

# Small Scale Irrigation (SSI) Project at Abba Samuel River Watershed

UCONN - Engineers Without Borders Ethiopia Program  
& Civil and Environmental Engineering Design Project



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# Group Members

- Alex Curry
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# Overview

- Introduction
- Project Goal
- Design Tasks
- Budget
- Timeline

# Location

Village of Woreta in  
the Amhara region of  
Ethiopia



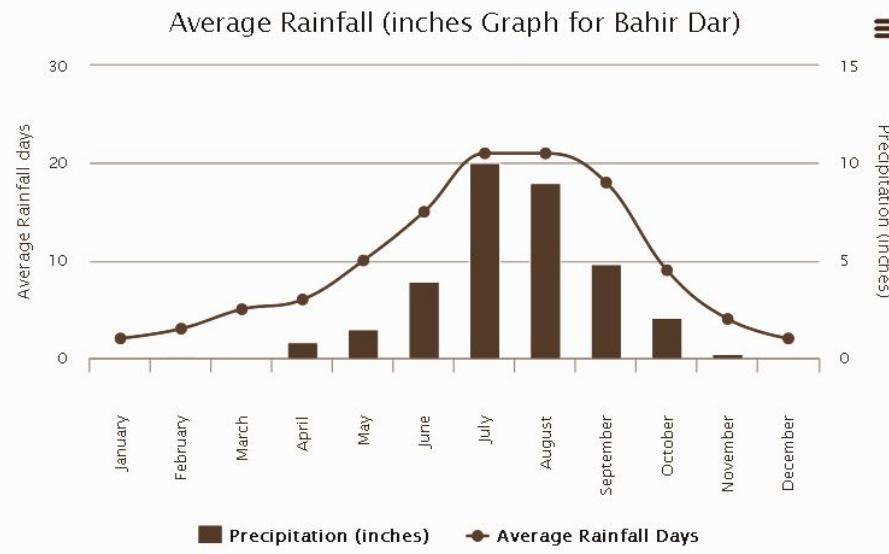
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# About Ethiopia (ኢትዮጵያ)

- Population: 97 million
- Kirmet – July through to Sept.
- Fogera District, Woreta Zuria Kebele Administration
- Ethiopia in Crisis
  - Recurring droughts, 2015 one of worst droughts in decades
  - 8.2 million in need of food assistance
  - 80% of population work in agriculture



# Local Community





# Conditions in Woreta

- June to August – rice
- September – oats
- No crops are produced in remaining months
  - The community would like to produce: mango, avocado, potato, carrot, corn and tomatoes in the dry season



# Traditional Irrigation



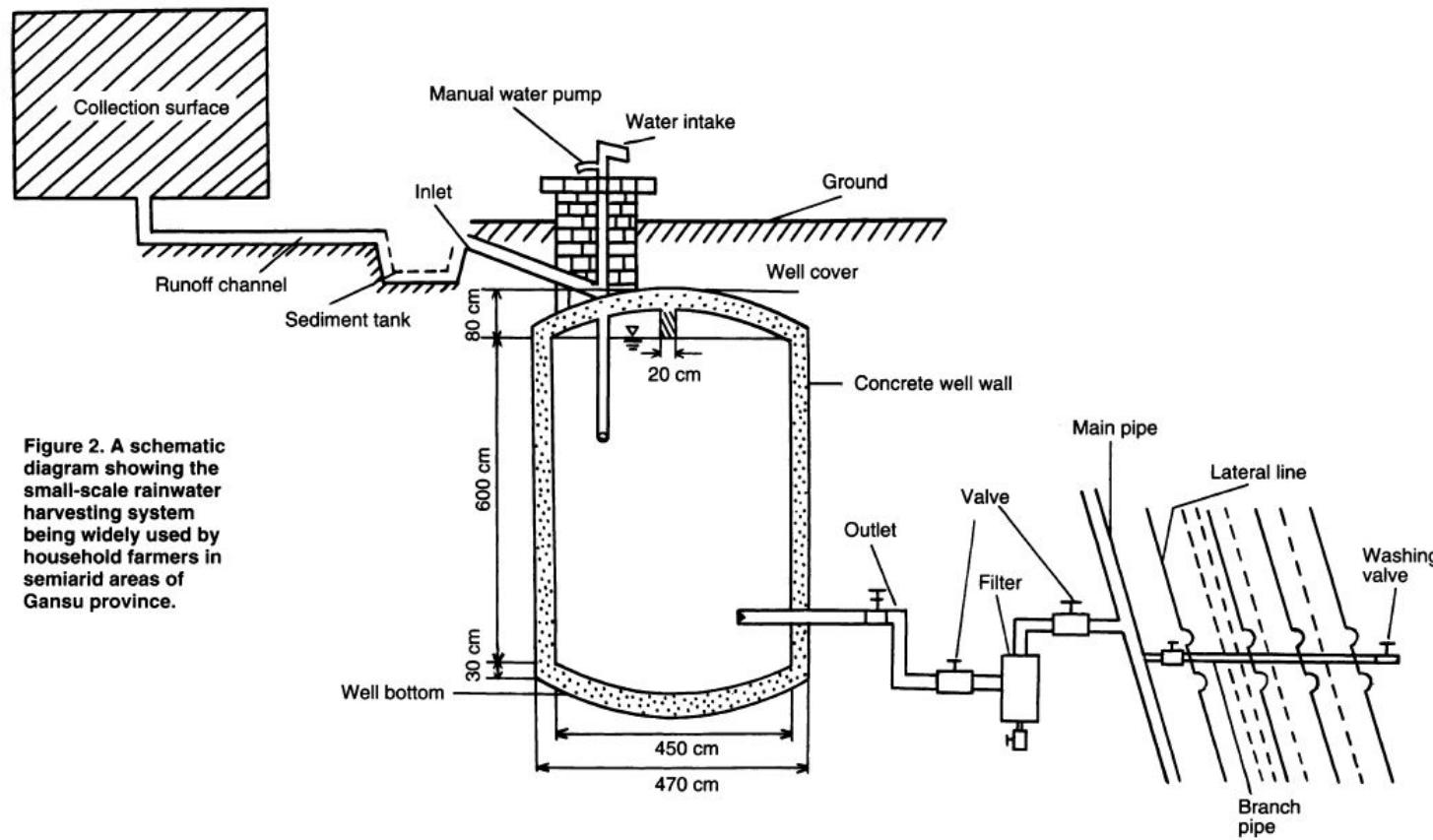
- Inefficient methods
- Leakage in gate
- Evaporation losses
- Lack of proper distribution
- Reliance on seasonal stream



# Design Overview

- Can surface water be utilized for sufficient crop irrigation, and is rainfed agriculture without groundwater dependence feasible?
- What system design would best suit this community?
  - Overall land cover used for farming and length of time possible for irrigation
  - 150 households, 3 fields at most per household
    - Community gardens, full field irrigation, or both
- Introduction to design
  - system of storage structures stemming out from main water source, designed for gravity fed distribution from highest point to outlet of watershed

# Rainwater Harvesting



# System Visualization



# Naturalized Rock Catchment

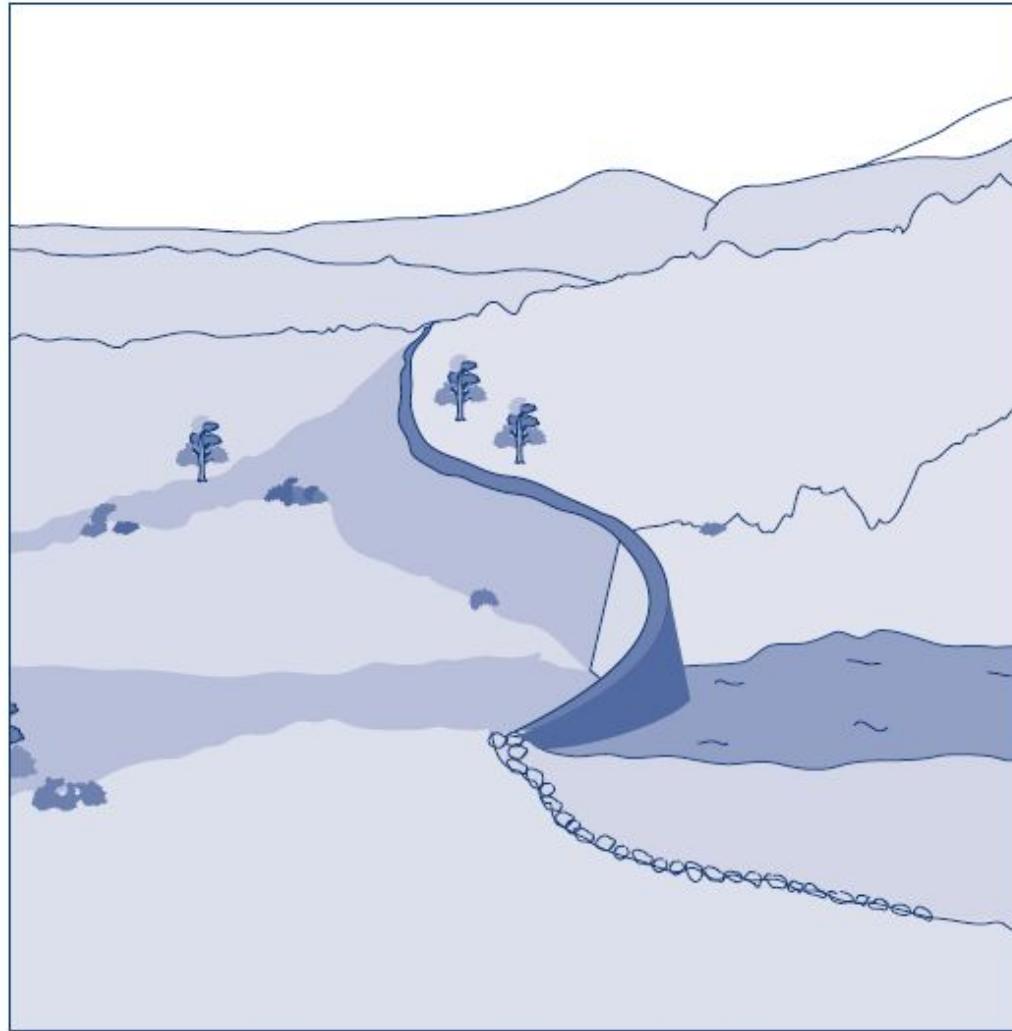


Fig. 7.4. Rock catchment



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# Design Tasks

## 1. Watershed model

- Water resources available; groundwater and surface
- Current water use by community
- How water flows within watershed and where it accumulates.
- Impact of flooding and stormwater on watershed

## 2. Dam type and basin build

- Types of dams and storage basins

## 3. Identify best suited crops

- Crops that require less water, “dry farming” methods

## 4. Irrigation techniques

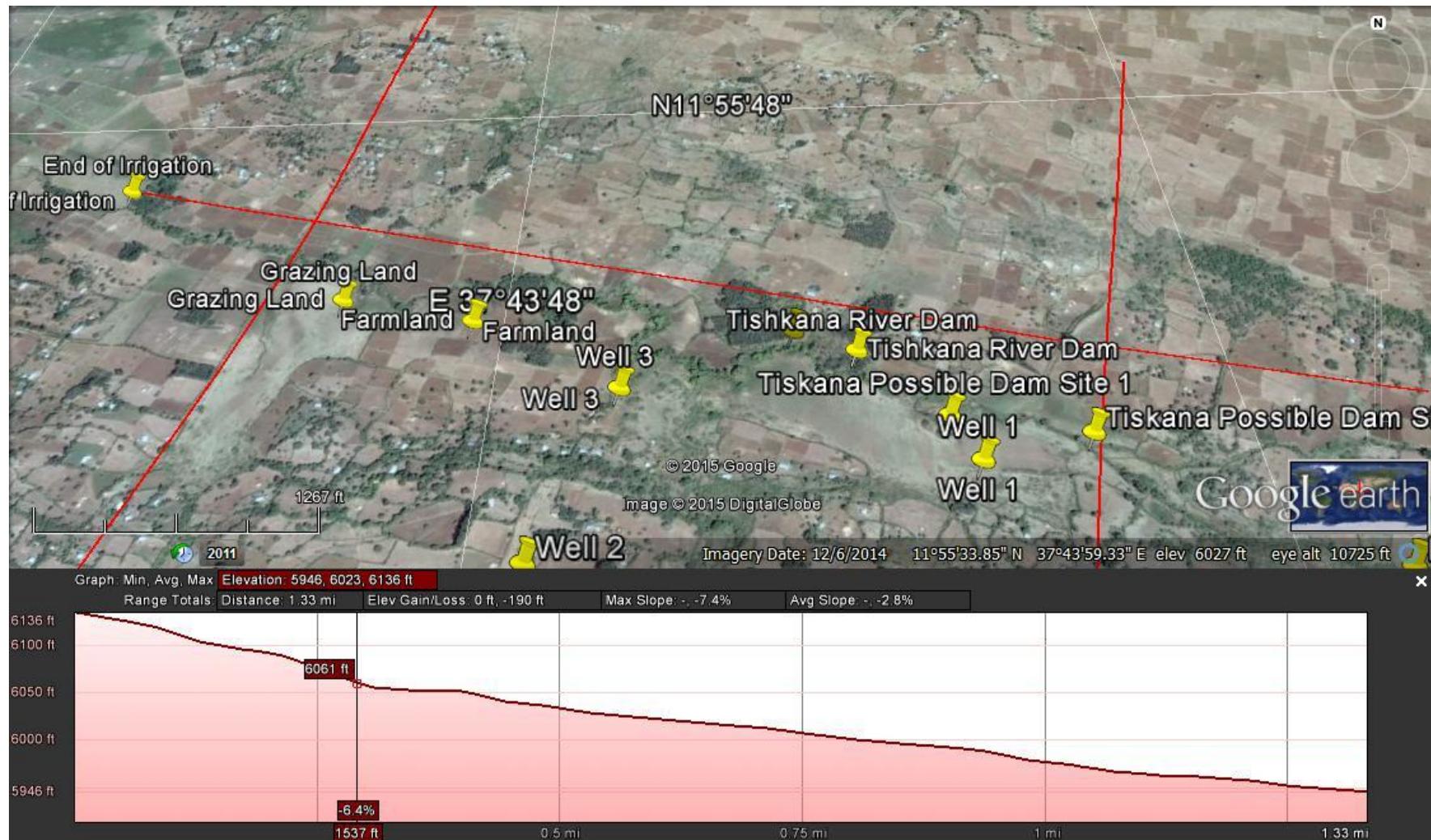
- Supplemental Irrigation provided through Drip Irrigation and Rainwater Harvesting methods

## 5. Budget

# Watershed Model

- Focus on Abba Samuel River Watershed in Nile River Basin
- Visual development in ArcGIS w/ LANDSAT add on
- CT 2004 Stormwater Quality Manual as reference combined w/ TR-55 calculation to estimate water quality volume based on storms
- Average precipitation as determined by statistics provided by Ethiopian Institute for Water Resources (EIWR)
- Estimated loss of water due to runoff, seepage, and evaporation

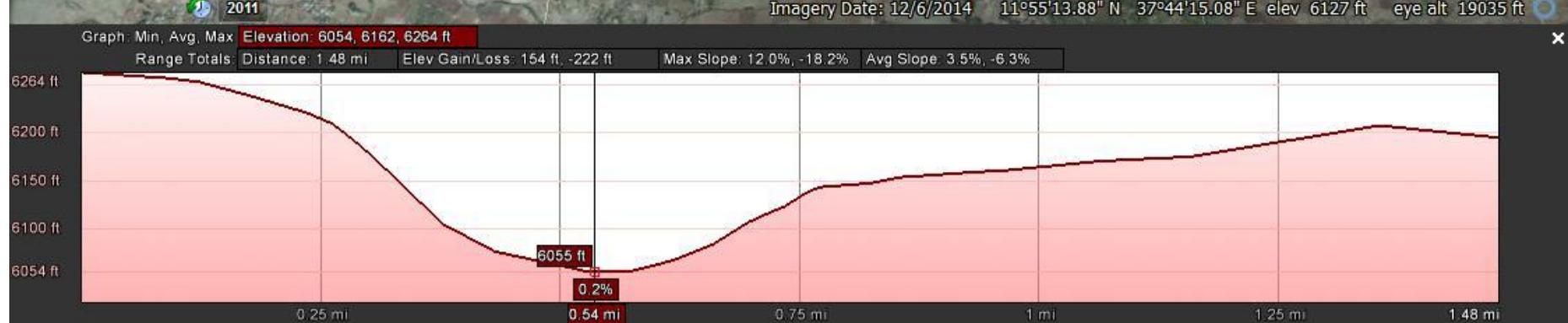
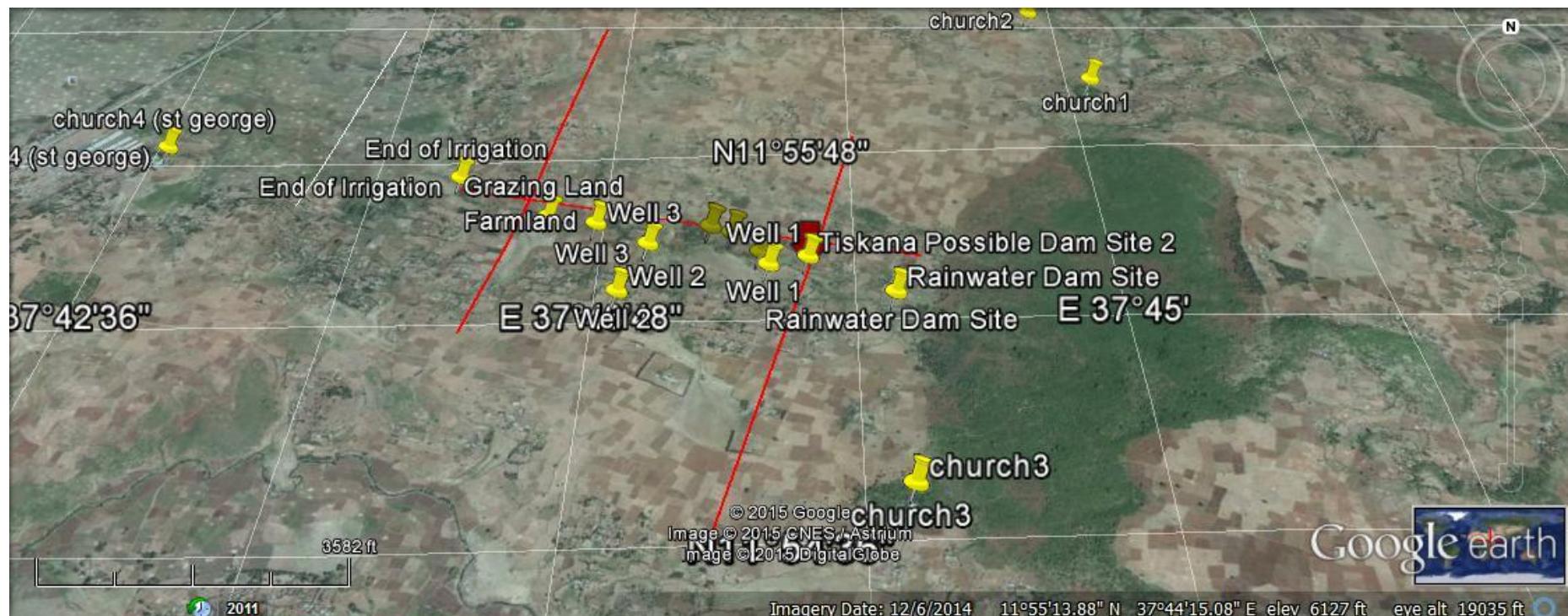
# Watershed Site Overview





Imagery Date: 12/6/2014 11°55'45.87" N 37°43'37.08" E elev 6029 ft eye alt 18307 ft





# Potential damming sites





# Damming Techniques

## **Suggested Dam Type:**

Embankment Dam

(Earthen Dam)

- Created by the placement and compaction of various soils, sands, clays or rocks
- Semi-pervious natural waterproof covering for its surface with a dense impervious core
- The friction and interaction of the particles binds them together to create a stable mass
- Low construction Cost



# Storage Structures

## Ferrocement Tanks

- Water tanks made from reinforced cement mortar
- Widely used in many parts of the world for domestic, stock and irrigation purposes
- Made from commonly available materials
- Simple skills needed
- Simple equipment, techniques are straightforward and do not require use of expensive and sophisticated machinery

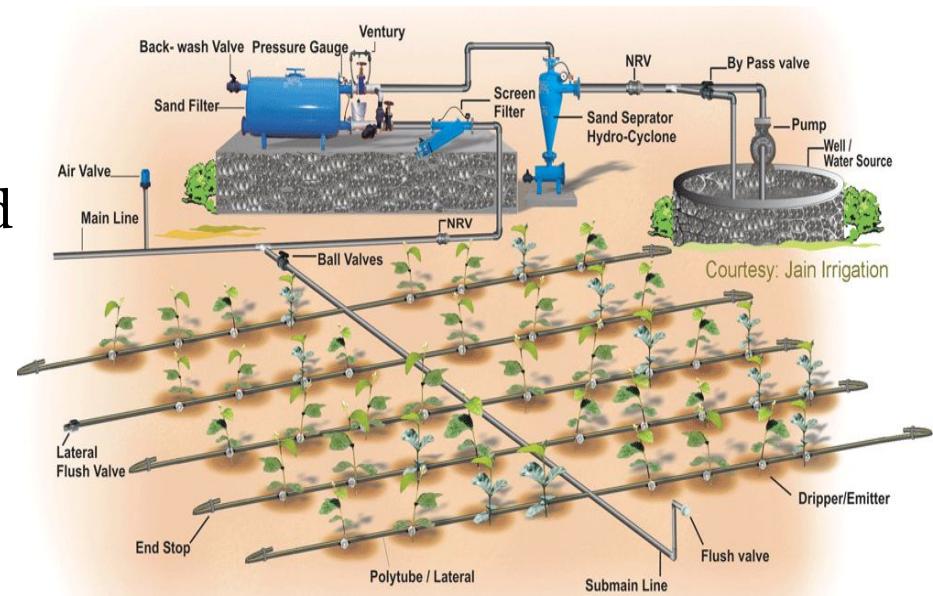


# Crop Assessment

- Sustenance crops vs. cash crops
- 1838 meters, north, highlands
  - pulses - second most important crop for national diet
  - niger seed, flaxseed
  - teff, wheat, barley
    - teff- takes a lot of energy and land
- Vegetables - limited consumption, high cost
- Mango, avocado, potato, carrot, corn and tomatoes in the dry season
  - tomatoes- small area of land
- Research
  - space constraints, profitable, nutrition, utilization, dry farming, culture
  - cowpeas, legumes, beets, sweet potatoes, yams

# Irrigation Techniques

- Sources: Surface water vs. groundwater
- Pumps-necessary depending on topography
  - Human, solar, animal power
- Water transport
  - Furrow
  - Drip line
    - pump and filter needed
  - Sprinkler

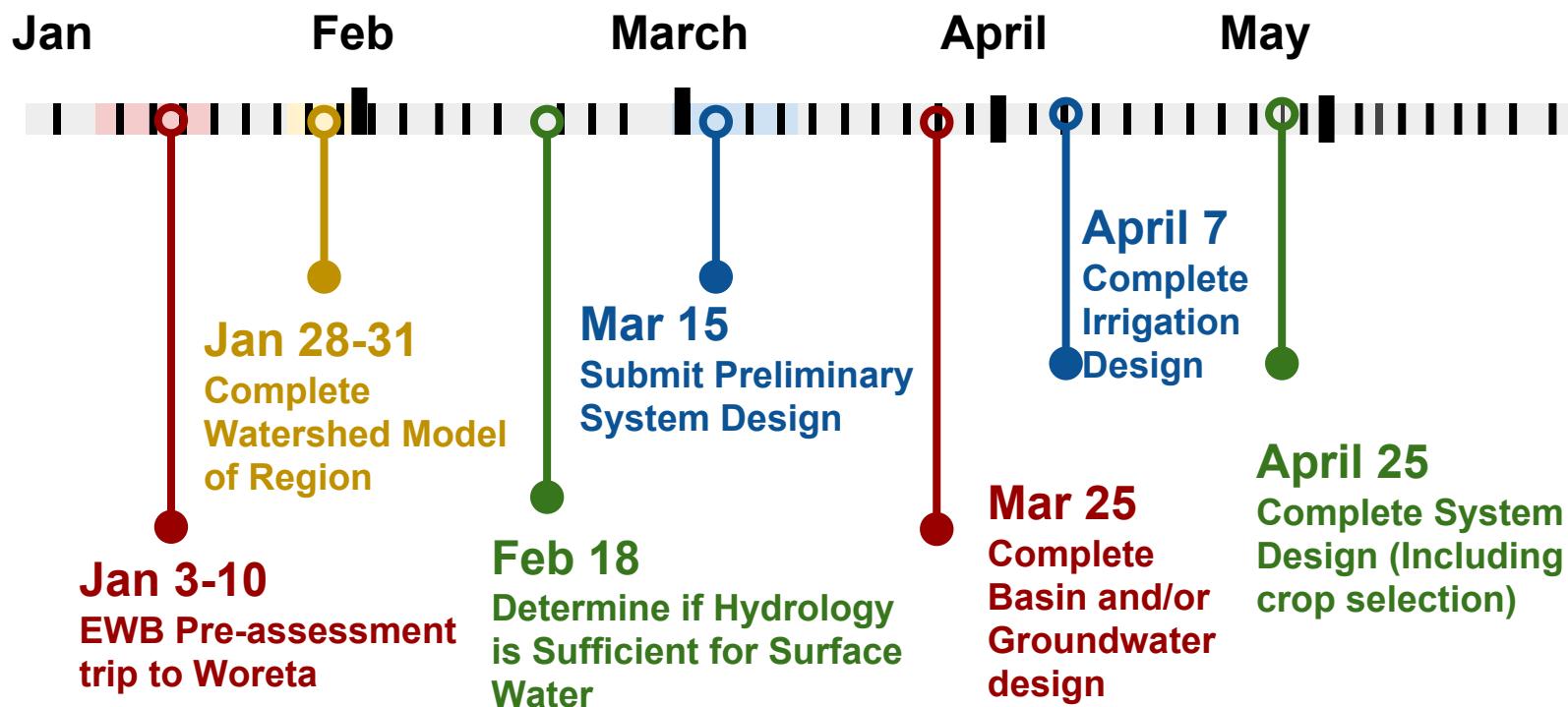


# Assessment Trip Tasks

Test	Tool	Plan
infiltration	minidisk infiltrometer	Single and double infiltrometer from Bahir Dar University
soil types	sieve, soil core samplers	Texture analysis can be done in the soil mechanics lab of Bahir Dar Uni. They do hydrometry analysis and have sieves of various sizes.
groundwater table	steel/electric tape, pressure transducer	Need a plan or equipment.
existing "basin" volumes	tape measurer	N/A
surveying	hand held GIS unit & abney level	Need to purchase abney level
evaporation?	Evapotranspirometers, evaporation pan/tank	Need a plan or equipment.
stream flow	N/A	Will just do a simple analysis if there are streams.
groundwater availability	Need a plan or equipment.	Need a plan or equipment. Yigrem said he will try to help us develop a plan for this.
surveys of community	Smart Phone App	Use the app the Jon has used in the past for community surveys
N/A- not applicable		

- Local material assessment
- Local market assessment

# Timeline of Objectives



# Budget for travel - 5 people, 1 month

Item	Computation	Cost
Airfare: NYC to Addis Ababa (round trip)	5 people * \$1,300	6500
Airfare: Addis Ababa to Bahir Dar (round trip)	5 people * \$295	1475
Food and Lodging	5 people * 30 days * \$25	3750
Car Rental	30 days * \$100	3000
Visas	5 people * \$50	\$250
University of Connecticut Travel Insurance	4 students * 30 days * \$15	\$1,800

# Materials for Earth Removal for Basin and Cover

Item	Justification	Computation	Cost
Shovels	Used to dig out the basin structure to hold water	5 * \$10	\$50
Pickaxes	Used to break up hard earth while digging basin structure	2 * \$15	\$30
Single and double ring infiltrometers and soil texture class analysis	Needed to measure soil permeability for determination of basin location		\$0 *
Buckets	Transportation of earth for building materials as well as evaporation measurements	8 * \$10	\$80
String	Basin cover construction	1 * \$10	\$10
Paint	Basin cover sun protection	1 * \$30	\$30
Cement	Basin liner additive	1 * \$40	\$40
Medical Supplies	Health and Safety for travel team	1 * \$30	\$30
			<b>\$270</b>

# Budget Supplied by Community

	<b>Estimated Cost</b>
Labor	\$ 24,800
Materials	\$ 35,000
Equipment	\$ 15,000
Airfare	\$ 7000
Food, lodging, other expenses	\$ 3,575
<b>Total</b>	<b>\$ 85,375</b>

- This budget was supplied to EWBUSA for program approval

# Conclusion

If we determine surface water is a feasible source for irrigation, a design of the system will be constructed.

If we determine surface water is entirely insufficient for irrigation, alternative solutions will be suggested.

- groundwater system - well, holding tank, pumping
- combination of groundwater and surface water



# Questions?

(photos of Addis Ababa)



# What is the P3 Program?

- A two-phase grant competition for teams of students to design for improvements in sustainability
- Support innovative research on projects or designs
- Developed by an interdisciplinary team of students whose goals are to:
  - improve quality of life for people
  - promote prosperity by developing local economies
  - protect the planet by conserving resources and minimizing pollution