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GTIA

Gashora Irrigation Project
Critical Design Review

Global Team for Irrigation in Africa

Purdue University

National University of Rwanda

Presenters: Tim Bond, T. Reid Gray, Jeremy Koehler, Erin Potrzebowski, Tyler Williams

Presentation Outline

- Update from Preliminary Design Review
  - Further Analysis
  - Capital Cost Considerations
  - Faculty Meetings Summary
  - Conclusions
- Simulation Program Overview
- Final Project Report Overview
- Looking Forward

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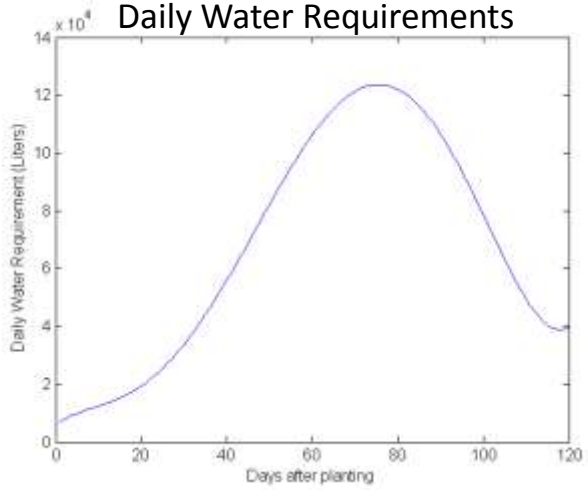
UPDATES FROM PRELIMINARY DESIGN REVIEW

Preliminary Goals for Critical Design Review

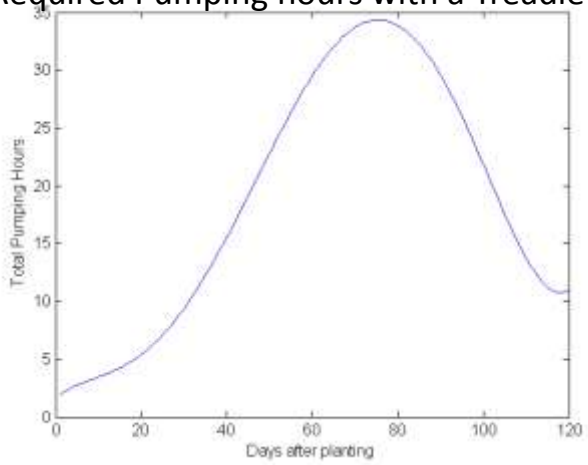
- Improve detail in the following areas:
  - More detailed water requirements over time
  - Detailed map of field
  - Pressure regulation and analysis
- Select final design for irrigation system
  - Detailed system design
- Scale final design to maximize profit
  - Assistance provided by Ag-Econ supporting members
- Evaluate options for capital cost acquisition
- Perform detailed sustainability analysis

Further Analysis
Refined Water Requirements

Daily Water Requirements



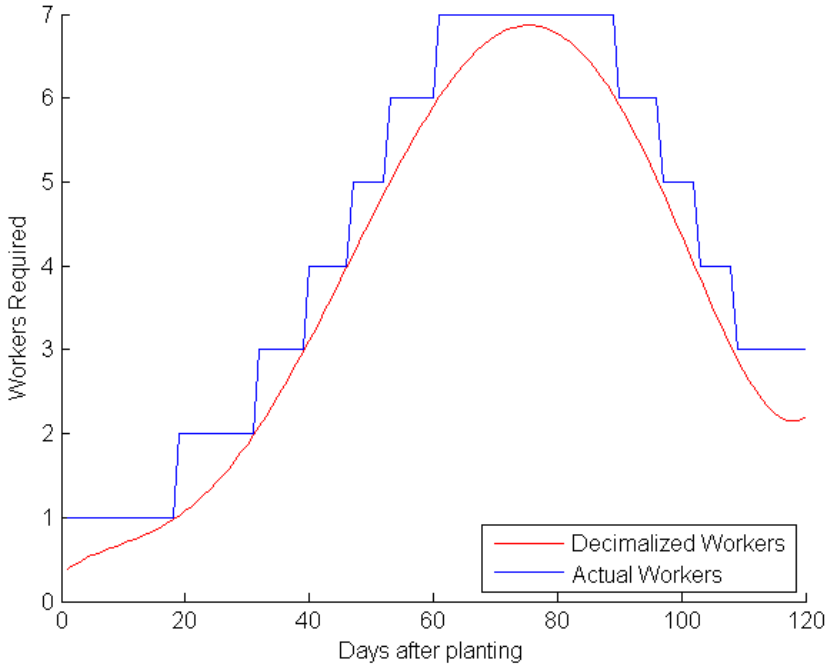
Required Pumping hours with a Treadle Pump



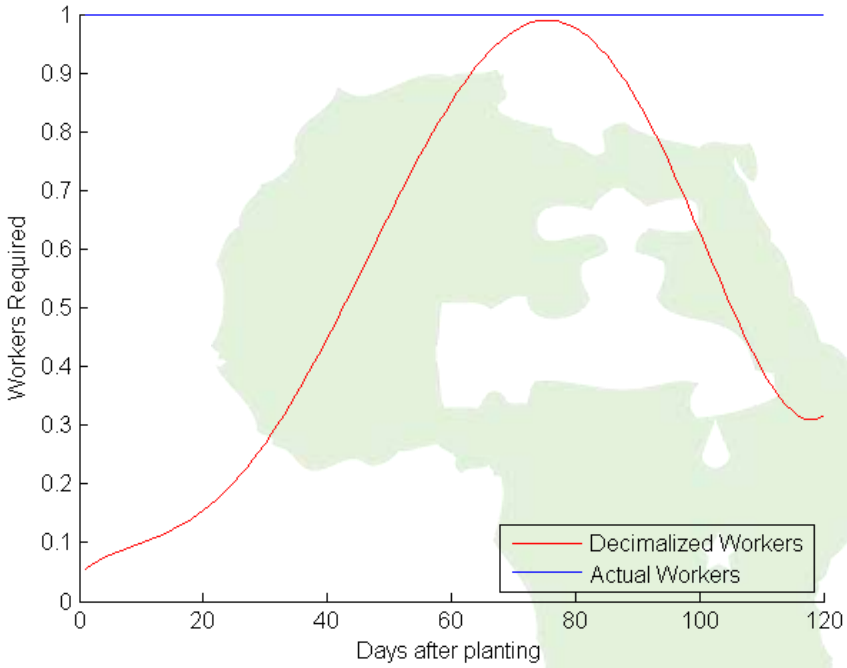
- Furrow irrigation was considered in more detail
- Detailed analysis provides the following requirements for each day of any scale of field:
  - Liters of Water
  - Pumping Hours
  - Number of Pumps
  - Number of Workers
  - Fuel Consumption

Further Analysis
Pump and Labor Requirements

Treadle Pumps

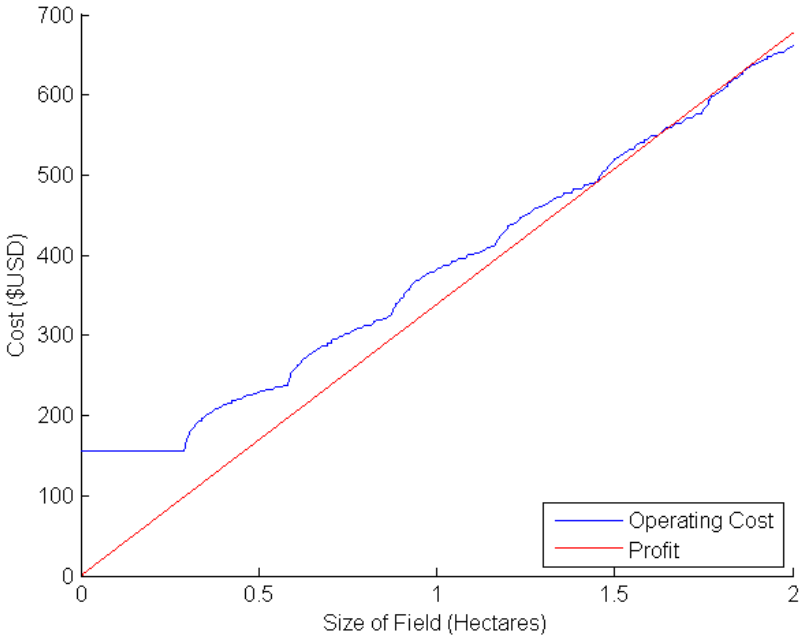


Gas Pumps

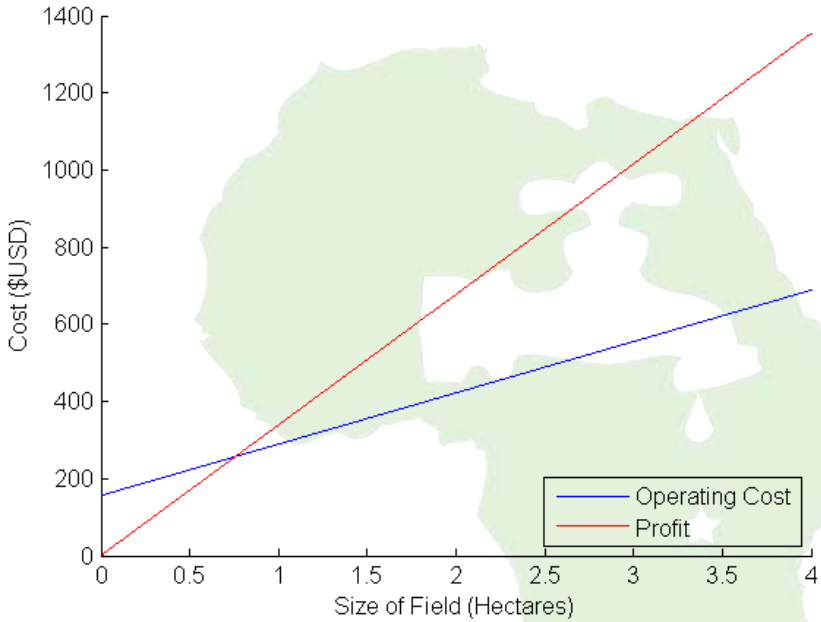


Further Analysis
Operating Cost vs. Size of Field

Treadle Pumps

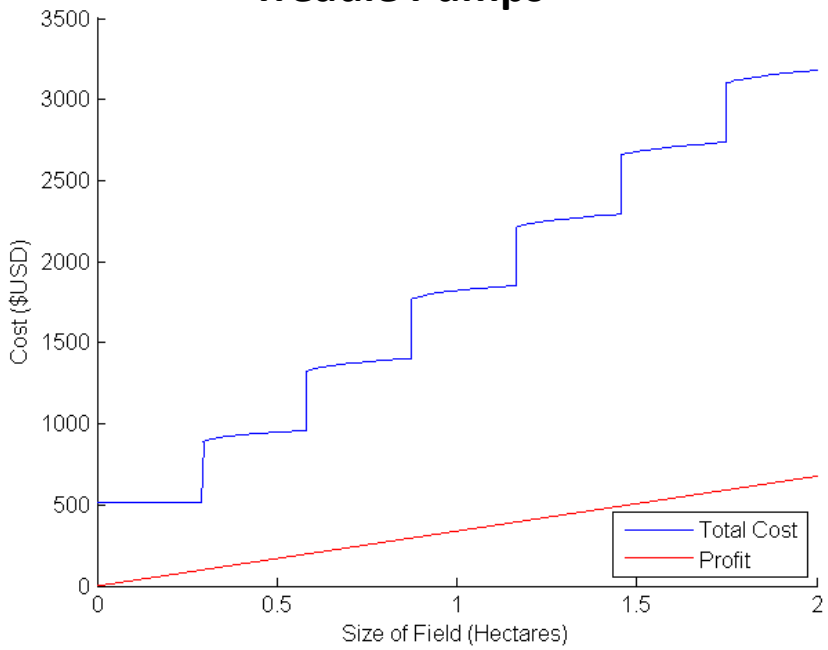


Gas Pumps

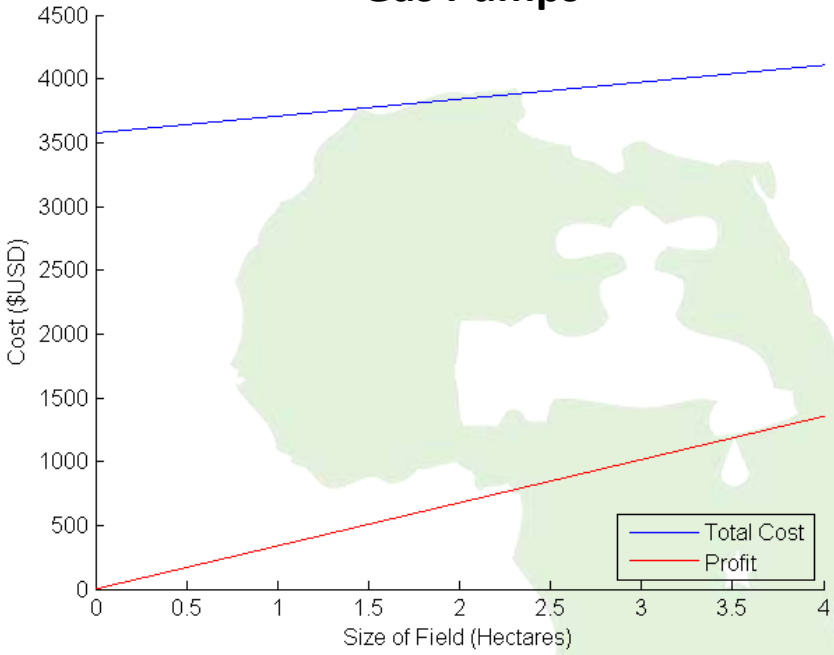


Further Analysis
Total Irrigation Cost vs. Size of Field

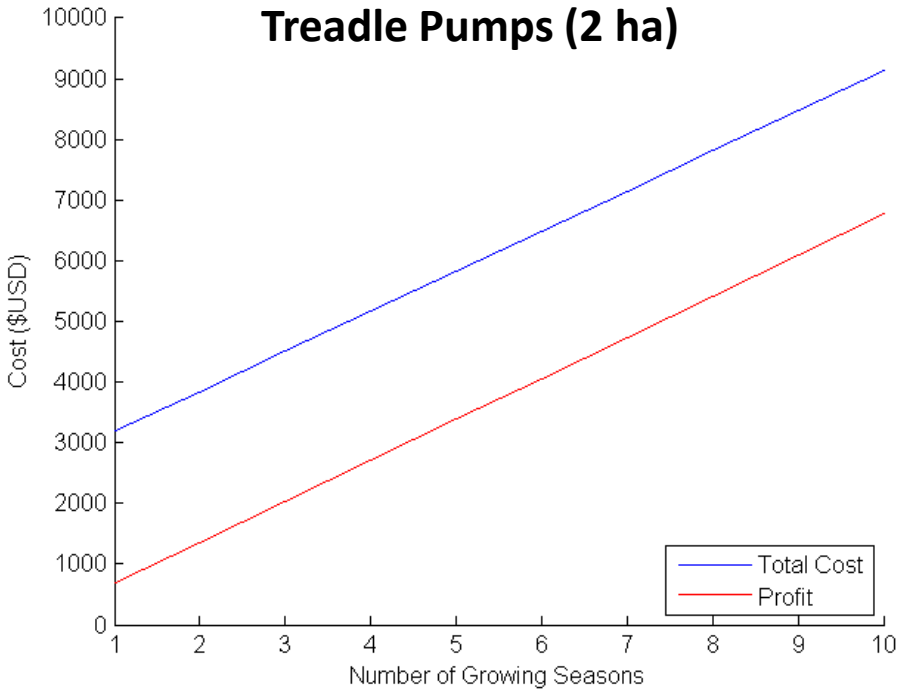
Treadle Pumps

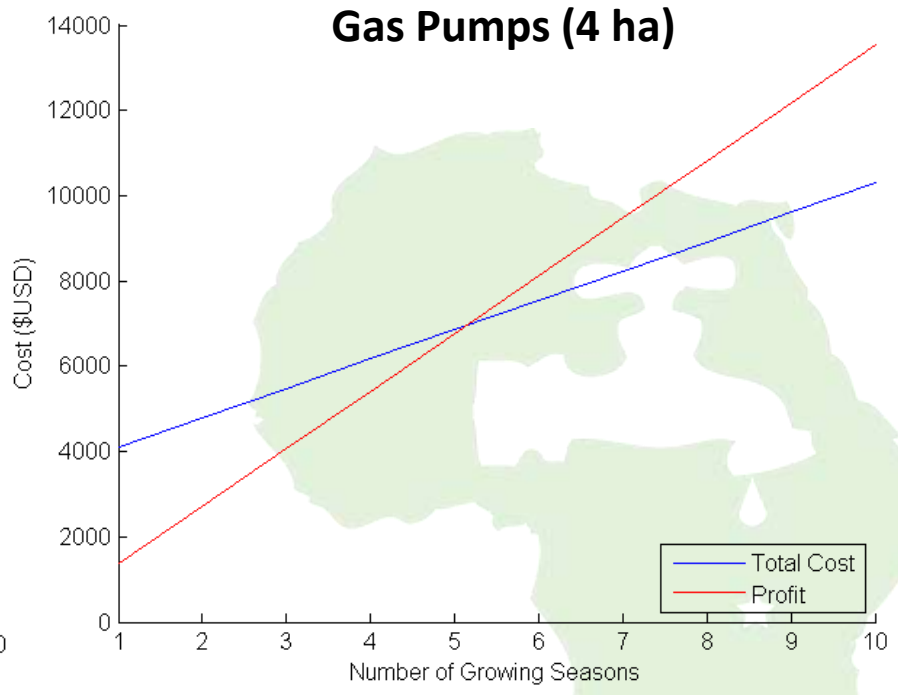


Gas Pumps



Further Analysis
Total Irrigation Cost vs. No. of Seasons





Analysis Summary

- For a 2 ha field:
  - Treadle and gas pumps have equal capital cost
  - Gas pumps have a lower operating cost than treadle pumps
- Gas Pumps
  - Begin to make a profit in the 5th growing season
  - Only have a one year warranty
  - High risk of failure due to improper maintenance and care
- Treadle pumps
  - 7 pumps and 7 workers are needed at the peak water requirements for a 2 ha field
  - Can only break even with operating cost at best
  - Cannot make up capital cost
- Neither option provides a feasible solution

Capital Cost Considerations

- Capital costs were not considered in detail in PDR
  - Allowed consideration of more expensive projects with the possibility of government subsidy
- Micro-Loan availability in Rwanda
  - Start around $40 with 4-month payback
  - Interest can be over 100%
  - Not always readily available
- Sustainability of externally-funded projects
  - If farmers do not invest anything, they have less motivation to use the system
  - Availability of external funds is not consistent
    - USAID is no longer funding any irrigation in Rwanda
  - Current large-scale irrigation project uses 77% external funding from European countries
  - According to a pump supplier in Rwanda, pump supplies are very limited

Agriculture Meetings Summary

- Dr. Rabi Mohtar
  - Comments from meeting
    - Corn is one of the most water-inefficient crops
    - Make sure you understand the soil characteristics
- Dr. Gebisa Ejeta and Dr. Mitch Tuinstra
  - Comments from meeting
    - Why corn?
      - High water requirement and low market price
    - This system would not be built in the U.S.
      - The farm would be terraced and flood irrigation would be used
    - Look into cultivating horticulture crops
    - The water requirement vs. time plot is qualitatively correct

Post-PDR Conclusions

- There are no economically feasible solutions for the given constraints
- As a result of further analysis, the project has changed focus.
- Two main deliverables:
  - Create a MATLAB program to model the analysis performed
    - Provide a method of summarizing our analysis for future projects
    - Allow relaxation of constraints (i.e. different crops/water requirements, different field dimensions, different labor situations, etc.)
  - Write a comprehensive final report
    - Detail entire project and process
    - Provide conclusions and recommendations for future projects

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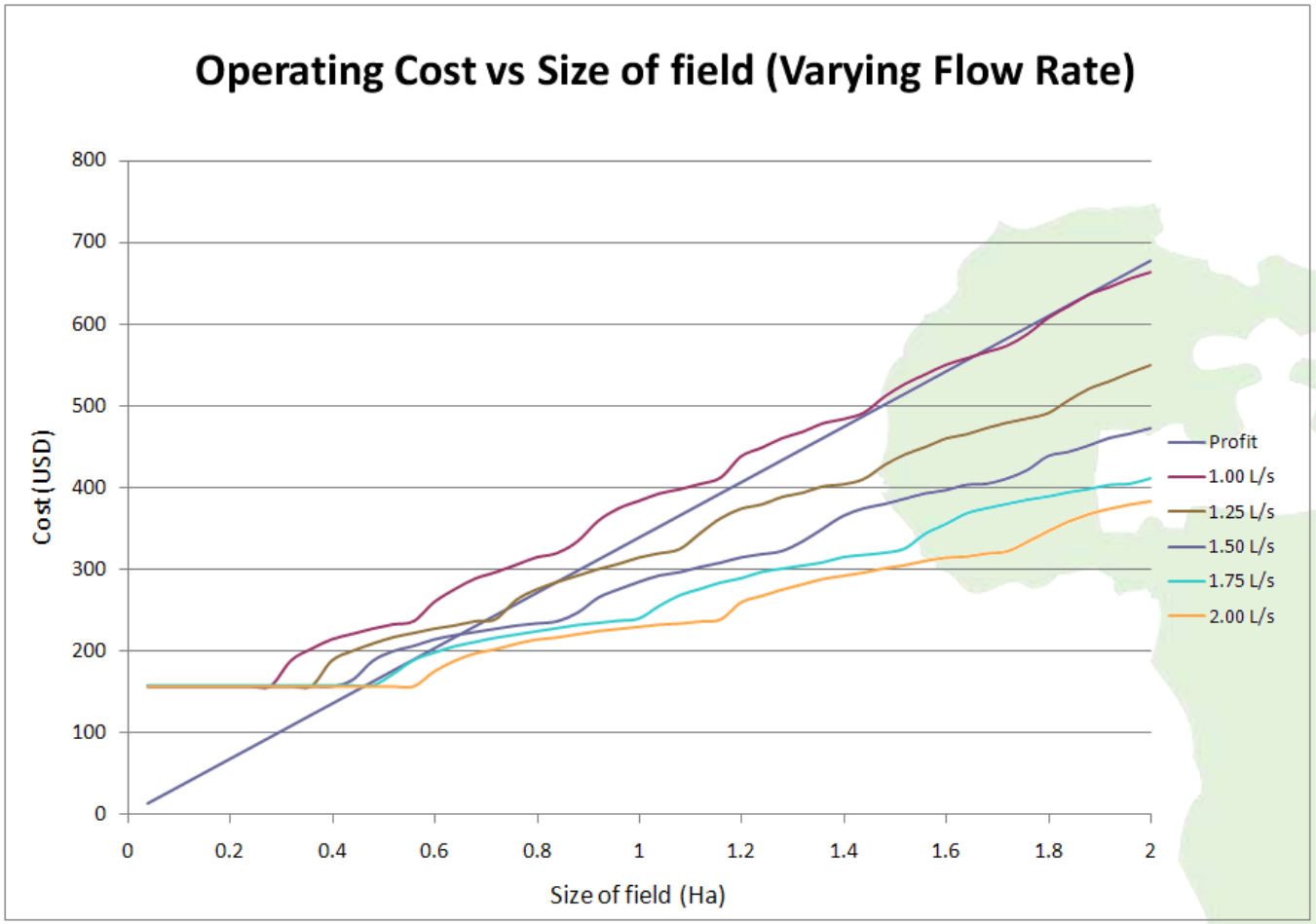
SIMULATION PROGRAM OVERVIEW

Simulation Program Overview

- Program's Purpose:
  - Provide a method of summarizing research and analysis for future projects
  - Allow relaxation of constraints
    - Different crops/water requirements, different field dimensions, different labor situations, etc.
  - Easily explore feasibility of different situations
  - Highlight direct areas for improvement

Example of Program's Purpose: Highlight Profitable Improvements



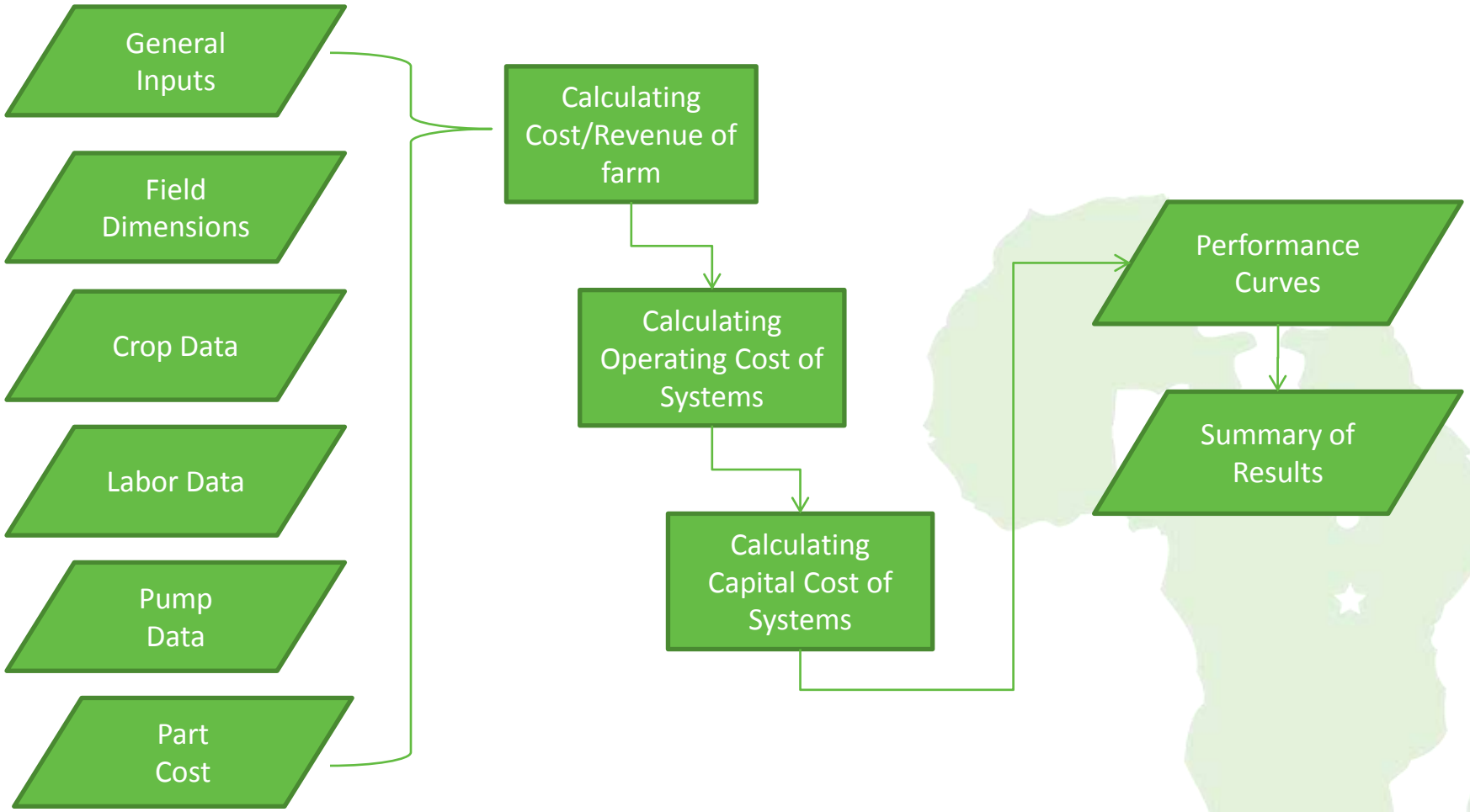
Program Target & Customers

- Target application: future projects in Gashora
- Primary customers:
  - Future ESW-Purdue design groups
  - Other ESW-USA / EWB-USA projects and groups
- Secondary customers:
  - National University of Rwanda
    - Agronomy / Irrigation Faculties
  - Minister of Agriculture for Rwanda

Program Deliverables

- All customers: sample test cases and values
- To customers with MATLAB available:
  - MATLAB code and instructions for modifying inputs and executing program
- To customers without MATLAB available:
  - Detailed flowchart and guide for manually calculating equations
    - Can also be used to adapt for another programming language or calculation medium

Program Flowchart



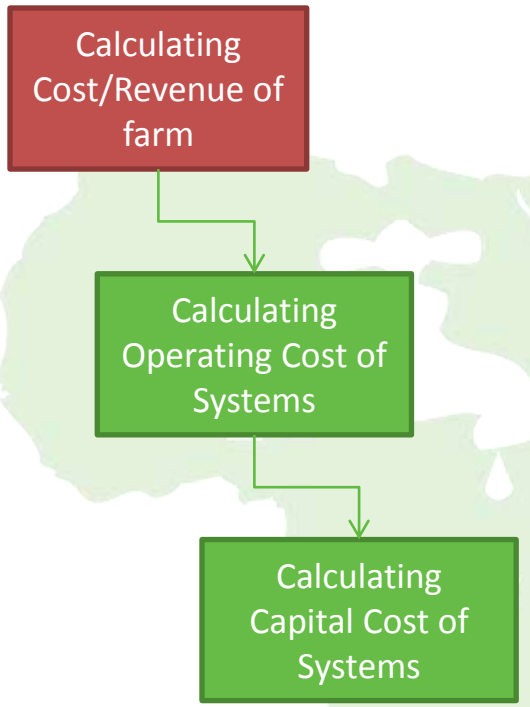
Program Inputs

General Inputs	• Cost conversion factor • Cost of petrol / L • Meteorological data
Field Dimensions	• Overall dimensions • Field slope / elevation change
Crop Data	• Types, market prices, seed cost • Planting (seeds/row, row spacing, seed-to-weight ratio, labor requirements) • Water requirements, yield per hectare
Labor Data	• Daily wages • Hours worked per day
Pump Data	• Cost, flow rates, head delivered • Labor requirements • Lifespan / maintenance

Part Cost	• Pipes/hoses/fittings
	  • Prices
	  • Diameters

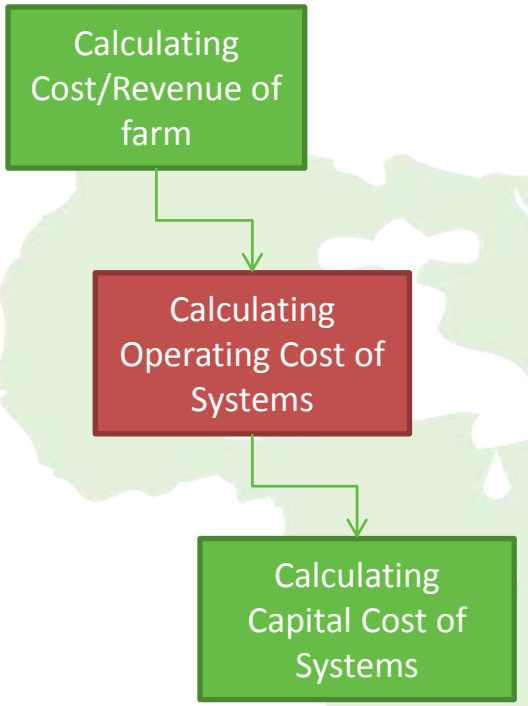
Program Calculations

- Cost/Revenue of Farm
  - Inputs:
    - Field dimensions, crop data, labor requirements
  - Assumptions:
    - Costs are linearly scalable
    - Planting specifications (distance between rows, etc)
    - Markets are available
  - Outputs:
    - Profit per hectare
    - Profit per day



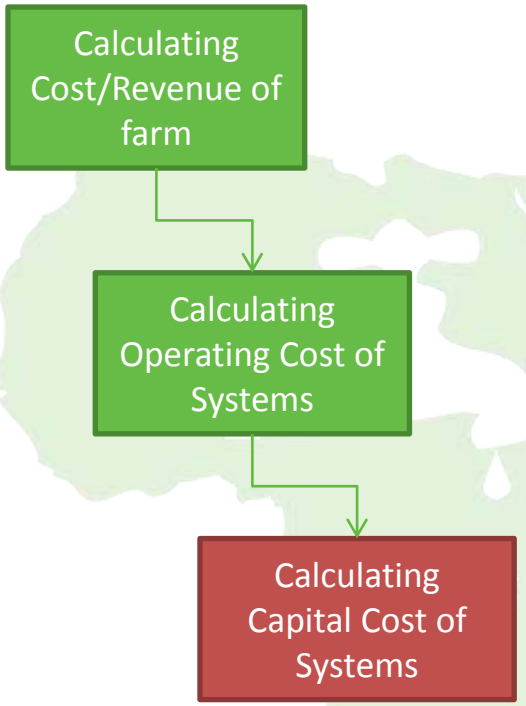
Program Calculations

- Operating Cost of Systems
  - Inputs:
    - Field dimensions, labor costs, water requirements, pump data, part data
  - Assumptions:
    - Labor is always available
    - Labor is considered on daily and not hourly basis
    - Petrol is available to farmers
  - Outputs:
    - Operating Cost vs. Time
    - Total Operating Cost per Season



Program Calculations

- Capital Cost of Systems
  - Inputs:
    - Field dimensions, water requirements, pump data, part data, irrigation data
  - Assumptions
    - Quoted prices remain constant
    - Supplies are available
  - Outputs:
    - Capital Cost vs. Field Size
    - Type of irrigation to be used
    - Irrigation Schedule



Program Outputs

Performance Curves

- Operating costs vs. size of field
- Capital costs of systems vs. size of field
- Total costs of system vs. size of field
- Total costs and profits vs. number of growing seasons

Summary of Results

- Pump(s)
  - Specific pump to use
  - Quantity of pumps
- Labor requirements
- Amount of piping and hose required
- Irrigation type
- Percentage of field irrigated
- Pressures at outlets

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FINAL PROJECT REPORT OVERVIEW

Jeremy Koehler

Final Report

- Purpose
  - Document the process for future groups
  - Summarize research findings
  - Explain analysis & conclusions
  - Provide recommendations for future work

- Target Audience
  - Original project customers
  - Future research teams
  - Future groups looking to irrigate farms in Africa

Final Report Outline

- Executive Summary
- Introduction
  - Background Information
  - The Project
  - The Global Team
- Assessment Trip
  - Interaction with Farmers
  - Interactions with NUR Administration and Local Government
  - Field Specifications
  - Constraints
- Research Summary
  - Pumping
  - Storage
  - Distribution
- Evaluation of Research
  - Performance Analysis
  - Sustainability Analysis
  - Economic Analysis
- Program / Model
  - Assumptions & Process
  - Inputs/Outputs
  - Customer / Audience
- Conclusions
  - Irrigation in Bugesera, Rwanda
  - Global Teaming Reflections
- Recommendations for Future
- Appendices
  - Model Test Cases
  - Analysis of new technologies
  - Program operations manual

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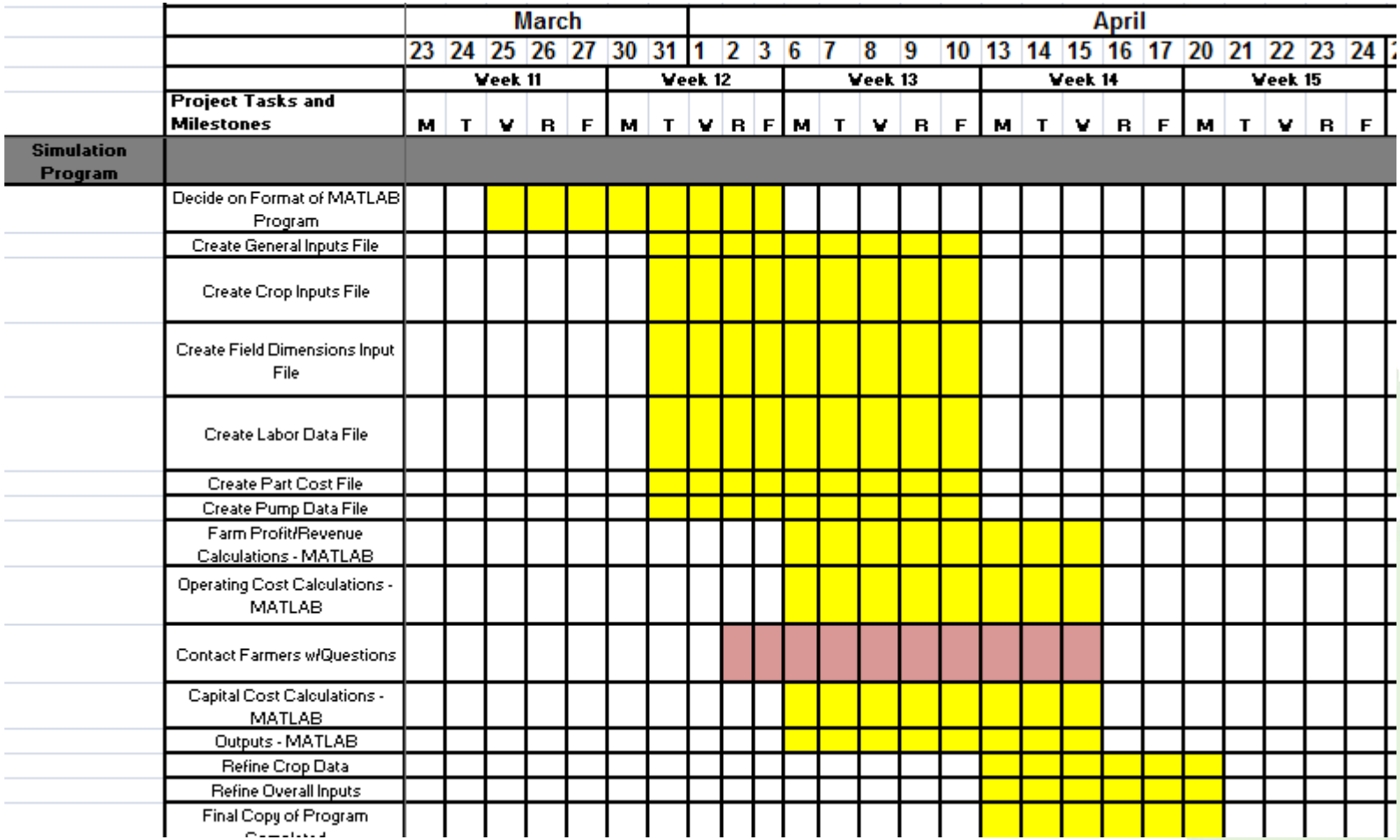
LOOKING FORWARD

Detailed Timeline

March and April Simulation Highlights



Key Upcoming Dates

- April 13, 2009 – ESW-Purdue Club Callout
  - Several interested members
  - Will be used to continue current project as well as to find and cultivate new projects.
- April 29, 2009 – Final Presentation
  - Simulation Program Delivered
  - Final report and project reflections due
- May-June 2009 – Possible Return Trip

May/June Trip to Rwanda

- Original plan: implement irrigation system
- New plans:
  - If simulation yields suitable system, implement it
  - If not:
    - Use trip to build a better information base and find answers to questions we are currently seeking
    - Supply capital cost of a smaller system and implement for testing and research purposes
    - Work on other ESW-USA projects in area
    - Research other possible projects with NUR

Questions That Need To Be Answered

- Originally told government mandates that corn be grown
  - Is this still the situation?
  - Does this include Season C?
- Are there other crops besides beans and corn for which the farmers have access to seeds and markets?
- Are crops used for profit or subsistence?
- What other possible sources of capital are there?
- Do the farmers anticipate working their own farm? Any other possible sources of free labor?
- How much profit is made when inter-cropping is used?
- How much are the farmers willing to invest in a system?*
- Are the hired workers able to work more/less than 5 hours?
  - If so, how much does the wage change?

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QUESTIONS?

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Critical Design Review Appendix

Global Team for Irrigation in Africa

Purdue University

National University of Rwanda

International Pump Availability

- Original Assumption: Pumps available in US/Europe are available in Rwanda for an increased cost
- The shipping companies do not guarantee passage through customs nor provide transportation to the site
- The shipping costs from West Lafayette, IN to Kigali, Rwanda are prohibitively high if a cheap pump could be acquired from outside of Rwanda
  - 70 lb package (24” x 24” x 24”)
    - USPS: $988.00
    - FedEx: $2331.23
    - UPS: $1444.20