Step 3: Finally a fertilizer calibration tool is used to convert the recommendation, expressed as kg of fertilizer per hectare of land, to a more farmer-friendly measure. Few if any small-scale farmers will have access to scales to weigh out the fertilizer and not all will know the size of the plots they are using to grow each crop. To overcome this problem, the calibration tool is based on the use of items that are freely available and that can be adapted and used as calibrated measuring scoops. These include cut-down, discarded plastic bottles that previously held water or some other liquid; bottle tops, such as the crimped metal bottle-tops commonly used to cap beer or soda (known as crown corks); or rectangular containers, such as empty match boxes. The calibration tool runs on a laptop. First the dimensions of the container to be used are entered; the tool uses these to calculate the volume of the cylindrical or rectangular container. Secondly, the type of fertilizer being used is selected from a drop-down menu: not all fertilizers have the same density, so one bottle-cap full of one fertilizer will have a different weight to the same bottle-cap full of another type of fertilizer. Next the number of kg of fertilizer to be applied per hectare is entered, along with the method of application (broadcast, banding or point placement, also known as micro-dosing) and the distance between rows and plants within rows. Based on the information provided, the calibration tool provides a user-friendly fertilizer recommendation; for example, instead of 40 kg DAP per hectare it might suggest a plastic water bottle lid full of DAP applied as a band 2.1 meters long.

Where to find the OFRA tools
The FOT tools are available at [http://africasoilhealth.cabi.org/tools/fertilizer-tools](http://africasoilhealth.cabi.org/tools/fertilizer-tools)
The reports section of the website [http://africasoilhealth.cabi.org/reports/](http://africasoilhealth.cabi.org/reports/) contains value information, including the OFRA monograph series.
Farmers who do use mineral fertilizers often buy compound fertilizers which contain the three main crop nutrients, nitrogen (N), phosphorus (P) and potassium (K) in the same bag (NPK fertilizers). Although it may appear simpler to apply one fertilizer that supplies all three major nutrients together, in most cases it would be more cost-effective and efficient to use several different single nutrient fertilizers, each of which supplies just one of the three nutrients. This allows the correct amount of the three major nutrients to be applied, with each nutrient being applied when it is needed by the crop, minimizing waste and losses of nutrients to the air or being washed away with water. Some examples of single nutrient fertilizers include urea (to supply N), triple superphosphate (TSP – to supply P) and muriate of potash (MOP – to supply K).

The problem
Most small-scale farmers in Rwanda apply little or no mineral fertilizers to their crops. They also usually incorporate less organic matter into the soil than is ideal: manure and compost is often available only in limited amounts on small-scale farms; for crop residues, including straw and stover, there are often competing uses, such as for animal feed or bedding, as thatching materials or as fuel for cooking. In addition, organic matter is bulky and therefore expensive to transport and handle. The result is that these farmers’ yields are lower than they could be. This can make them food insecure and prevent them from generating cash incomes from the sale of surplus crops – locking them in to a cycle of poverty.

Even if farmers wish to apply some mineral fertilizer to their crops, it is difficult for them to know the right fertilizer to apply at the right rate of application, at the right time and in the right way. Applying the wrong fertilizer, applying it to the wrong crops, or applying it at the wrong rate could all result in the farmer failing to benefit from the fertilizer they purchased – they could waste their hard-earned money.

Most existing fertilizer recommendations tell farmers how much fertilizer they should apply to a specific crop, usually expressed in kg per hectare. These blanket recommendations often apply to huge areas, even up to whole countries, and encompass several agro-ecological zones. Such recommendations do not help farmers decide which of their crops results in degraded and impoverished soils which are hard, sometimes impossible, to restore to good health.

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The solution
Fertilizer Optimisation is an approach designed to address many of these issues. Some crops respond better to the nutrients applied than others and different crops need different nutrients – for some nitrogen (N) will be the nutrient that limits the yield, while for others this will be phosphorus (P) or potassium (K). In all cases, the relationship between the price paid for fertilizer and the value of the crops produced is important.

Fertilizer Optimisation entails allocating the available single nutrient fertilizers to the crops a farmer wishes to grow, such that the farmer’s return on their investment in fertilizer is maximized.

A set of three complementary tools, based on the principle of fertilizer optimization, has been developed for use in a range of agro-ecological zones in Rwanda. They are based on data generated from several series of crop-nutrient response trials carried out in Rwanda, both prior to and under the auspices of the Optimising Fertilizer Recommendations for Africa (OFRA) project.

The 3 complementary OFRA tools
Step 1: First the Fertilizer Optimisation Tool (FOT) is used. Different FOTs have been developed for different agro-ecological zones in Rwanda. FOTs were developed for different crops in the following AEZs:

- Eastern region, below 1800m
- North western highlands

The FOT currently runs on a laptop or tablet. The FOT is based on a Microsoft Excel spreadsheet. It uses Solver, a standard tool within the Excel spreadsheet which can be used to identify optimal solutions. An even simpler ‘paper-based’ version is being developed based on look-up tables that will need no electronic gadgets.

For the version currently available, using a laptop or tablet onto which the FOT has been loaded, the extension worker and farmer together enter the acreage of the various crops being grown, the price of fertilizers available, the expected price for crop outputs and how much money the farmer has to invest in fertilizer. They then press the ‘optimize’ tab. The Excel Solver then generates a table showing how much of which type of fertilizer should be applied to which crops. The solution, expressed as kg of fertilizer per hectare, aims to maximize the financial return on the money spent on fertilizer.