	Crop: Cowpea Function: Site selection and Field layout	SOP #	IITA-CP-SOP01
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Standard Operating Procedure (SOP) Site Selection & Field Layout

Site selection and field plot layout are important components of experimentations and require adequate attention. Poor site selections and field layouts are major sources of heterogeneity in experimental fields and can have adverse effects on the data quality. This SOP describes the standard processes to be followed in the cowpea breeding programs to ensure appropriate sites are chosen for experiments and the field plot layouts are appropriate. This document describes standard operating procedures (SOPs) for careful selection of sites for setting cowpea trials. This is a living document that will continuously be updated to reflect the most current advances in the cowpea breeding programs.

2. Purpose

The purpose of this document is to outline the roles, responsibilities, and guidelines for choosing appropriate sites for cowpea evaluation. This SOP can also be used as a checklist of what to consider prior to setting up cowpea experiments across sites.

3. Scope

This document contains outlines of steps involved in the choice of experimental sites. It covers key considerations for site selections and field layout, detailing items to look for when searching for a good experimental site.

4. Definition of terms

Site: An area in a specified locality that can be used to conduct field trials
Field lay-out: A map of how trials are placed in the field, with clear

5. Roles and Responsibilities

All staff involved in implementing breeding activities in the cowpea improvement program at IITA must use the site selection and field layout SOP. NARS partners involved in Regional Coordinated Trials or any other Network designed trials are highly encouraged to follow the same SOP for site selection and field layout. No alteration should be made to the procedures unless approved exceptionally by the program leaders. The list of individuals responsible for each section of the SOP is listed below.

Crop Lead breeder (CLB): Responsible for the overall management of the breeding program and for delegating team responsibilities. The crop lead is also responsible for making formal requests for lands that are both inside and outside the research farm unit.
Associate scientists (AS): Support the CLB with follow up and implementation of activities.
Research associate (RA): Responsible for conducting site assessments to establish issues with soil heterogeneity, cropping history, slopes, waterlogged areas etc.
Research supervisors (RS): Responsible for physical on-site verification and mapping of the sites.
Field technicians (FT): Responsible for soil sampling cross sites where necessary, supervising and participating in mapping sites.

6. Procedure

Site selection for cowpea must be guided by the steps outlined below:

Step1: Timing
Site selection is a crucial initial step and must be conducted early. This should be done at least 3 months prior to the beginning of the cropping season. This is to allow ample time to carry out other required operations before establishing trials.

Step2: Consider the representativeness of selected sites

Consider the geographical location of the sites to ensure that the testing sites are representative of the target environments; that is, the environments in which released materials will be grown. Here, use should be made of weather data and geographical information, soil suitability for cowpea and site suitability for some biotic or abiotic stresses. For initial and preliminary yield trials, 3-5 sites are sufficient, while for advanced yield trials, a minimum of six sites should be considered.

In West Africa, we have identified three main Target Populations of Environments (TPE) (Figure 1). These TPEs were identified using cowpea production, area under cowpea, rainfall, temperature, and soil characteristics. For the late testing stage and National Performance Trial, it should be good to have at least 2-3 testing sites per TPE.

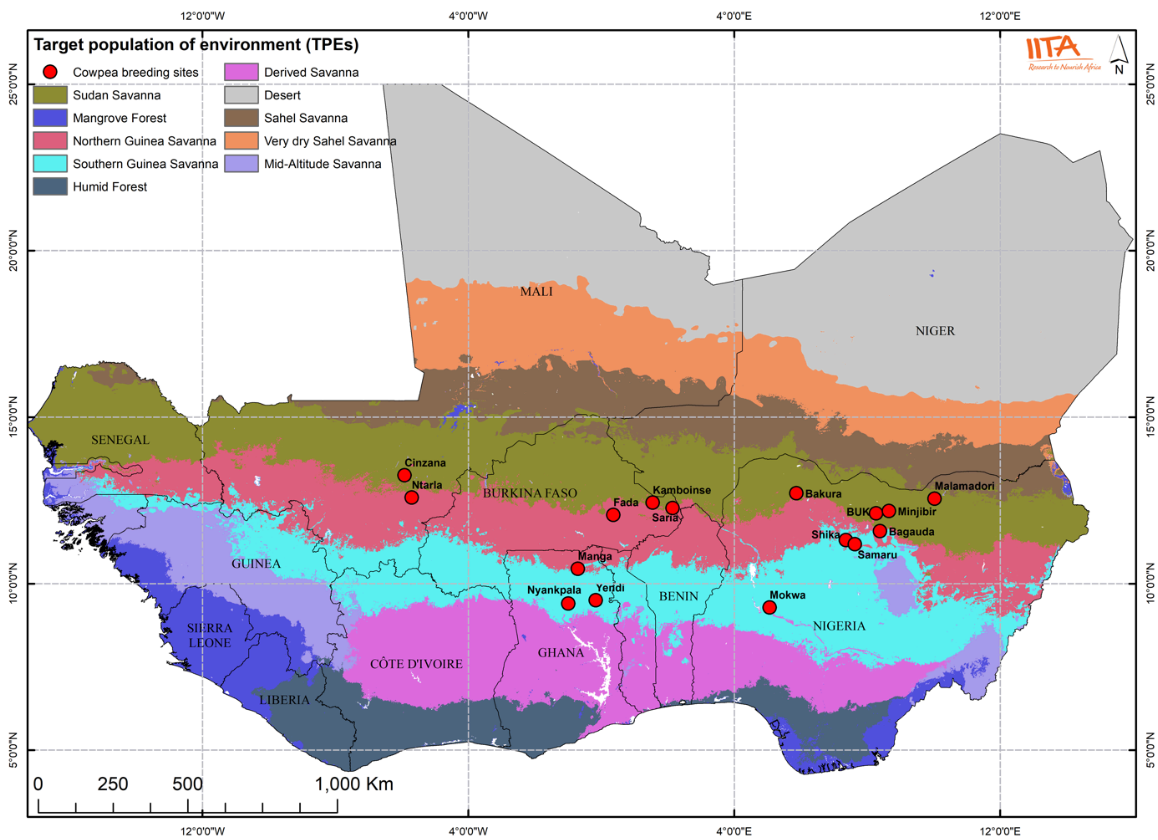

Figure 1: Main cowpea TPEs in WA (Sahel, Sudan Savanna, Northern Guinea Savanna, Southern Guinea Savanna)

Step3: Consider soil heterogeneity

Cowpea can be grown in diverse types of soils ranging from predominantly clay to predominantly sandy and acidic to basic. A well-drained, open-textured sandy loam to clay loam soil between pH 6 to 7 is the best. To choose an experimental site that has minimum soil heterogeneity, attention must be drawn to the features that magnify soil differences. These are described below:

a. **Slopes:** Fertility gradients are generally most pronounced in sloping areas, with lower portions more fertile than high areas. This is because soil nutrients are soluble in water and tend to settle in lower areas. An ideal experimental site, therefore, is one that has no slope. If a level area is not available, an area with a uniform and gentle slope is preferred because such areas generally have predictable fertility gradients, which can be managed using proper blocking.

b. **Site history:** Different treatments used in experimental planting usually increase soil heterogeneity. Thus, areas previously planted to different crops, fertilized at different levels, or subjected to varying cultural managements should be avoided, if possible. Otherwise, such areas should be planted to a uniform variety and fertilized heavily and uniformly for at least one season before conducting an experiment. In order to manage diseases, insects, and weeds, the history and crop rotation of the field should be known.

c. **Empty plots:** Another source of soil heterogeneity is the presence of non-planted alleys, which are common in field experiments. Plants grown in previously non-planted areas tend to perform better. Non-planted areas should be marked so that the same areas are left as alleys in succeeding plantings.

d. **Avoid graded Areas:** Grading usually removes topsoil from elevated areas and dumps it in the lower areas of a site. This operation, while reducing the slope, results in an uneven depth of surface soil and at times exposes infertile subsoils. These differences persist for a long time. Thus, an area that has had any kind of soil movement should be avoided. If this is not possible, it is advisable to conduct a uniformity trial to assess the pattern of soil heterogeneity so that a suitable remedy can be adopted by proper blocking or by appropriate adjustment through the use of the covariance technique.

e. **Avoid waterlogged areas:** Like many other crops, cowpea does not perform optimally in waterlogged soil. The soil should be well drained or avoided if drainage is not possible.

f. **Large Trees and Structures:** Avoid areas surrounding permanent structures. Such areas are usually undependable because the shade of the structures, and probably some soil movement during their construction, could contribute to poor crop performance.

g. **Unproductive Site:** A productive site is an important prerequisite to a successful experiment. Thus, an area with poor soil should not be used unless the experiment is set up specifically to evaluate such conditions. Frequent soil nutrient analysis (every two years) should be conducted to evaluate the productivity of the soil. Monitor plant growth and productivity from current trials to understand soil deterioration in experimental fields.

h. **Field dimension and GPS:** Record the dimension of the selected field and area (ha or acres) and take the GPS.

i. **Soil analysis:** Regular soil analysis is required to monitor variability in the soil. Soil nutrient tests for cowpea experimental sites should be conducted after every 3 years. For new sites, soil samples must be taken for nutrient analysis before considering the site for trials. This will help ascertain fertility gradients in the field. For frequently used sites, frequent soil analysis (after every 2 years) should also be conducted.

Step4: Considerations for field layout

- Once sites have been chosen, it is paramount to consider minimizing some of the unavoidable sources of heterogeneity using proper field layouts.
- After describing the fertility pattern of an experimental area, several options are available for reducing the effect of soil heterogeneity. These options can be inexpensive, involving only a change of plot or block orientation, but at times, the option may involve enlarging the experimental area or increasing the total number of plots. The options that are commonly used, these are:

i. **Plot Size and shape**

  - The contribution of soil heterogeneity to experimental error stems from differences in soil fertility between plots within a block. The smaller this difference is the smaller the experimental error.

- Therefore, the choice of suitable plot size and shape should reduce the differences in soil productivity from plot to plot within a block and consequently reduce experimental error.
- The gain in precision decreases as the plot size becomes increasingly large.
- Furthermore, higher costs are involved when large plots are used. Hence, the plot size that a researcher should aim for is one that balances precision and cost. This is commonly referred to as optimum plot size.
- Once the optimum plot size is determined, the choice of plot shape is governed by the following considerations:

a. Use long and narrow blocks for areas with distinct fertility gradient, with the length of the plot parallel to the fertility gradient of the field.

b. Blocks should be as square as possible (close to a square) whenever the fertility pattern of the area is spotty or not known, or when border effects will manifest.

ii. **Block Size and Shape**

- Block size is governed by the plot size chosen, the number of treatments tested, and the experimental design used. Once these factors are fixed, only the choice of block shape is left to the researcher.
- The primary objective in choosing the shape of blocks is to reduce the differences in productivity levels among plots within a block so that most of the soil variability in the area is accounted for by variability between blocks.
- Information on the pattern of soil heterogeneity in the area is helpful in making this choice. When the fertility pattern of the area is known, orient the blocks so that soil differences between blocks are maximized, and those within the same block are minimized.
- For example, in an area with a unidirectional fertility gradient, the length of the block should be oriented perpendicular to the direction of the fertility gradient.
- On the other hand, when the fertility pattern of the area is spotty, or is not known to the researcher, blocks should be kept as compact, or as nearly square, as possible.
- Because block size, for most experimental designs, increases proportionately with the number of treatments and because it is difficult to maintain homogeneity in large blocks, a researcher must also be concerned with the number of treatments.

- If the number of treatments is so large that a uniform area within a block cannot be attained, incomplete block designs may be used (This is addressed in detail in the experimental design SOP).

iii. **Number of replications**
- Heritability, i.e., selection accuracy based on variety trials, improves with increased number of replicates.
- However, each replicate is associated with considerable cost. Therefore, it is important for crop variety trials to be optimally replicated.
- For all cowpea multi-location trials, use should be made of at least three replications except for initial evaluation trials where one replication is acceptable due to insufficient seeds and a large number of entries.

iv. **Field layout sketch**
- After the above considerations are taken care of, a sketch layout for each trial should be drawn.
- This should indicate the trial dimensions, areas of the field that will be avoided and spaces for boarder rows.
- The information on trial dimensions will help select the site of the trial in each location

v. **Actual mapping and pegging**

a. Planting manually
- Check the trial design and the sketch
- Determine number of rows per plot and the plot length.
- We often use four rows and four meters for all trials except IET where two rows of 4 meters are used.
- Establish 90-degree angle at every corner of the field
- Mark the 4-meter plot length and place pegs, leaving 1-meter alleys in-between. Use 75 cm spacing between rows.

b. Planting with planter
- Measure the dimension of the field and determine the number of four row columns and number of ranges
- Based on the number of columns and ranges, determine the number of trials that can be established in each field

- Use the field layout obtained from BMS to map all the plots of the different replications per trial for all the trials that will be established in this field
- Use the obtained map to arrange the seed packets in each tray for each column independently from trials and replications (see SOP on seed packaging).

7. Appendix

Contacts for support

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8. References

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