Sustainable Microforestry

An adaptive management tool for smallholder agroforestry farms in Ganze District, Kenya

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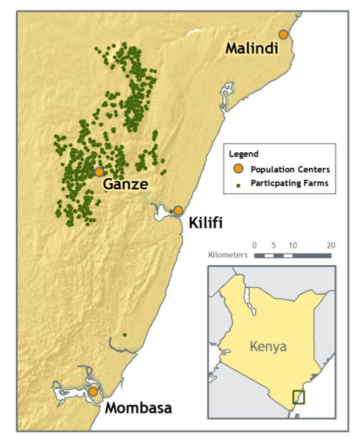
Introduction

The Region

Ganze District is a semi-arid agricultural region in Coast Province, Kenya with poor soils and minimal infra-structure. Impoverished farmers in this area seek to supplement their incomes by both intensifying their crop production and by participating in the charcoal trade.

Location of KOMAZA's participating farms



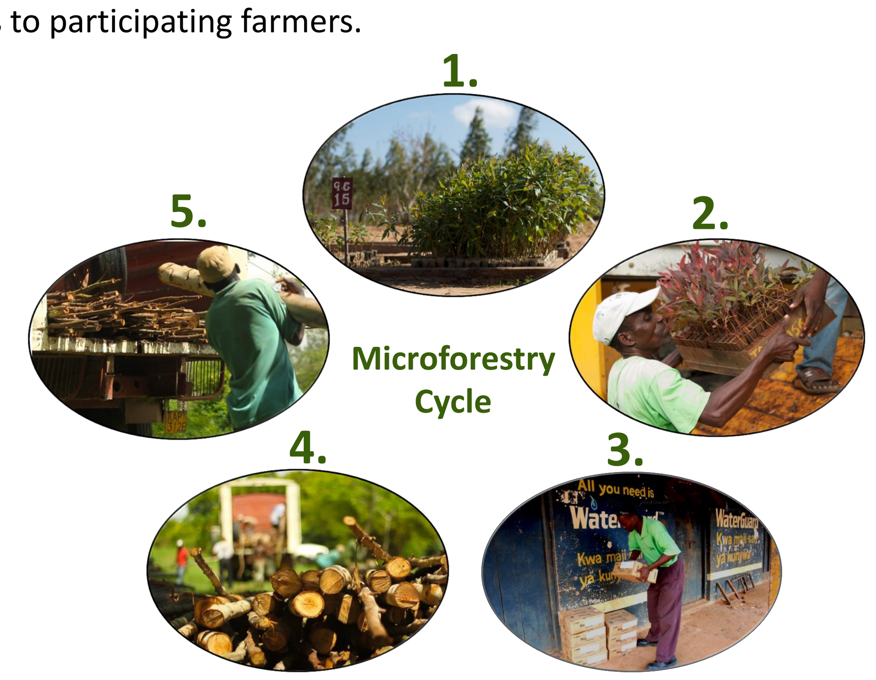
A Vicious Cycle

Agricultural intensification and charcoal-driven deforestation have led to reduced land productivity. This has created a positive feedback cycle where poverty and environmental degradation continue to drive each other.

- **An economically and environmentally sustainable source of income is needed to break this cycle.**

The Opportunity

KOMAZA, a microforestry NGO, aims to alleviate poverty by partnering with farmers to establish small-scale agroforestry plots on their farms (**see microforestry cycle below**). KOMAZA recoups its costs at the sale of the trees and delivers all of the profits to participating farmers.



1. Raise seedlings
2. Help farmers with planting
3. Provide annual inputs
4. Assist with harvesting and processing
5. Transport trees to market

KOMAZA's Need

KOMAZA

Have not completed a full harvest cycle

Currently relying on donor and investor support → **Limited resources**

Limited operational experience → **Limited data**

Will KOMAZA's agroforestry business be financially sustainable **?**

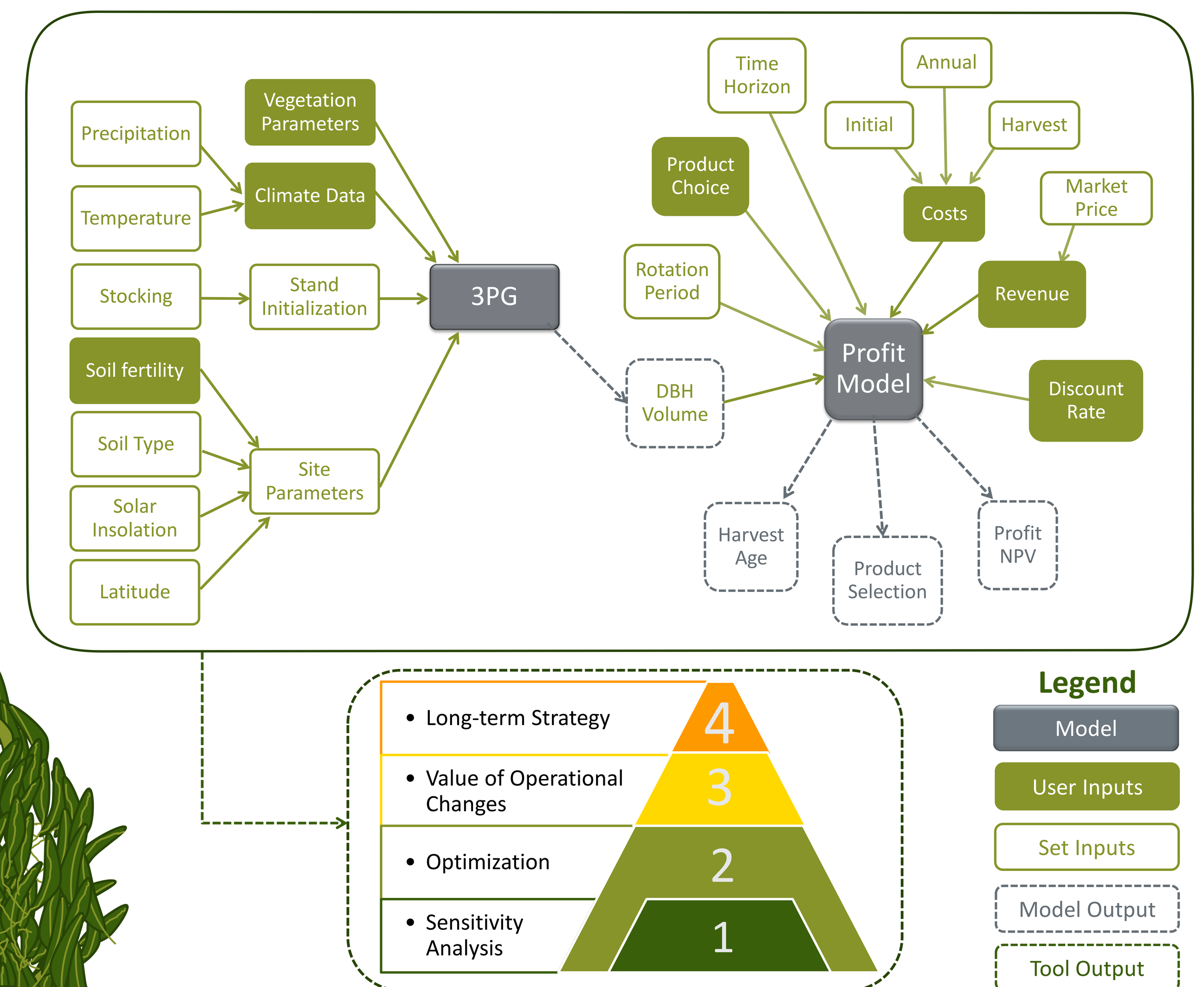
This knowledge gap makes it especially difficult for KOMAZA to adapt its forestry strategies to the range of varying and uncertain conditions in Ganze District.

Project Objectives

1. **Create a flexible tool**, designed to estimate forest productivity and likely profits for a range of environmental and market scenarios.
2. **Demonstrate the various functions of the tool** that can be utilized by KOMAZA to aid management decisions.

Creation of the GaPP Tool

The GaPP Tool



The GaPP Tool

The Growth and Profit Prediction (GaPP) Tool is a tool and user interface that estimates the growth and profitability of KOMAZA's operations under a variety of user-defined scenarios. It integrates a biophysical growth model called 3PG* and our very own Profit Model.

*Landsberg, J., and Waring, R. (1997). A generalized model of forest productivity using simplified concepts of radiation-use efficiency, carbon balance, and partitioning. *Forest Ecology and Management, 95*(3), 209-228.

Using the GaPP Tool

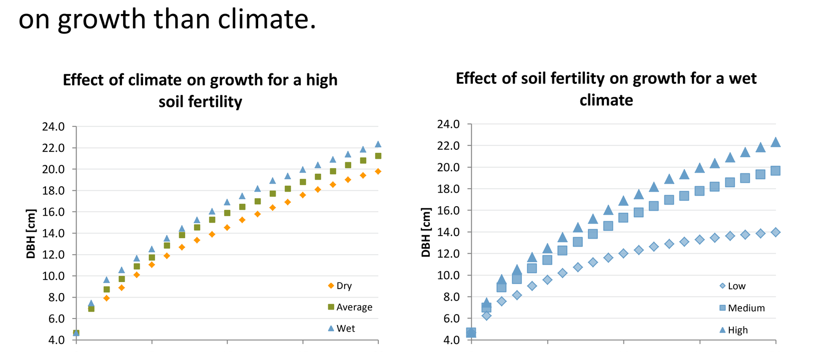
The Four Functions

The GaPP Tool has four primary functions. These functions can be used to estimate profit under different economic and environmental conditions as well as farmers' choices of when to harvest and which forest products to market. The four functions also build upon one another, increasing the scale of the resulting analyses.

Function 1: Sensitivity Analysis

Determining the effect of a change in inputs or environmental conditions on tree growth and profit

Example: Sensitivity of growth to soil fertility and climate.
As shown below, we found that soil fertility has a greater impact on growth than climate.



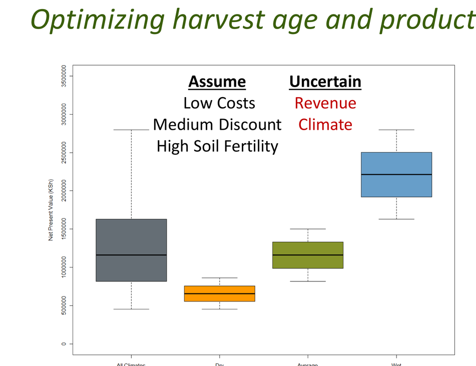
Function 3: Value of Operational Changes

Calculating expected value of changes to operational procedures

Example (Not shown): Effect of increasing or decreasing fertilizer use over a tree's life cycle on expected growth and profit. Results from this analysis varied; depending on the climate, decreasing fertilizer use had either no effect or resulted in a decrease in profitability.

Function 2: Optimization

Optimizing harvest age and product selection to maximize profit

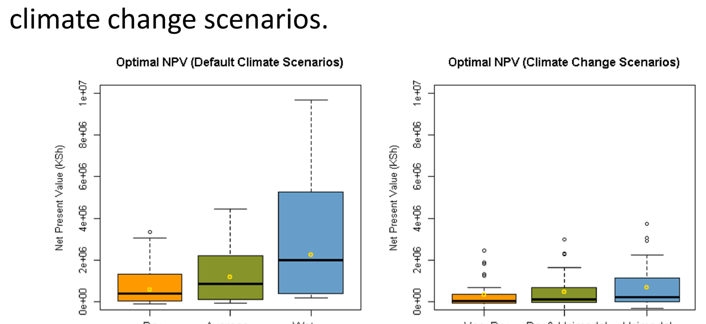


Example: Expected maximum net present value (NPV) of profit given uncertainty in revenue and climate (gray boxplot). When climate is known (or assumed), the range of expected profit decreases (orange, green and blue boxplots).

Function 4: Long-term Strategy

Developing strategic long-term management plans

Example: Effect of climate change on expected profit.
Overall, our analysis showed that profits will decrease under modeled climate change scenarios.



Expected NPV for normal climate and climate change scenarios given parameter uncertainty. Our best estimate is indicated in yellow.

Discussion

Takeaways

- The GaPP Tool provides a clear way to determine the best management option under conditions of uncertainty.
- The GaPP Tool offers analyses across spatial and temporal scales, offering KOMAZA's planners the flexibility to apply a management decision at a regional scale or on a site-by-site basis.
- The GaPP Tool provides a systematic way to analyze trade-offs between profitability and environmental concerns.

Key Strengths of the GaPP Tool

The GaPP Tool is able to offer analyses that are relevant to various decision-makers throughout KOMAZA's team, from data collectors to the CEO.

Tool Function 1 will allow **George, KOMAZA's Information Manager,** to strategically invest resources in refining inputs that have high uncertainty, high impact, and/or low collection costs in order to improve strategic planning and decision-making.

Erin, a Project Manager with KOMAZA , can use Tool Function 3 to calculate the expected value of making an operational change on an individual farm or a series of farms.

Tool Function 4 will enable KOMAZA to effectively scale up its business over time, improving the financial opportunities for as many farmers as possible in an environmentally sustainable way, which is of utmost importance to **Tevis, Founder and CEO of KOMAZA.**

Next Steps

The GaPP Tool effectively fills KOMAZA's knowledge gap caused by a lack of resources and a lack of experience, allowing the organization to predict profit on multiple scales despite uncertainty in environmental and market conditions. However, future improvements to the GaPP Tool should be made to ensure that the tool stays relevant and valuable in aiding KOMAZA's key management decisions.

Specific areas of improvement include:

- **Modeling Environmental Impacts**
- **Validating Model Against Observations**
- **Monte Carlo Sensitivity Analysis**

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For further information, please visit our website at http://www2.bren.ucsb.edu/~kenyaplanit/
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