties at each site

Soil samples will be collected at a depth of 0-20 cm in each experimental plot after land preparation and prior to application of fertilizers or other amendments. A composite sample will be obtained from the mixture of four samples collected using a Y frame method.

- Emergence rate

Emergence rate will be determined 10 days after first seedlings emerge by comparing number of emerged plants versus the planting holes.

- Plant growth measurements

Plant height and basal diameter of 8 randomly selected plants per plot will be measured at three growth stages of sorghum as follows;

- 30 days after emergence
- At 50% flowering (about 50 to 60 days after emergence)

- Plant tissue sample for nutrient analysis

Ten flags leaves per plot will be sampled after heading and placed in well labeled paper bags which will be tightly closed. These samples will be kept cool and sent to the Sotuba lab to be decontaminated with distilled water. The samples will then be oven dried at 60° for 48 hours and sent to ICRAF - Nairobi, Kenya.

- Grain and stover yield determination

Grain and stover (aboveground non-grain biomass) yields in each plot will be determined from a net plot of 4 rows x 3 m (leaving out 1 row from each end and 1 m from each of the sides). Harvesting will be done after the crop has attained physiological maturity. First, the number of plants in the net plot will be counted and recorded. Before cutting the sorghum stems in the net plot, all heads/panicles shall be cut at the base of the head, counted and the fresh weight determined. Then all the stovers (without heads) in the net-plot will be cut at the soil surface and weighed. Five stovers will be randomly selected and the fresh weights determined. The stovers will be cut into 5 cm strips, well mixed and a sub sample of about 500 g taken. For the panicle heads, 10 representative panicles/heads will be selected and their total weight and the individual panicle length recorded. For these 10 heads sub-sample, kernels (grains) will be threshed (separated from the heads (husks)) and both fresh grain and husks weight determined.

The three plant parts (grain, husks and stover subsample) will be oven dried (60 °C for 48 hours) and dry weight measurements taken. In cases where many plants are lost or are not properly filled, the 12 best plants in the plot will be selected and used to determine grain and stover yield.

• Grain and stover nutrient concentration

From a subsample of five plants, a quantity of 50 g of ground biomass will be collected for grain and stover and placed in a plastic bag. These samples will be sent to ICRAF Nairobi for the determination of NPK concentration. The sample bags will be labeled with the name of the site, plot, date and type of the sample.

Land use history

The land use history of the experimental fields for the last ten years will be determined. This shall include information on:

- Cultivation period
- Cropping systems
- Types of fertilizer used in the last 10 years
- Organic fertilizer use in the last 10 years
- Crop residue management
- Fallow periods

Table 3. Observation of working time in 1000m² field

Treatment	Sowing	Fertilizer application	1 st weeding	2 nd weeding	3 rd weeding
T1					
T2					
T3					
T4					
T5					
T6					

Indicate the time in the cell and the number of people involved in this activity: (ex = 2:30, 3 people)

Table 4. Emergence rate recording

Treatments	Planting hole/ 10m ²			
	1	2	3	4
T1				
T2				
T3				
T4				
T5				
T6				

Table 5. Harvesting form

Treatments	Ears harvested				Ears (Kg)				Stover (Kg)				Grain (Kg)			
	Plot 10m ²				Plot 10m ²				Plot 10m ²				Plot 10m ²			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
T1																
T2																
T3																
T4																
T5																
T6																

Table 6. Field observations

Treatment	Harvested planting holes plot (10 m2)			
	1	2	3	4
T1.				
T2,				
T3				
T4.				
T5				
T6				

Daily labour wage _____

Detailed rainfall of the planting season (including day, decade, month and year) will also be recorded.