

Efficient Forestry

How Forest Technology and Optimization Modeling
Can Improve Your Revenue Opportunities

Greg Albert, MS

Forest Planning Analyst

American Forest Management, Inc.

Outline

- Background and Introduction
 - Education and experience
- Forest Genetics
 - Tree improvement and seedling selection
- Harvest Planning
 - Forest modeling and linear programming

Education and Experience

- B.S. in Envi Science 2009 - 2011
Binghamton University
- M.S. in Forestry 2012 - 2015
North Carolina State University
NCSU Tree Improvement Co-op
- Forest Planning Analyst 2015 - Present
American Forest Management, Inc.



Introduction

- **Efficient** and **sustainable** forest management is about making **data-driven** decisions
 - Seedling selection can impact the production efficiency of your forest asset by improving volume and survival
 - An optimized harvest schedule helps align objectives and reduce logistical inefficiencies over the duration of your management plan

Forest Genetics



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Forest Genetics Overview

- Trees are primarily being bred for gains in productivity traits
 - Diameter, height, volume
- Also a secondary focus on disease resistance and adaptability
- Gains achieved using selective genetics
 - Recurrent selection

Recurrent Selection



Breed



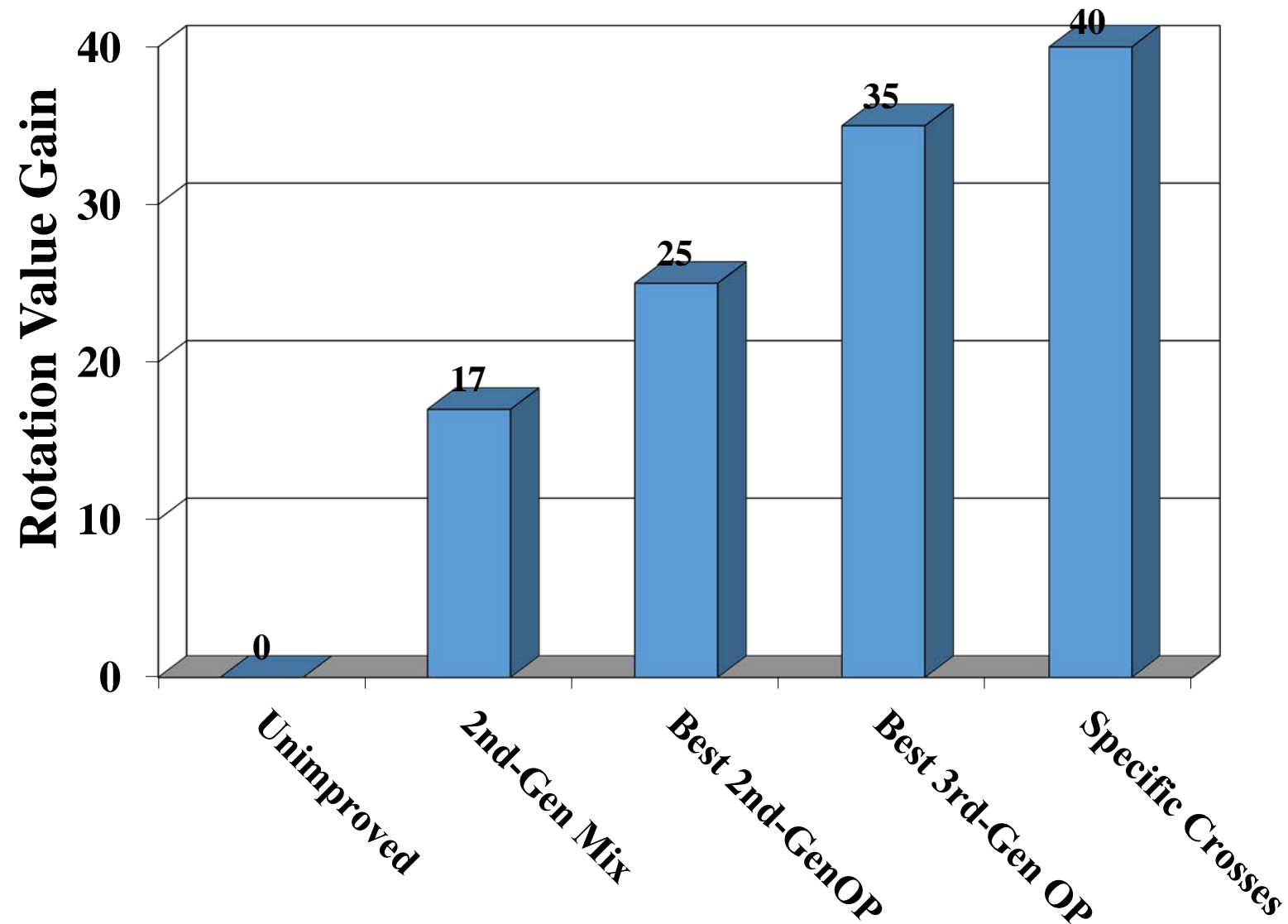
Select

Progeny Test

Levels of Genetics

- **Open-Pollinated (OP)*** - A family that is generated from a known female (a tree or set of trees in an orchard), but the male (pollen) is unknown. It could have come from another tree in the same orchard or from a wild stand nearby.
- **Control-Pollinated (CP)*** - Family offspring produced by deliberately controlling the males and females during mating in conjunction with taking steps to block undesired pollen.
- **Varietal (Clones)** - Bypasses sexual reproduction and seed production to minimize variation. Typically produced through vegetative propagation or somatic embryogenesis.

Summary of Genetic Gain Options



SAME AGE!

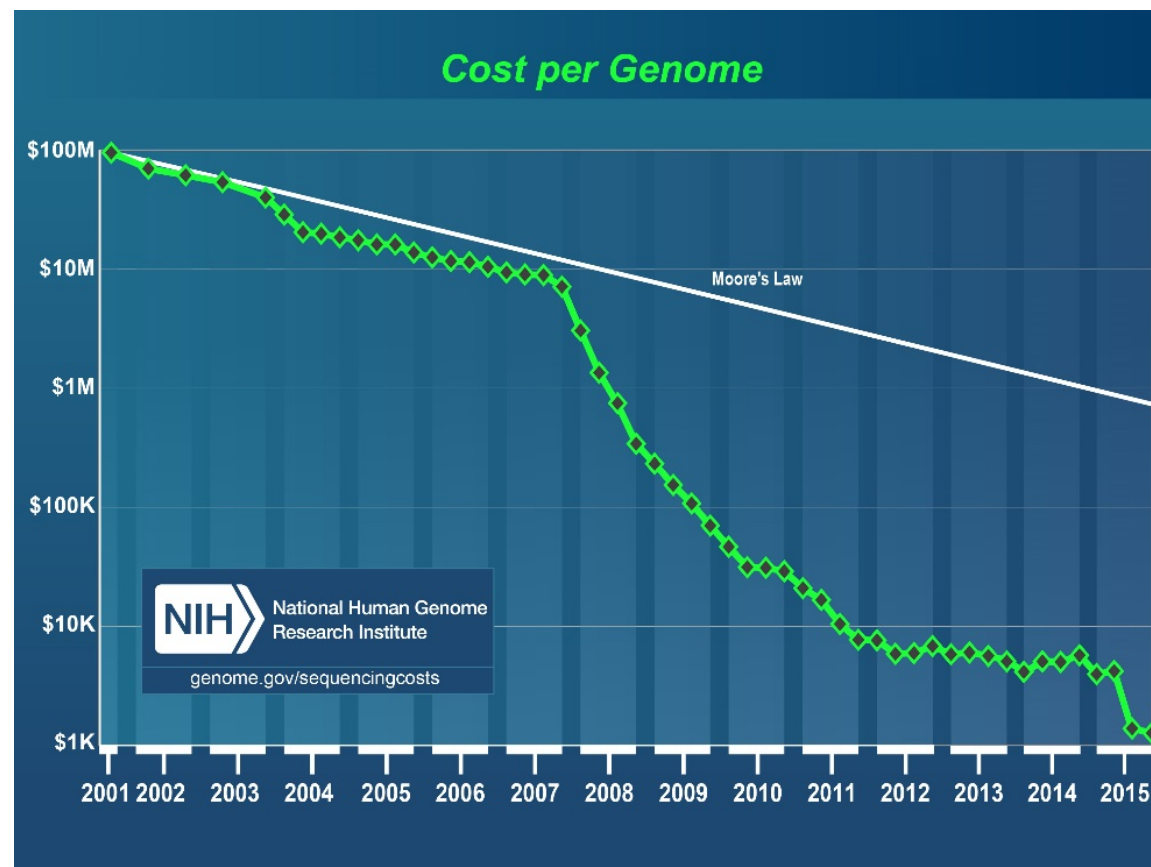
Improved OP

Unimproved



Future of Tree Improvement

- Tree improvement is **ACCELERATING**
- Factors accelerating tree improvement...
 - Implementation of advanced testing study design
 - Cost of biotechnology and integration of quantitative genetics



Harvest Planning

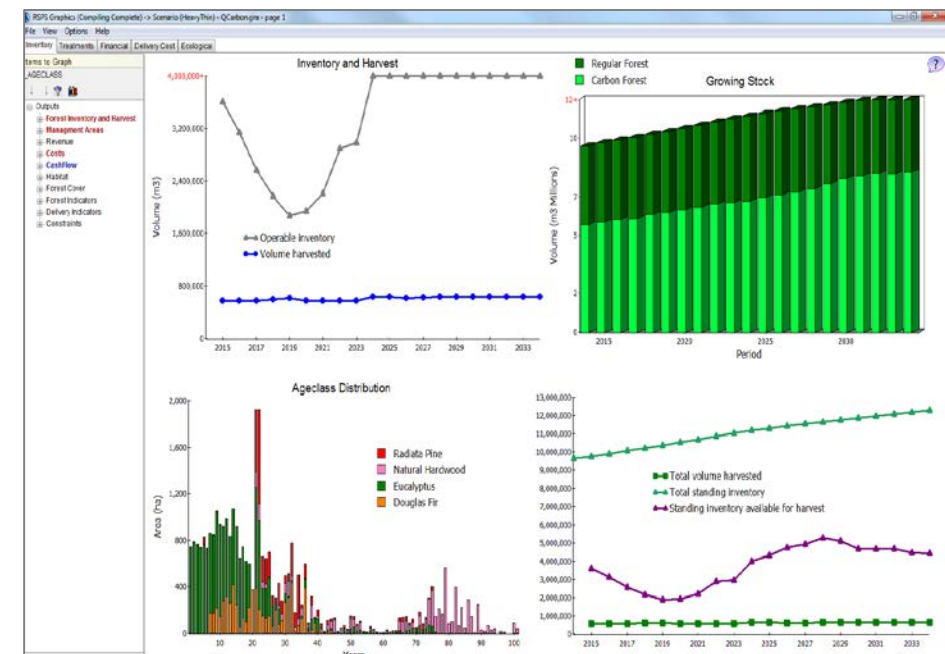
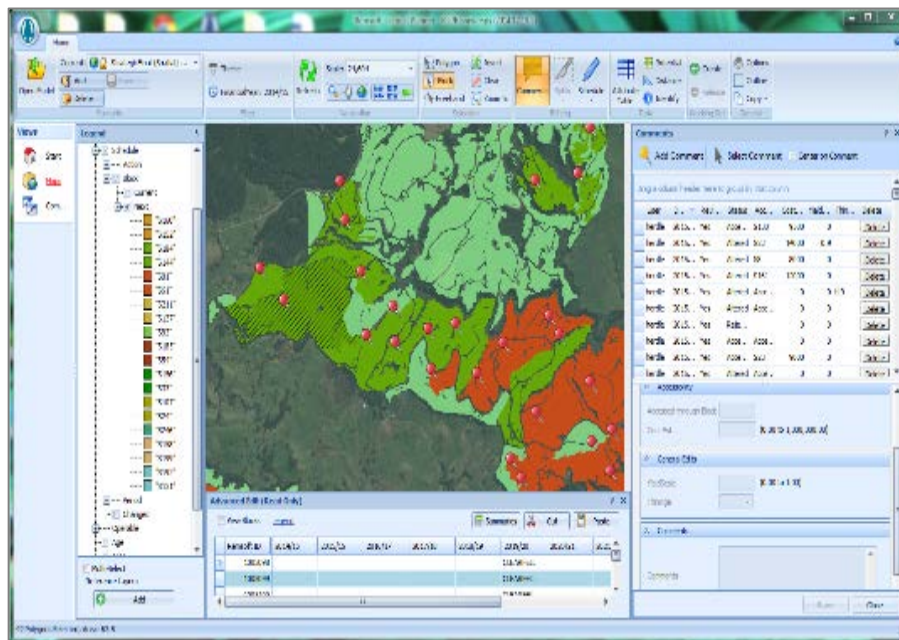


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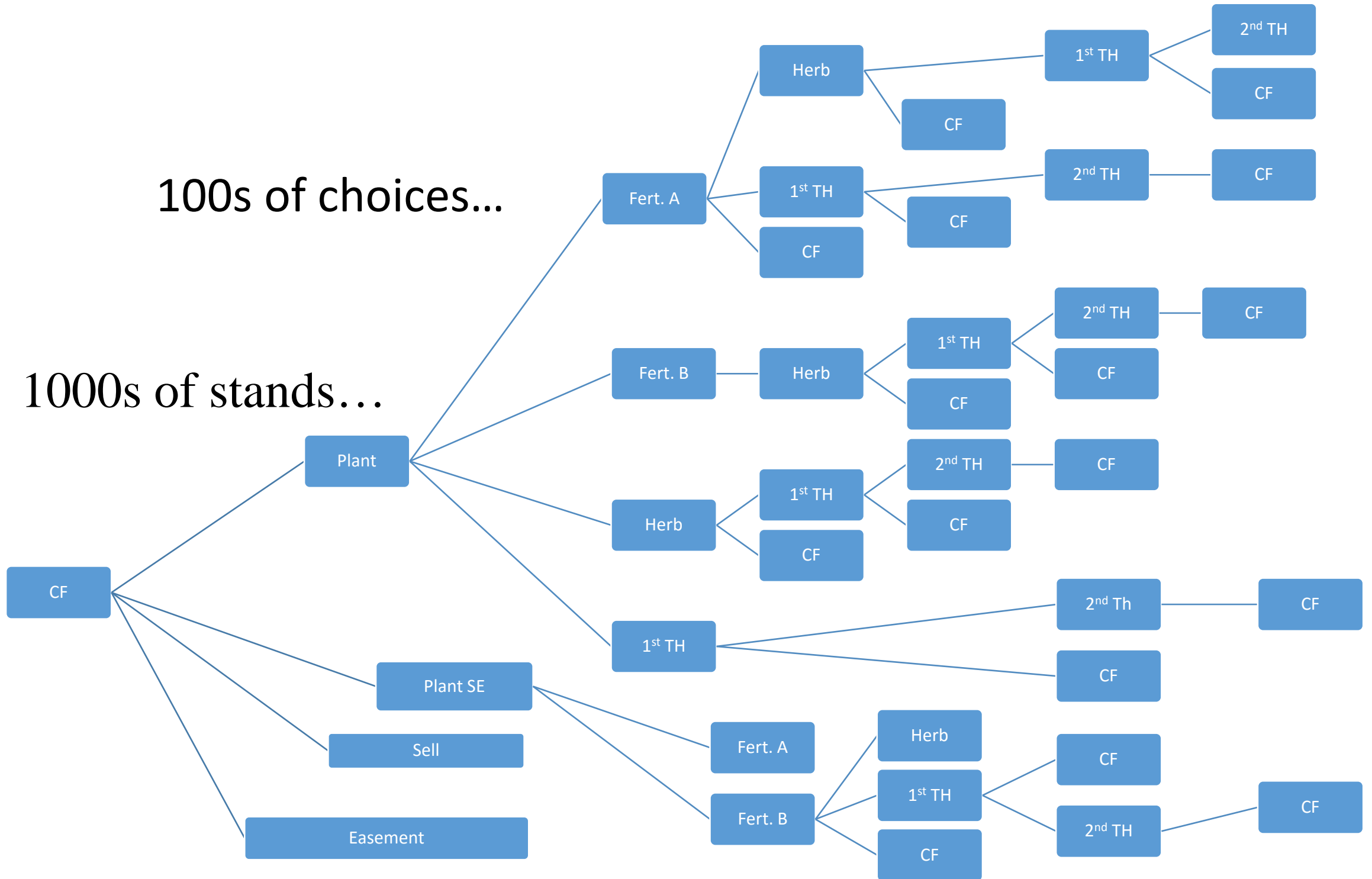


Harvest Planning Overview

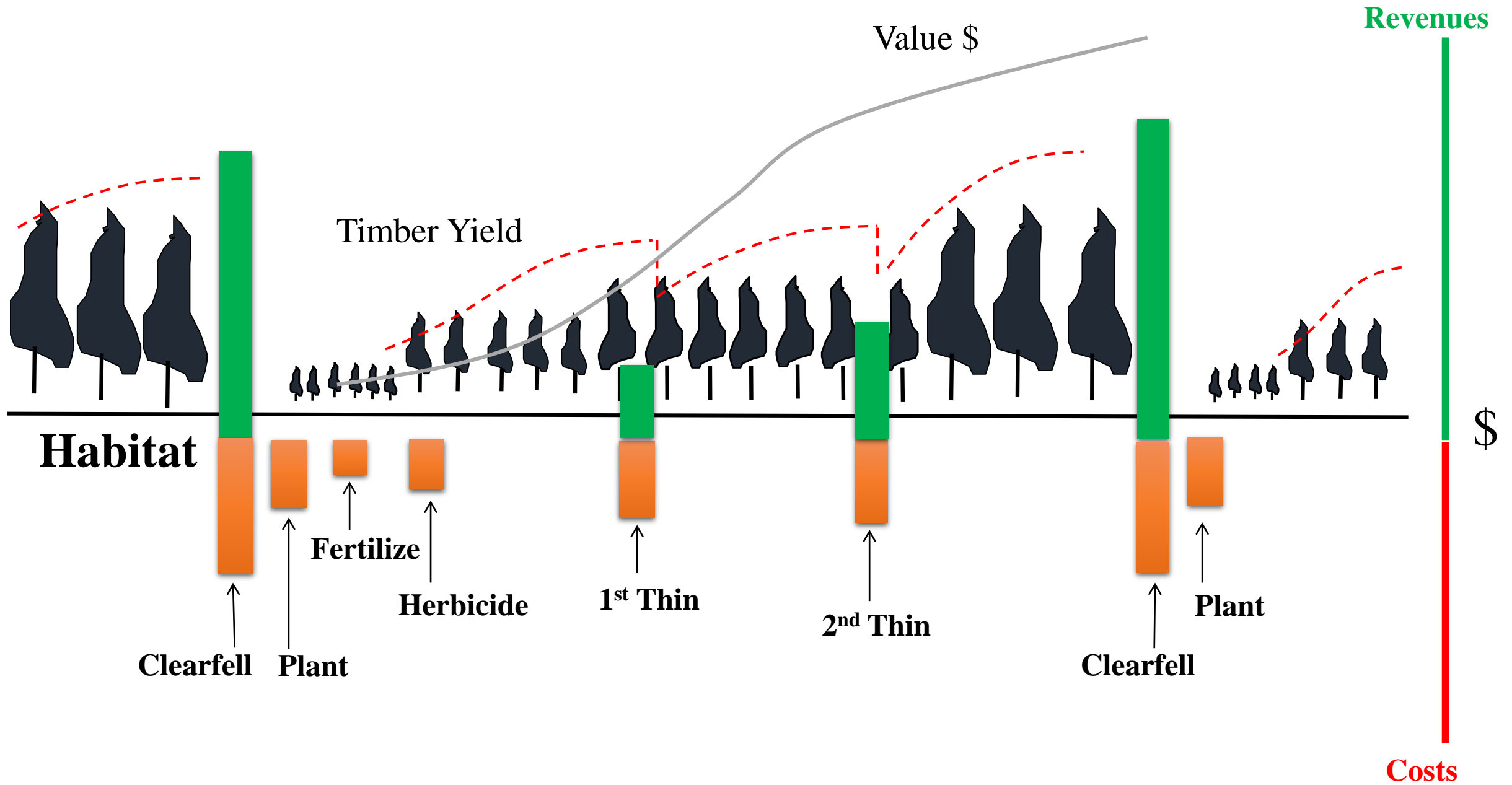
- Forest management is a complex endeavor with many decisions, each having cascading effects
- Forest planning software creates optimized harvest plans using linear programming solutions



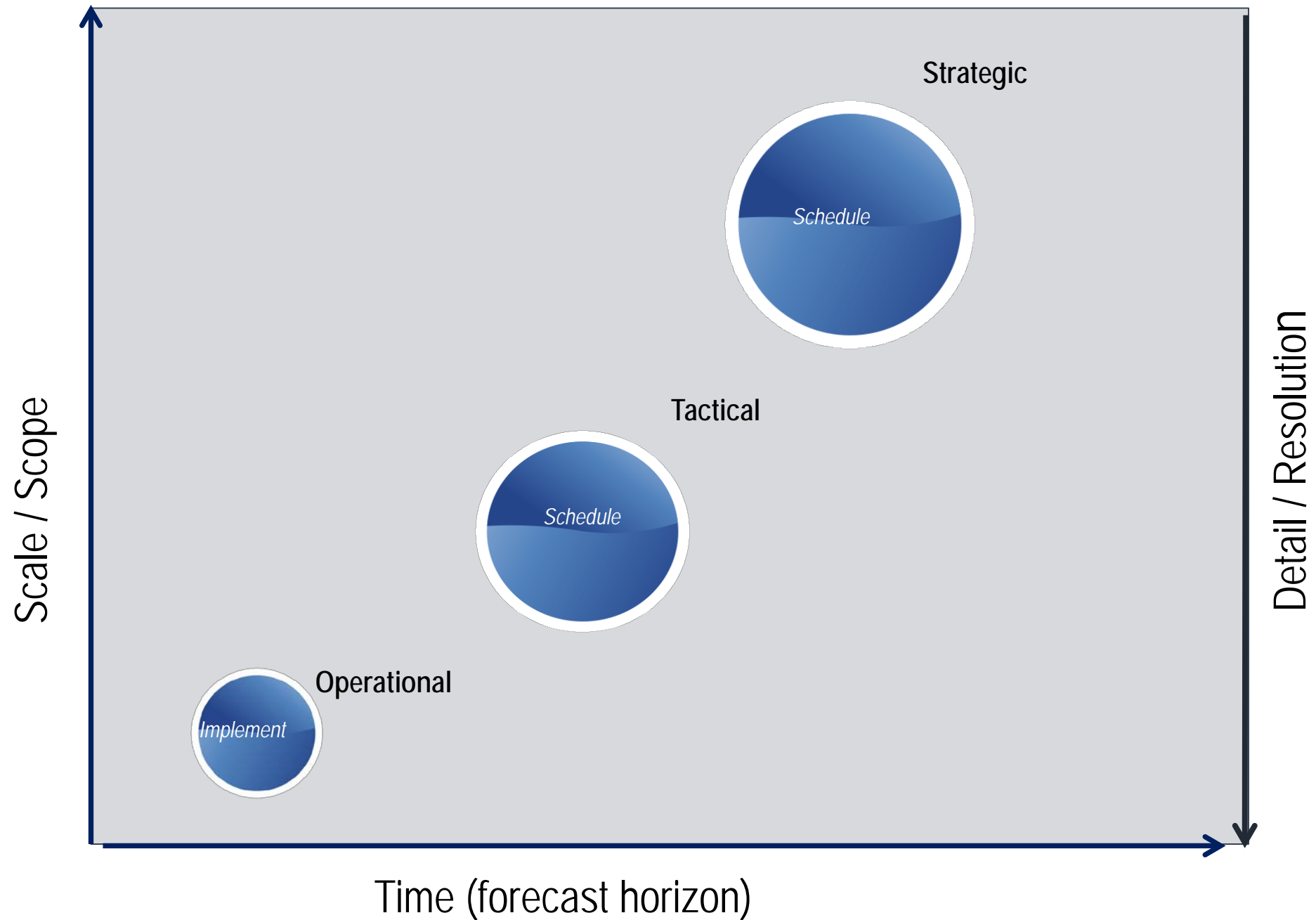
Lifecycle of a Stand



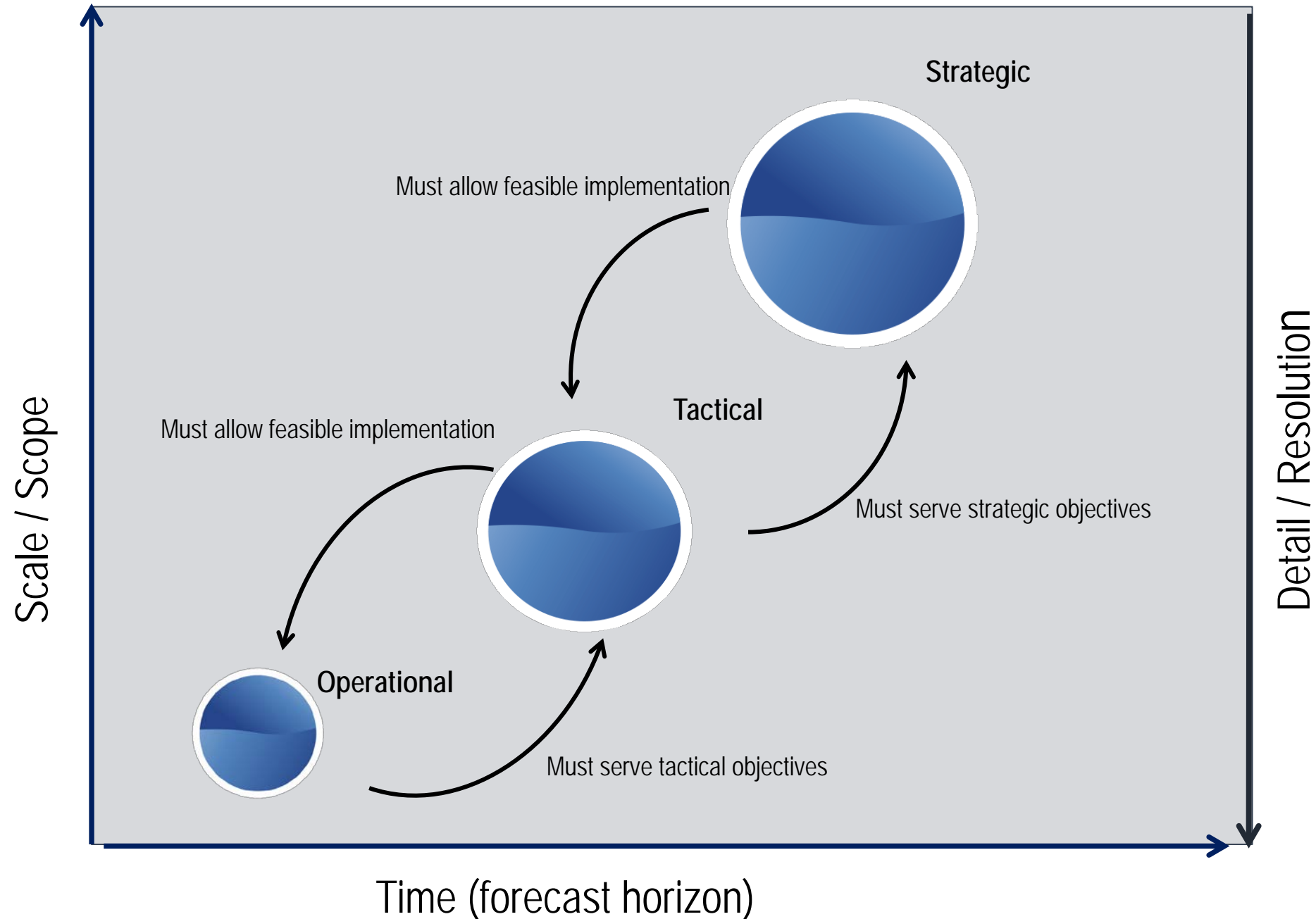
Lifecycle of a Stand



Lifecycle Planning



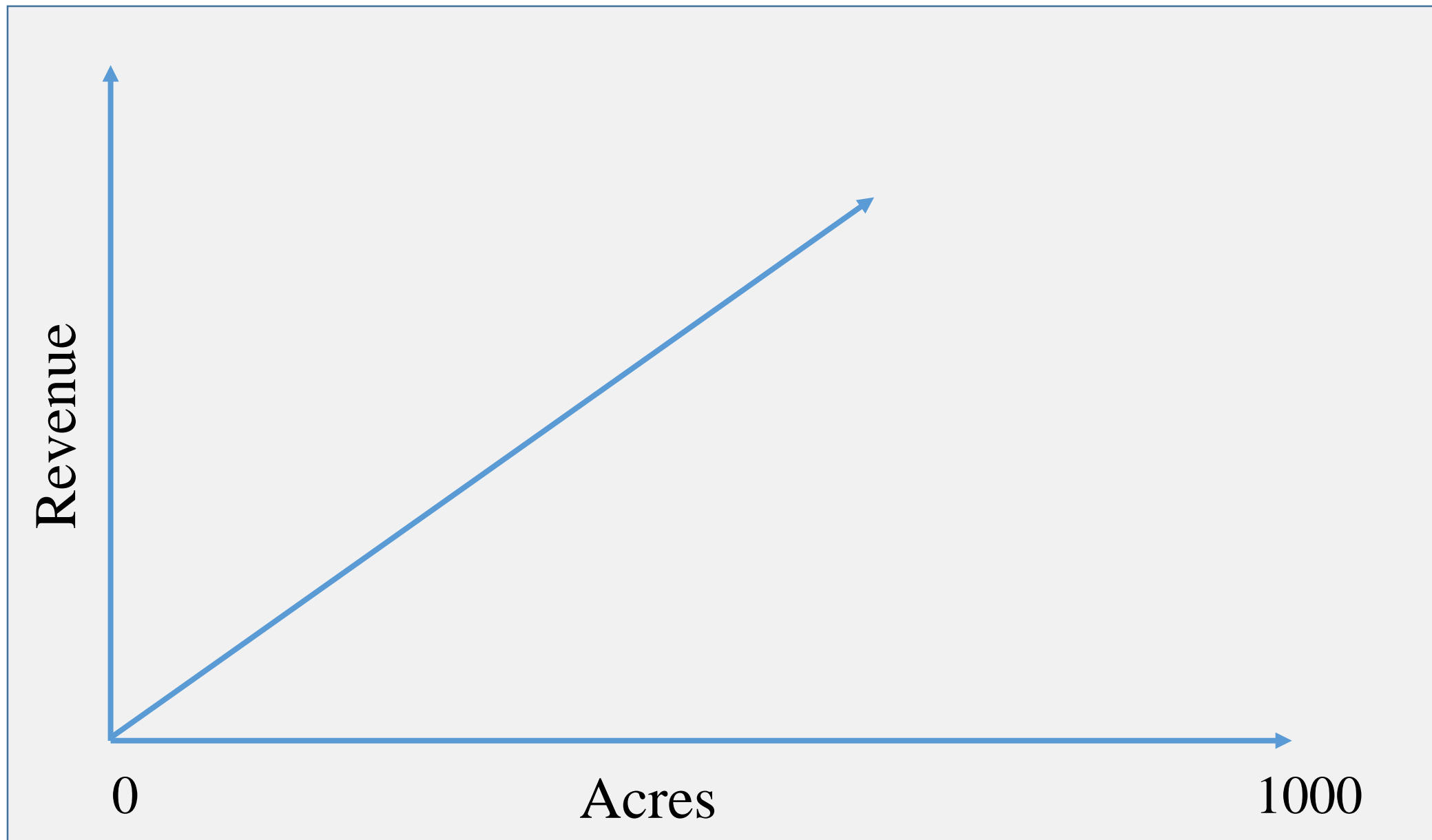
Lifecycle Planning



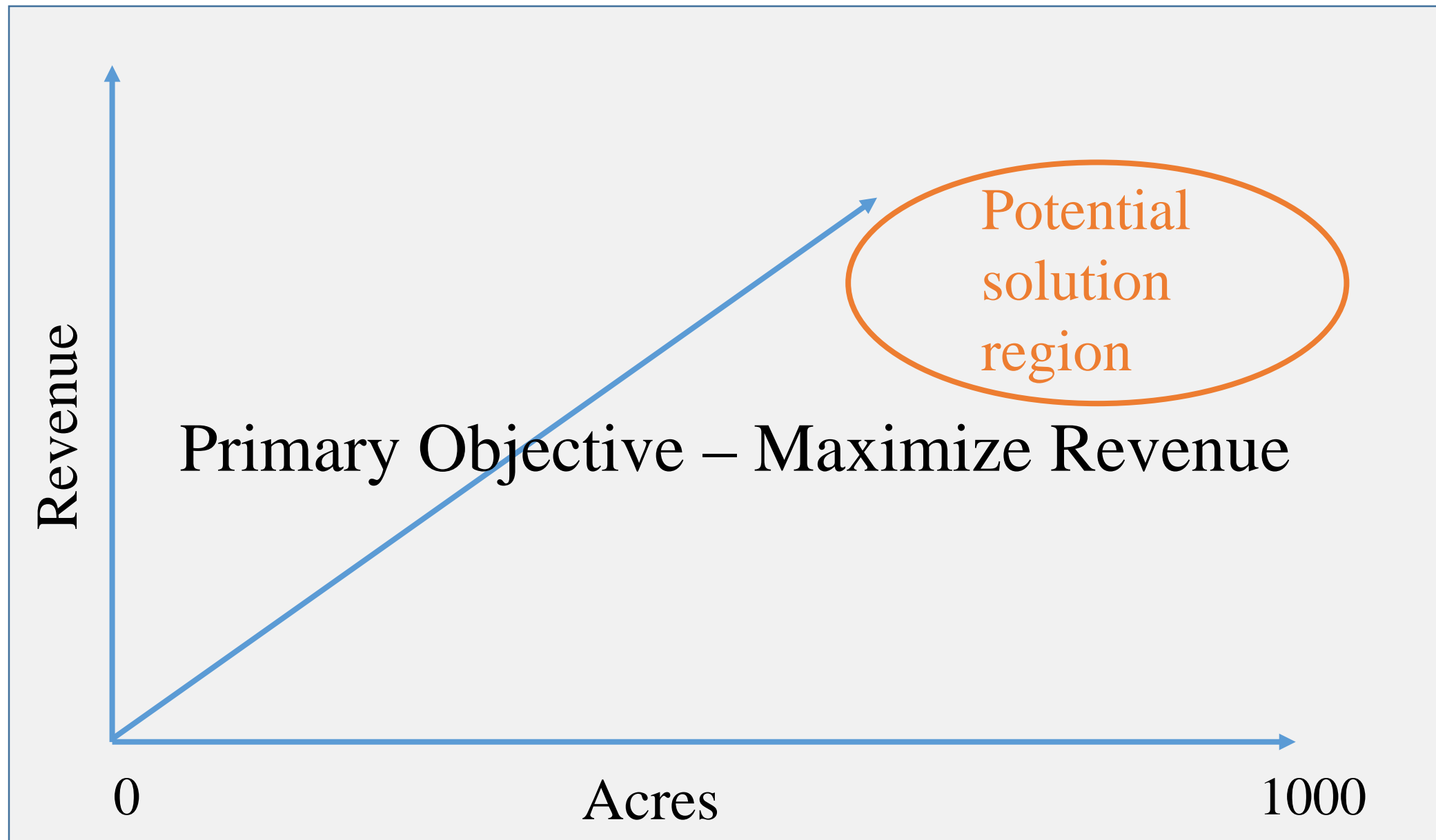
Objectives and Constraints

- The linear programming solution optimizes all of the harvest planning decisions around the objectives and constraints
- Objectives are typically value/revenue driven, but are not limited to this
- Constraints vary by property and client, but are typically logistic or legislative limitations
 - **Logistic constraints** such as minimum or maximum annual harvest quotas, % caps on harvest variation (evenflow)
 - **Legislative constraints** such as conservation laws (maintaining habitat for species), SMZ, and other special case considerations

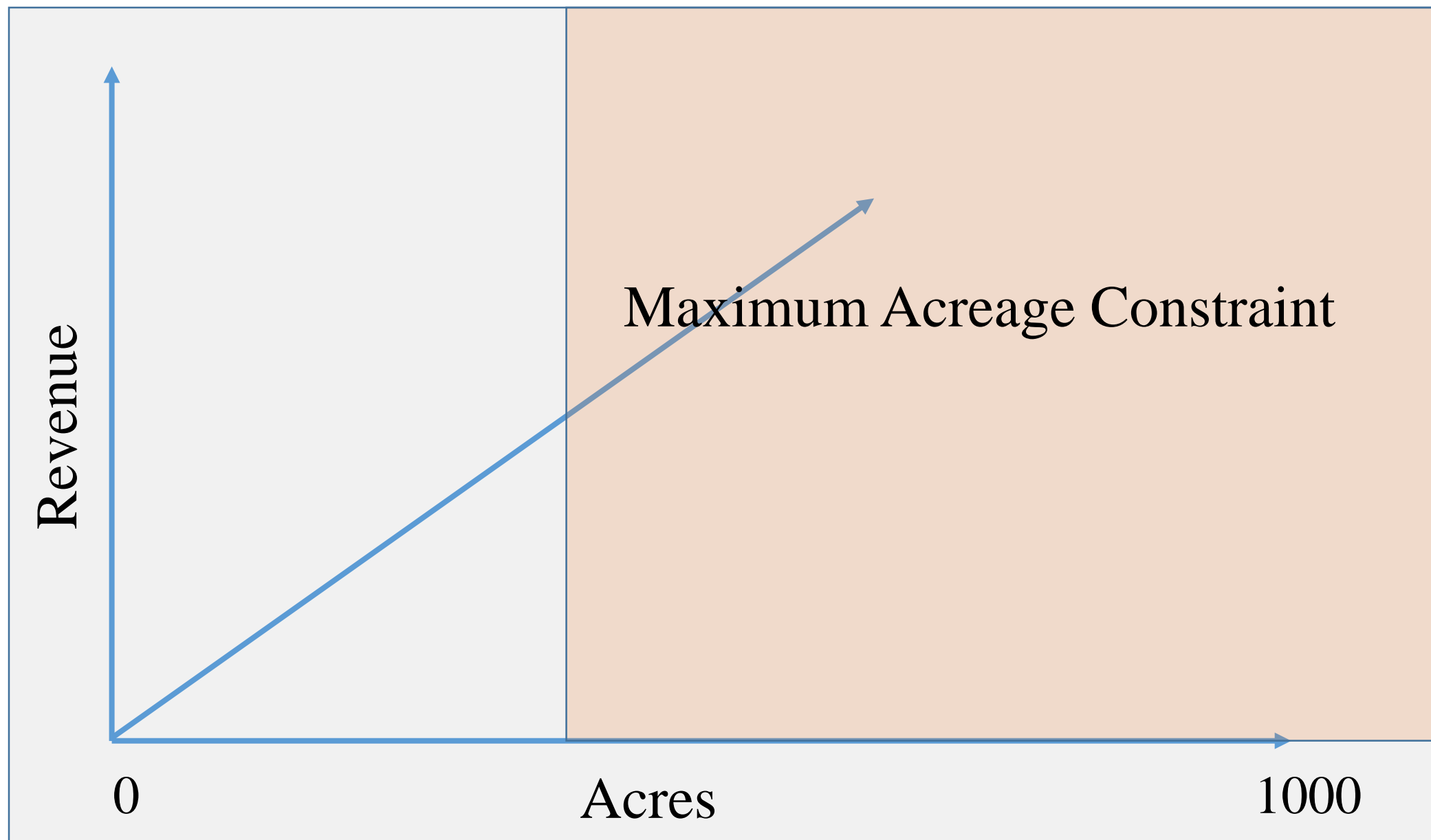
Linear Optimization Solution



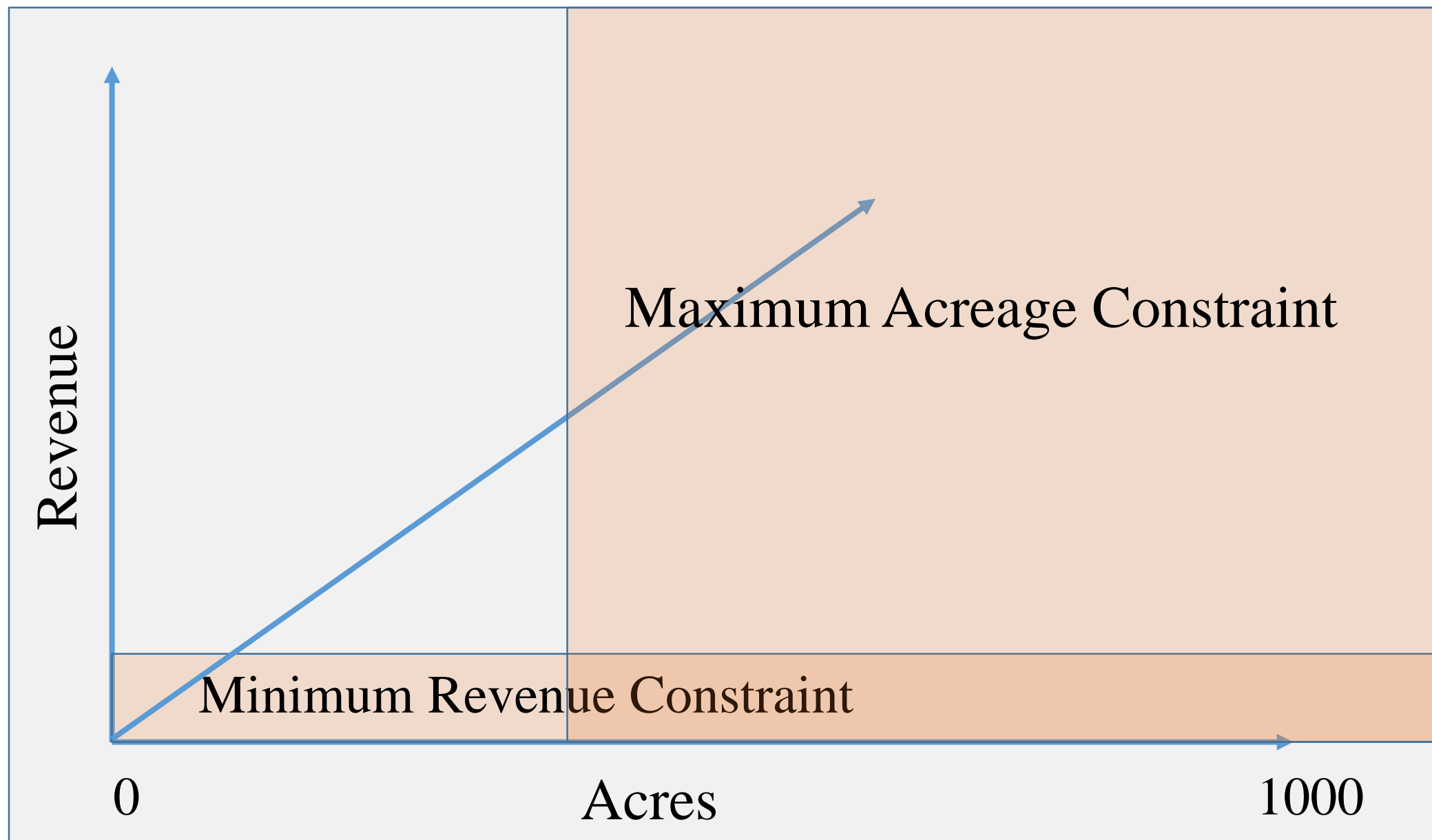
Linear Optimization Solution



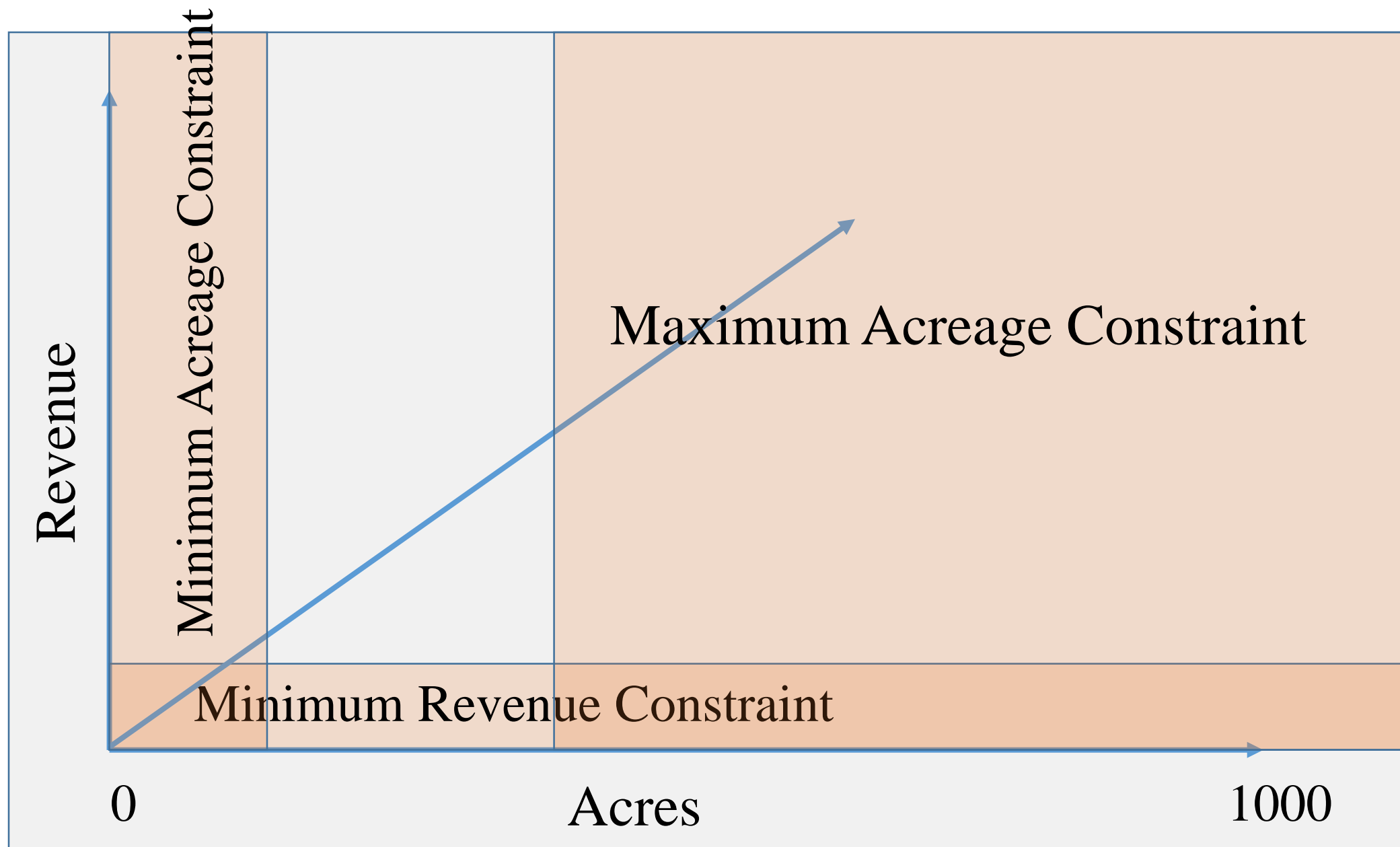
Linear Optimization Solution



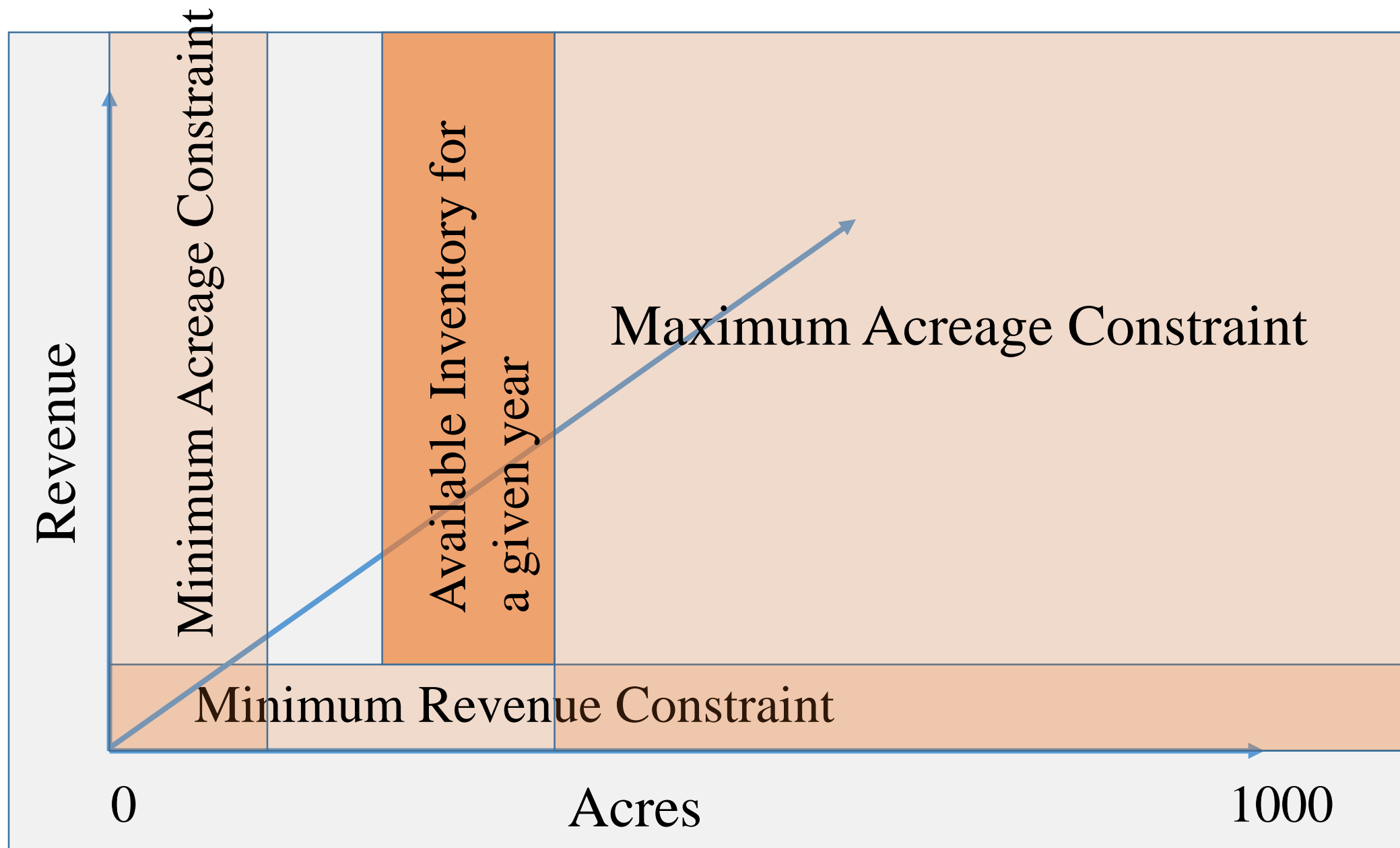
Linear Optimization Solution



Linear Optimization Solution



Linear Optimization Solution



Summary

- Seedlings of advanced genetic pedigree can be used to boost revenue potential (enhanced productivity)
 - Choose the right seedling option for your budget and goals
 - Any good forester/consultant should be able to help you navigate the seedling market (if not, consider a new one)
- Harvest planning software dramatically improves operational efficiency by linearly optimizing goals and constraints