PROGRAMMING OPTIMIZATION:

The Ugandan Fertilizer Optimization Tool runs on the Microsoft Excel 2007 or 2010 platform withthe Solver add-in to determine optimal crop-nutrient combinations. Chapter 2 explains the basic process of an optimization, the installation steps of Solver, functions of the add-in, and applicationsof the Tool.

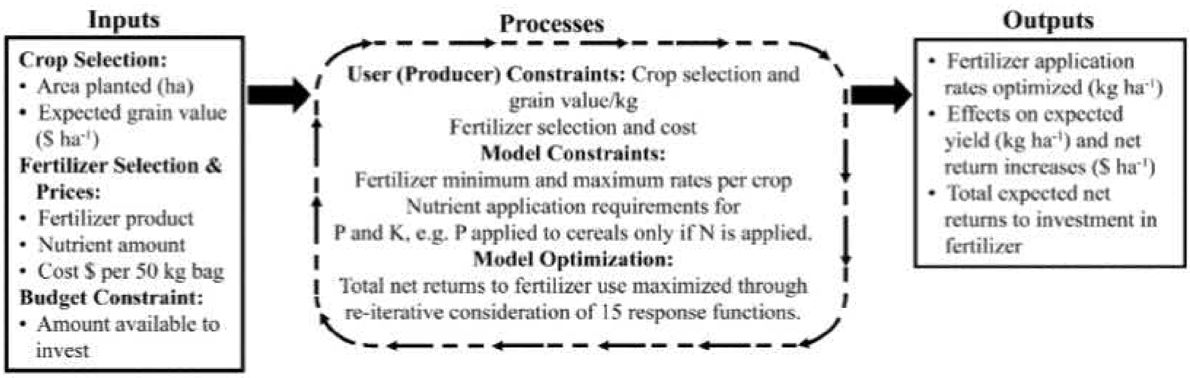
Optimization Basics:

A reiterative process is performed each time the Tool runs an optimization for a user. The following two sections give an overview of this process and explain the mechanics of an optimization.

Process Overview:

The process stage of the Ugandan Fertilizer Optimization Tool considers the farmer input data or farmer specified constraints, pre-determined model constraints, and the model' s optimization mode(Figure 2). The farmer imposed constraints include: i) the expected land area to be planted and predicted value at harvest for each crop; ii) fertilizers available; iii) the cost of using each; and iv) the farmer' s budget constraint. The model is constrained to avoid exceeding the range of inference for the underlying equations with maximum and minimum fertilizer amount limits imposed by the model for the crop-nutrient response functions.

Fertilizer Optimization Diagram



Operational flow model of the fertilizer optimization tool developed for Uganda.

Maximums prevent the amount of a specific nutrient recommended for a crop-nutrient function from exceeding the nutrient rate required for the yield response to plateau. Minimum nutrient application rates of zero kg hal^{l} for all crop-nutrient response functions prevent a non-negativityconstraint of the objective function. Also, the Tool requires some N application before P can beapplied to cereals and bean, and some P application before K can be applied to soybean and groundnut.

Optimization Mechanics:

The reiterative process performed by the Tool using Microsoft Solver add-in to reiteratively searchfor a solution that optimizes a specified mathematical function, often referred to as function, subject to specified constraints. The objective function in this case is to maximize net returns to fertilizer use as the difference of added crop revenue and added fertilizer costs, subject tofarmer input imposed constraints and internal constraints of the tool. The 15 crop-nutrient response functions are combined with fertilizer use, costs, and expected crop values to estimate expected net income given investment limitations until the financial resource is exhausted. The optimizer selectsthe crop-nutrient-rate combinations that deliver the highest net return on investment. The selection of the crop-nutrient-rate combinations relate to a circular reference where each combination must satisfy all constraints imposed by the user and tool.

The tool achieves the objective function of maximizing total expected net returns to fertilizer use by determining the optimal combination of crop-nutrient-rates subject to the budget and response function constraints. The costs for the total amount of fertilizer recommended cannot exceed the financial resources available for investment. Once the optimal crop-nutrient-rate combinations havebeen determined, the results are displayed including the optimized crop-fertilizer application rates for the 15 possible crop-nutrient combinations, expected effects on yield and net returns to fertilizer use, and total expected net returns to investment in fertilizer use. Each set of constraints imposed by the user delivers a unique, but optimized solution based upon attributes pertinent to the farmer’ s operation.