

# ***Field Experiments with Forages and Crops***

***Practical Tips for Getting it Right the First Time***



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and Peter Horne***



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YC and PH  
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## **ABOUT THE AUTHORS**

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## **WHY IS THIS GUIDE NEEDED?**

*Agricultural research for smallholder farmers in developing countries is undergoing great change. Many workers now recognise that agricultural technologies cannot be developed without involving farmers. A new grass for feeding animals, a new upland rice variety or a different method of crop management may each be seen by farmers in ways that scientists do not expect. As a result, many field experiments are being moved off research stations and onto farmers' fields so the farmers can actively participate in the development and evaluation of new technologies. Some of this technology development involves monitoring and encouraging farmer innovations and some involves more controlled experiments on farmers' fields. This often means that field experiments are being conducted in remote places by farmers and field workers who may have little practical experience in running formal experiments.*

*The most common cause of problems with field experiments in these situations is not poor experimental design. Problems usually occur because important, simple procedures are overlooked, such as preventing unwanted livestock from eating the test plants or ensuring that the plots are permanently labelled. This guide provides practical tips for researchers, field workers and students on how to avoid such common mistakes. Many of the examples presented in the guide relate to forages, but the suggestions are also relevant to field experiments with most crop plants.*

## **SOME USEFUL TERMS EXPLAINED**

*Field experiments are often undertaken to select the best and most appropriate of alternative technologies. These alternatives are called TREATMENTS. Treatments can be things that we can see and hold, such as different varieties or species of forage or different types of fertiliser. Treatments can also be things that we cannot see and hold, such as different sowing depths, different rates of seed application, different methods of sowing or different methods of cultivating soil.*

*The treatments are applied to areas of land called PLOTS. One complete set of all treatments is called a REPLICATE. Field experiments usually have 3 or more replicates. Replication is necessary because one plot might be damaged or destroyed. It will also confirm that what is observed in one plot also occurs on other plots with the same treatment. If each replicate is kept separate from the other replicate, it is called a BLOCK. Blocks should be used particularly when the site for the trial is not uniform (for example, on sloping land).*

*VARIABLES are what you measure about each treatment to determine the performance of that treatment. Some examples of variables are plant height, fresh weight, dry weight and seed yield. They can also be factors like protein content of leaves or number of aphids per plant.*

Consider, as an example, an experiment testing the effects of N fertiliser on yields of upland rice. The experiment has 5 rates of N application (0, 20, 40, 60, 80 kg/ha of N) with 3 plots for each rate of N application. On each plot, the researcher measured number of seedlings, plant height, weed density and grain yield.

The rates of N application are the TREATMENTS. What the researcher measured are the VARIABLES.

If the site is sloping and growth of the rice was expected to be greater at the bottom of the slope, the experiment might look like Figure 1, which has 3 BLOCKS. This is called a RANDOMISED COMPLETE BLOCK DESIGN.

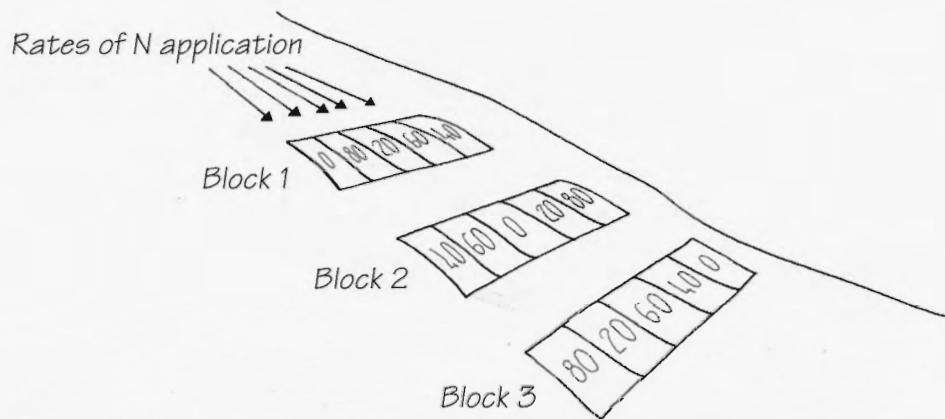


Figure 1: Randomised complete block design

# 1

## ***Planning and Organising the Experiment***







### **Keep a diary and use it regularly.**

*Memories are unreliable. In six months time, will you be able to remember how much seed you sowed and on what date? Almost certainly not! So, as soon as you start planning and organising an experiment, keep a diary in which you write down all your plans, decisions, actions, observations, feedback from farmers and any unexpected events.*

### **Maintain regular contact.**

*Unexpected events often occur during experiments. Farmers and field staff need to know they can contact others for advice and support when dealing with these. Regular contact allows problems and misunderstandings to be resolved quickly.*

*Maintain regular contact with all people involved. Be flexible in your plans and be prepared to make changes if necessary.*

### **Involve farmers in the experiment as much as possible.**

*If the aim of your experiment is to identify and develop forages that will be adopted by farmers, you should involve them actively in all stages of the experiment. Farmers are natural researchers who can evaluate and compare treatments for you and help you understand why they prefer one treatment over another.*

**Explain the aims and procedures of the experiment.**

Often, the people responsible for an experiment cannot be contacted when problems arise. If everyone thoroughly understands the aims and procedures of the experiment, they will be better able to identify and deal with problems. This can be achieved by preparing and discussing an outline of the experiment, which includes:

- **the experiment name** (people may use different names for the experiment. Having a standard name for the experiment that is known by everyone will avoid confusion).
- **the aims and objectives of the experiment.**
- **the location.**
- **plot size and layout.**
- **the date of sowing/planting.**
- **design of the experiment** (what plants should be planted, where, when and how).
- **data collection methods and timing.**
- **methods of collecting, drying and handling samples.**
- **the people responsible for each task.**
- **management of the experiment** (for example, sowing rates, rate and time of fertiliser application, measurements, weed control, animal control and pest management).
- **when you expect the experiment to be completed.**
- **who will write the report and where the data should be sent.**

**Keep the experimental design as simple as possible.**

Simple experimental designs are often the most appropriate, easily managed and easily analysed. Refer to a book on experimental design for examples (e.g. Gomez and Gomez, 1984).

#### **Allow enough time for the experiment to be successfully completed.**

*Experiments may last for a few months or for several years, depending on the objectives. An experiment that cannot achieve its aims properly is a waste of resources and time. Plan enough time and resources for the experiment to produce the results that will achieve its aims.*



#### **Understand your responsibilities.**

*Before starting an experiment, everyone involved should know what tasks they are expected to do, how to do them and how long they will be involved in the experiment. A simple and effective way of doing this is to have everyone's responsibilities clearly written down and discussed by the group. Each person can then explain his or her responsibilities back to the group to make sure they understand.*

#### **Prepare a timetable for the experiment.**

*To help you plan what you need to do before and during the experiment, organise the activities in a timetable. The most important event is often the time when you have to sow the experiment. This may be, for example, one week after the first wet season rains. You should avoid planting in sub-optimal conditions as establishment failure will affect the future of the experiment. Rain will come at the beginning of the wet season whether you are ready or not! All pre-sowing activities, such*

as planning the experiment and organising seed and fertiliser, will have to be completed to make sure you are ready to sow on time. Include other activities like the dates for applying treatments, data collection and field visits in the timetable. If you later make changes to the timetable, write these down in the diary and make sure everyone concerned knows.

### **Prepare in advance the materials that you need.**

Making a list of the things you need before you start an experiment (such as seed and vegetative planting material, fertiliser, labour and tools) will help you plan ahead. It would be very frustrating to make all the preparations for an experiment and then find you don't have the seeds ready. Check that all the equipment you will be using, such as weighing scales, are working properly (see 'Useful tools in the field' on page 37 to remind you of some of the tools you may need).

### **Protect the quality of your seeds.**

Seed is valuable and alive! Seed quality (especially of grass seeds) drops rapidly if it is not stored properly. When you receive seed for your experiment, immediately store it in a cool and dry place. If seed is stored in a hot and humid place, it may be dead by the time it is sown.

A convenient way to package dry seed is in sealed plastic bags. However, do not leave seed, that is stored in plastic bags, exposed to the sun as this can kill the seed.

If you are going to store larger quantities of seed for a long time (>3 months), it is useful to test its quality (germination and viability) before storage. Storing dead seed is not only a waste of time, but can ruin subsequent experiments.

# 2

## **Selecting the Experimental Site**



**Is the site typical of the area you are interested in?**

*The most important step in selecting a site is to make sure that it is representative of the area of interest. For example, if you want to test forages for farmers who have sandy soils, put the trial on similar soils in their region and not on a site that is more convenient to you.*

**The experimental site should be as uniform as possible.**

*Avoid putting the experiment on areas with different soil types, rock outcrops, uneven slope or next to roads, trees and buildings, as these will unevenly affect plant growth.*

*However, it is often difficult to find uniform sites. You should then arrange your blocks so that the plots in any one block are as alike as possible. Try to minimise the variation within each block.*

*If you have a sloping site that is wetter at the bottom than at the top of the slope, arrange your blocks so that Block 1 is across the top of the slope, Block 2 is further down and so on (see example in the section 'Some useful terms explained'). If soil types are different, arrange your blocks so that the soil is similar within each block.*

**Where appropriate, avoid sites prone to erosion.**

*When soil is left without cover, it is susceptible to erosion. Where possible and appropriate, avoid sloping areas where there is a high risk of damage from erosion and avoid areas where there is a possibility of damage from up-slope runoff.*



#### **Where appropriate, avoid sites prone to flooding.**

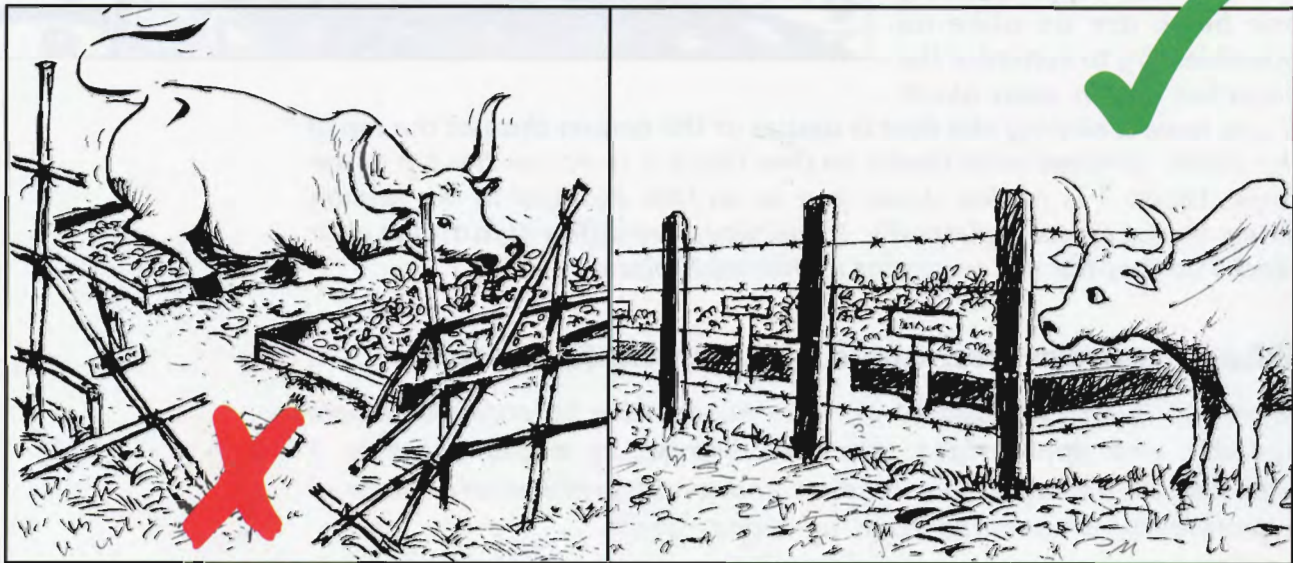
If you are selecting the site in the dry-season, make sure that it is not prone to flooding during the wet season. Flooding can make access to plots difficult and also destroy your experiment.

#### **Make sure the site is available for as long as you need it.**

You may not always know exactly how long the experiment will last, so always allow for the possibility of needing to extend the experiment.

#### **Protect the site from livestock and wildlife.**

A common problem with field experiments is the destruction of plants by wandering animals, especially during the early stages. Young green plants are very tempting to chickens, cattle, goats, sheep and other animals, so check that the fences around your trial will keep unwanted animals out.



### **Minimise outside effects on your experiment.**

The site chosen for the experiment should not be unevenly affected by other activities. For example, if your experiment is too close to fruit trees where farmers are using herbicide sprays to control weeds, chemicals may drift to your experiment, killing some plants.



### **Check how the site has been used before.**

The site could have been used previously for an activity that will affect your experiment. An old road, an old building, an area where a tree stump has been burnt or an area that has been fertilised may affect plant growth in some plots but not others. If you know the site history, you can minimise these effects by the way you arrange your blocks or by leaving some empty plots in the design.

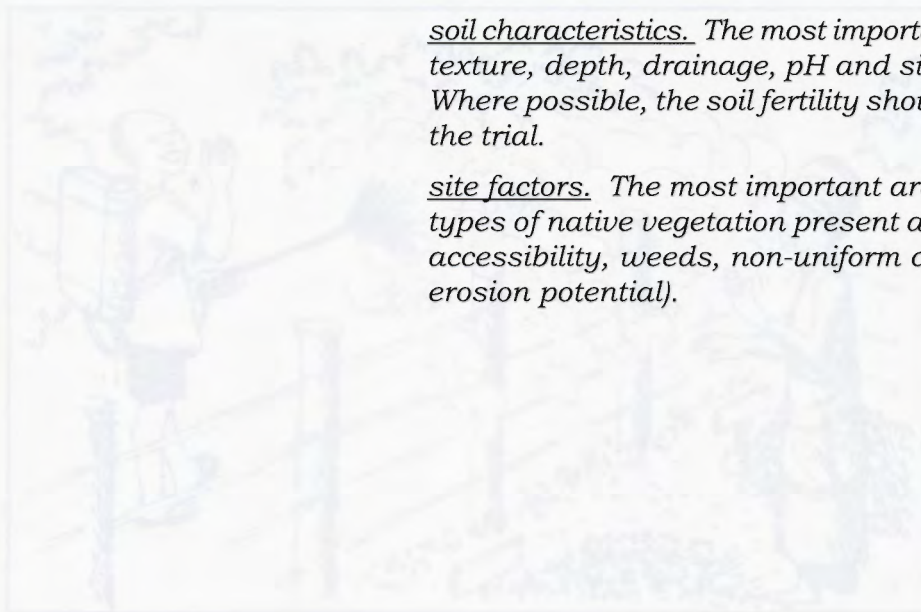
### **Make a description of the site.**

A good description of the conditions at the site will help you and other people better understand the results of the experiment. The site description should include:

long-term climatic information (where possible, 10 years of data).

The most important data are monthly rainfall, number of rain days per month, mean monthly maximum and minimum temperatures and the lowest and highest temperatures in each year.





soil characteristics. The most important data are topsoil and subsoil texture, depth, drainage, pH and significant nutrient deficiencies. Where possible, the soil fertility should be analysed before starting the trial.

site factors. The most important are slope, previous land use, the types of native vegetation present and possible problems (such as accessibility, weeds, non-uniform conditions over all the site and erosion potential).

# 3

## Before Going to the Field

