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An overview of a watershed-based research to mitigate land degradation & improve livelihoods: A case from the Gumara-Maksegnit watershed, North Gondar, Ethiopia

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Presentation outline

1. Introduction
2. Objectives
3. The watershed
4. Project partners
5. Approach
6. Watershed characterization
7. Research interventions
8. Highlight on Results

INTRODUCTION

- Ethiopia has great agricultural potential as it has vast area of fertile land, diverse climate, sufficient annual rainfall, & abundant labor force.
- However, the current performance of agric. is far below the potential, partly due to soil erosion & land degradtⁿ, lack of using improved technologies, lack of supportive services, poor socioeconomic infrastructure, & many more interrelated socioeconomic factors.
- Consequently, food insecurity & poverty have remained common features in the rural community.
- However, given the great natural resources endowment there is immense possibility to improve agricultural productivity & livelihood of the people by unlocking the potential of the rainfed agricultural system through integrated watershed development approach.

OBJECTIVES

- **To improve the livelihood of rural communities in the rainfed agro-ecosystem by:**
  - **Improving agricultural productivity & land and water resources through:**
    - **adopting SLM strategies,**
    - **efficiently managing rainwater,**
    - **adopting improved crop & livestock technologies & management practices.**

PROJECT PARTNERS

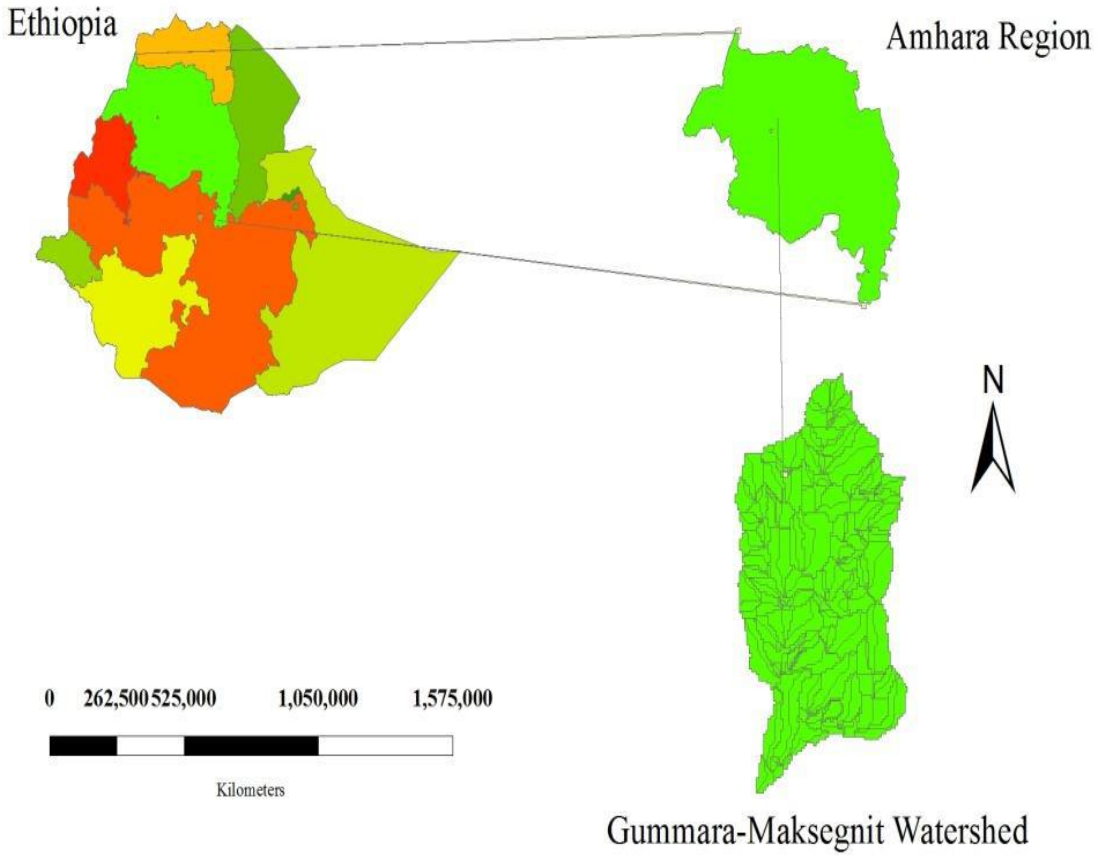
Partners

- ICARDA
- ARARI
- EIAR
- BOKU University, Austria
- Ministry of Agriculture

THE WATERSHED

Located in

- ❑ **Upper catchment of the Blue Nile River basin & Lake Tana basin**
- ❑ **Gonder Zuria district, North Gonder Admin. Zone**
- ❑ **WS area: ≈56 sq. Km**
- ❑ **Popⁿ: 4246 people & 1148 HHs**



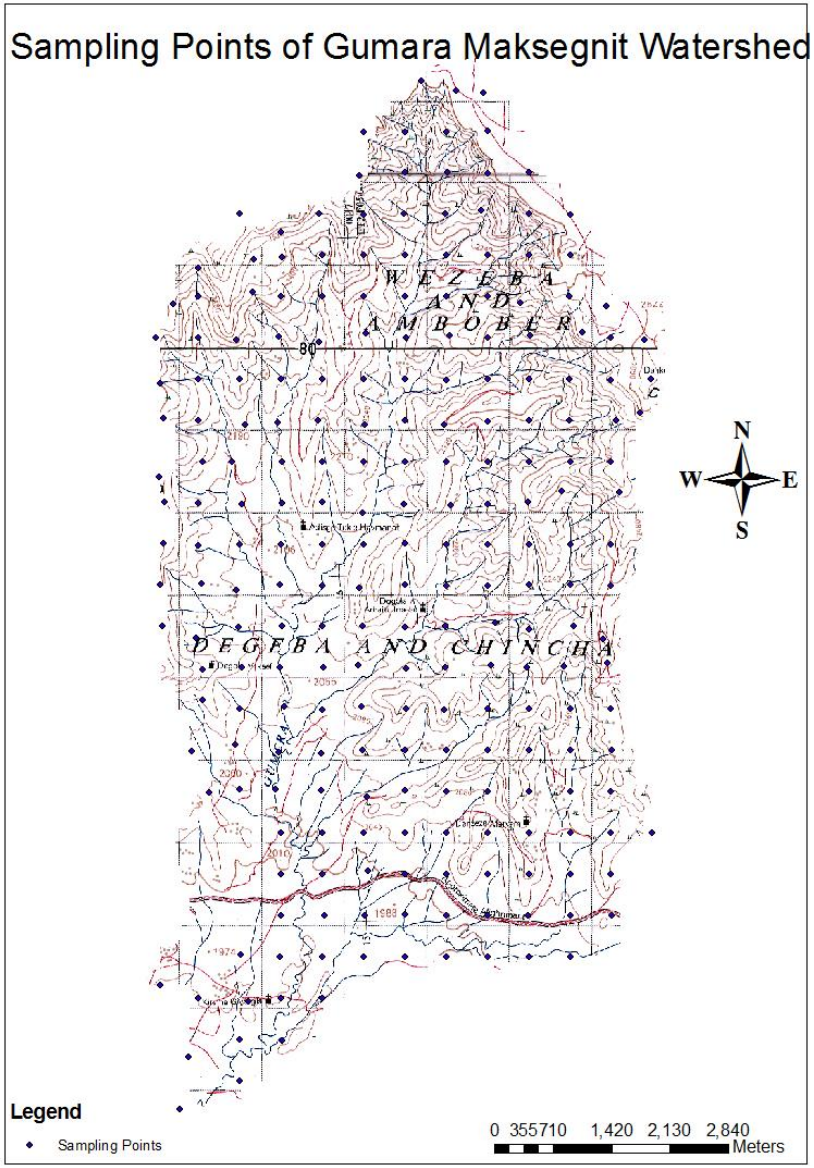
APPROACH

- **Integrated**
  - ❖ **Address all aspects of the Agric. sector:**
    - Land & water mgmt
    - Crop & livestock prodn.
    - Forestry
- **Participatory**
  - Watershed committee
  - FREG
  - Stakeholder planning
- **Demand driven**
  - Stakeholder planning

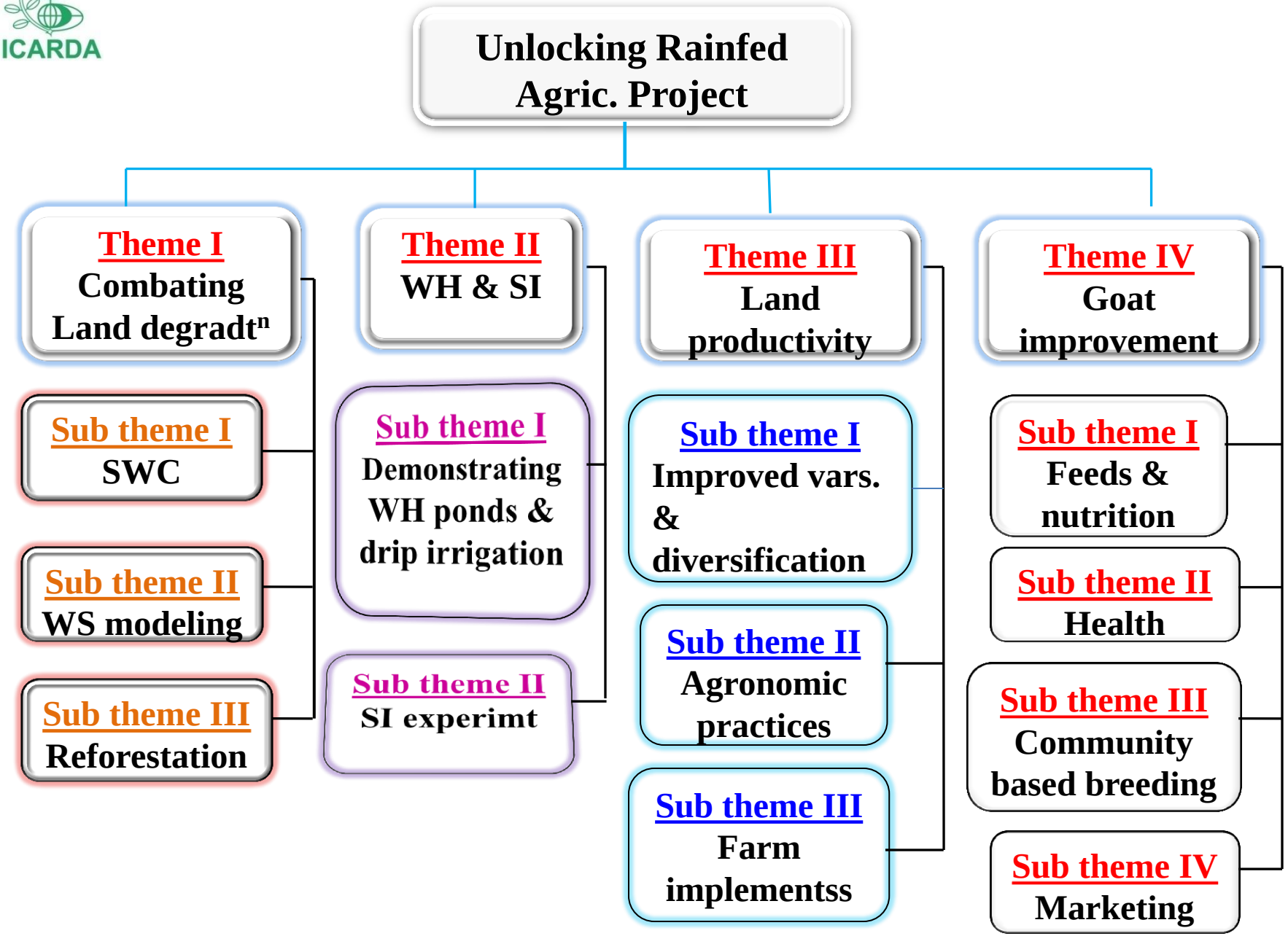
WATERSHED CHARACTERIZATION

- **Socioeconomic charact^{n}.**
  - PRA technique
- **Biophysical charact^{n}.**
  - Grids- 500 m X 500 m
  - 233 grids sampled
  - Data
    - soil physical & chemical properties data

❖ Then through these characterizations system constraints & potentials of the WS were identified & mapped.



Implementation/Research Interventions



Highlight on Results

Theme I. Combating land degradation & watershed modeling Subtheme I. SWC

Effects of SWC measures were monitored

- **Subtheme I. SWC - Field level**
- **Subtheme II. Watershed level -Modeling**

Subtheme I. SWC - Field level monitoring

1. Studying effectiveness of graded stone bunds on soil erosion processes.

2. Studying spatial distribution and temporal behavior of soil properties as indicators of effect of SWC measures.

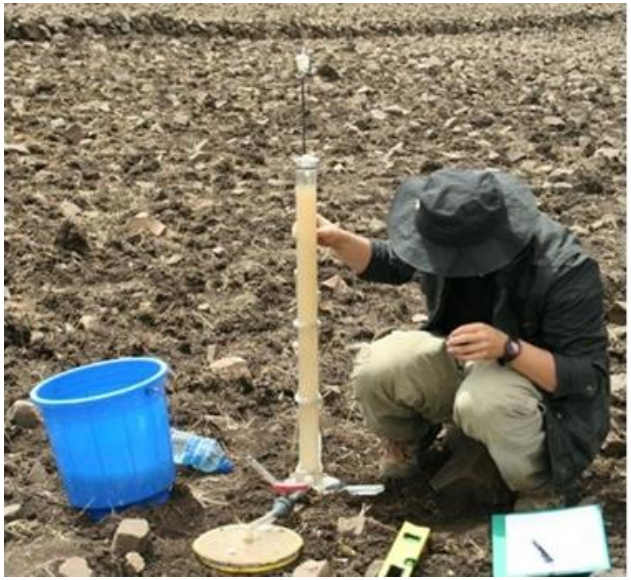
3. Investigating the impact of Stone bunds on soil water content.

4. Assessing gully erosion by linking photogrammetric approach and field measurements

- Data were collected from stone bund treated & untreated plots.
  - surface runoff
  - soil loss
  - soil bulk density
  - soil texture
  - soil moisture content
  - saturated hydraulic conductivity

- Data generated from these activities are used as input data to calibrate & develop a watershed model using SWAT.

Subtheme I. SWC -Field level monitoring



Theme I. Combating land degradation & watershed modeling Subtheme I. SWC (Cont.)

Other activities under combating land degradation

5. On-farm demonstration & participatory evaluation of biological SWC measures

Results-
Vetiver, elephant, bana, & green-gold grasses were planted on terraces of lands of 37 farmers, but failed due to termite damage & free grazing.

6. Assessment of forest cover change & its environmental impact using multi-temporal & multi-spectral satellite images

Results- Poster

Forest area has declined by 1056 ha (18.9%) during 1986–2007 compared to the base year (1986).

7. Estimating soil attributes using DEM & remote sensing techniques

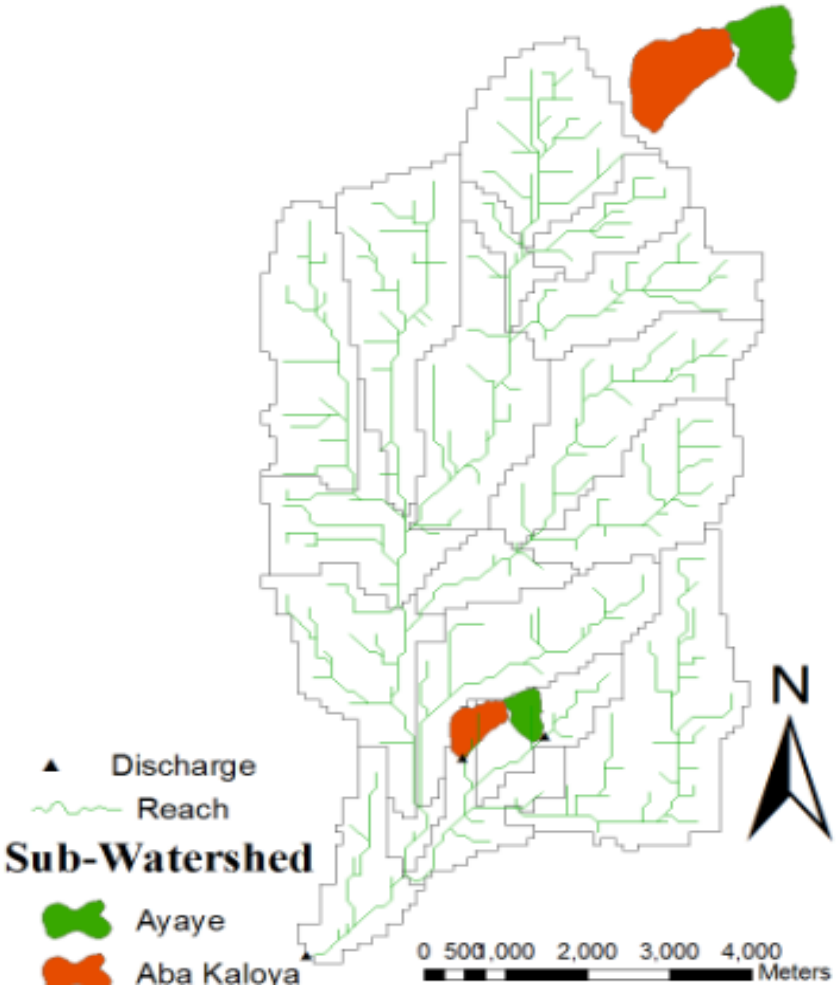
Results-

- **Mapping soil attributes using remote sensing techniques was found viable & fast alternative to classical labor-intensive field surveying.**
- **11 soil attributes were predicted from terrain attributes.**
- **Multiple linear regression models explained up to 85% of the variations in soil attributes.**

Subtheme II. Watershed level monitoring-Modeling

For watershed level monitoring

- ❑ **Outlets of 2 sub-catchments & whole watershed are gauged.**
- ❑ **2 sub-catchments- treated & untreated.**
- ❑ **Automatic water level & sediment load measuring equipments are installed.**
- ❑ **Runoff samples are also collected manually to determine sediment load & nutrient loss.**
- ❑ **Automatic weather station & rain gauges are installed.**



Gauging stations & Equipments

Subtheme II. Watershed level monitoring-Modeling (Cont.)

The 2011 data shows that:

- **For the whole watershed the amount of sediment yield ranges between 2.9 & 27.6 t ha^{-1}.**
- **It was found that about 21% of the rainfall leaves the watershed as runoff.**
- **SWC measures in the treated subcatchement reduced sediment yield by up to 44%.**

SWAT simulation

With SWAT model

- **Surface runoff, sediment yield, soil moisture content, nutrient cycles, crop growth & management practices are simulated.**

Runoff & sediment yield were simulated using 2 scenarios:

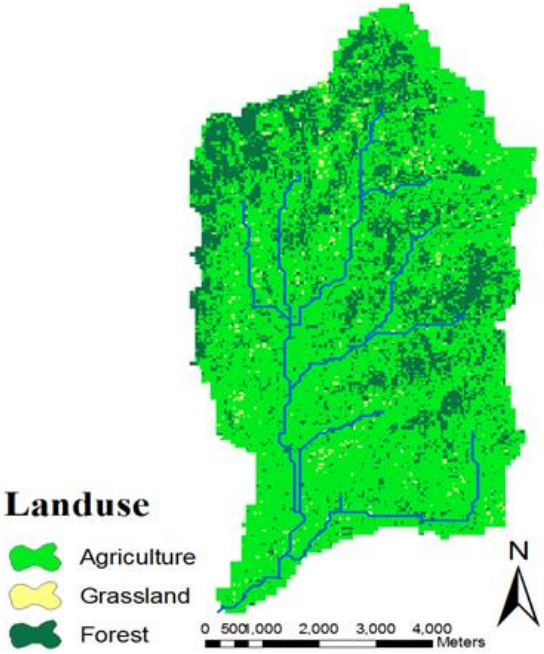
Scenario 1

- **The land use of the Northern part of the WS with slope >50% is changed into forest & most of the remaining WS covered with SWC structures.**

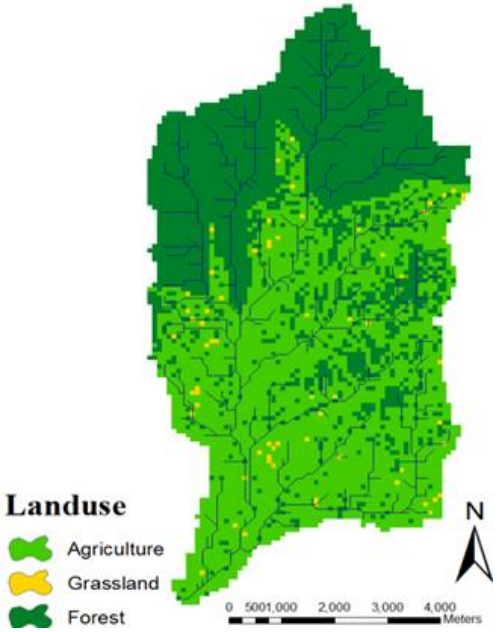
Scenario 2

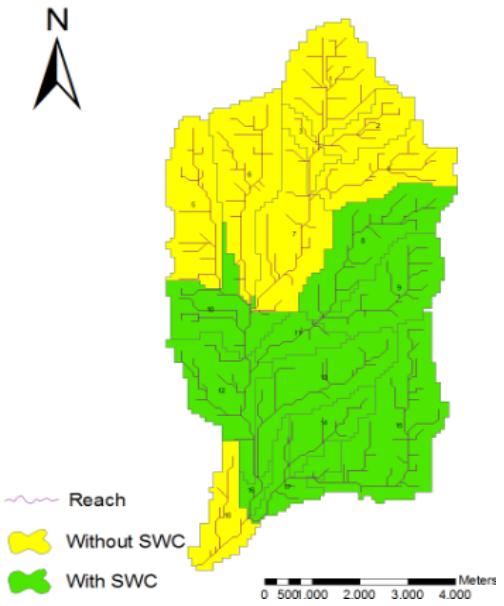
- **Only smaller part of the Northern part of the WS is changed to forest & SWC measures are applied to the remaining part.**

Scenarios



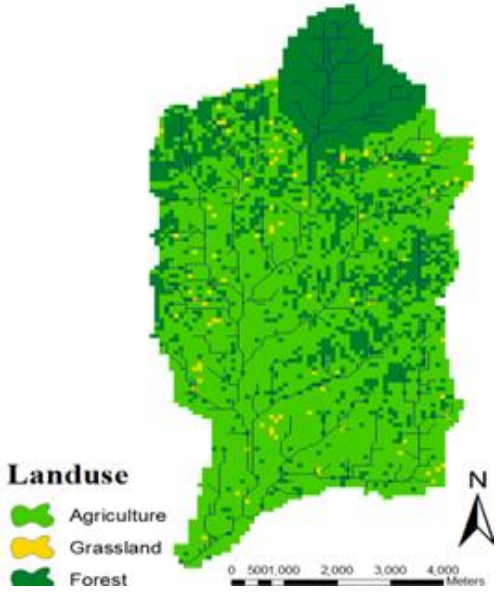
Status quo





Scenario 1

Scenario 2



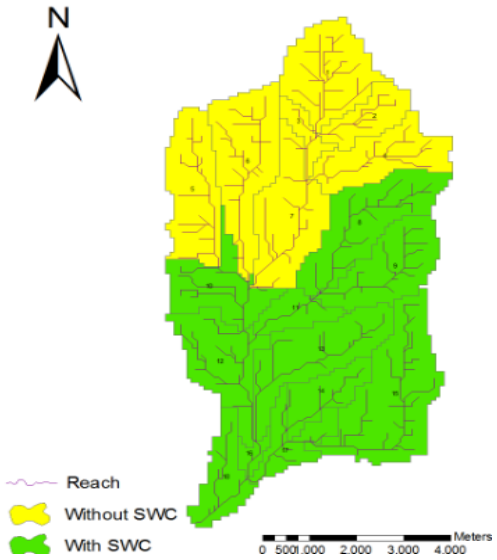


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Table 1. Annual values of sediment yield and surface runoff in the WS calculated by SWAT.

Parameters	Unit	Current status	Scenario 1	Scenario 2
Precipitation	mm	1159	1159	1159
Surface runoff	mm	271	189	214
Sediment yield	t/ha	22.6	3.1	4.7

Implementing the two simulated scenarios could reduce sediment yield by 79-86% compared to the present situation.

Theme I. Combating land degradation & watershed modeling Subtheme 3. Reforestation

Two activities were conducted

1. Tree species adaptation study conducted

- tree spp adaptable on degraded lands identified.

2. Introducing & evaluating mobile tree nursery

- Benefit analysis showed a net benefit of $39.5 from using mobile nursery.
  - Farmers liked it
    - low cost of investment
    - requires less space
    - easy to move from place to place
    - free from termite damage

Theme II. Water Harvesting & Supplemental Irrigation

WH ponds

- 5 WH ponds constructed
- Lined with geomembrane

- Field experiments were conducted to evaluate the effect of SI & N fertilizer on Pepper, Cabbage, Swiss Chard, and Carrot.

- Drip irrigation was used

- Results- **Poster**

Theme III. Land productivity
Subtheme 1. Improved vars & diversification

1. PVS- bread wheat, food barley, faba bean, chickpea, & lentil.

- **2 vars from each crop type selected & further demonstrated.**
- **Farmers' productivity increased by 27-56% from growing these vars.**
- **New crops- Cabbage, Swiss Chard, & Carrot introduced.**

Theme III. Land productivity
Subtheme 2. Agronomic practices

1. Rate determination on the combined use of compost & chemical fertilizer on the yield of bread wheat & soil chemical properties.

Result- poster
Compost & N & P rates which give 522% yield advantage were identified.

2. Determination of rate & time of nitrogen application on wheat & sorghum yields & yield components.

- **Preliminary result on wheat- Splitting N fertilizer - 1/3 at planting, 1/3 at tillering & 1/3 at booting stage gave significantly higher yields.**

Theme III. Land productivity
Subtheme 3. Farm implements

1. On farm evaluation and demonstration of animal drawn moldboard & Gavin plows

Moldboard, Gavin & traditional plows compared with no-till on 2 soil types & two crops

Results - Poster

- **No yield difference**
- **Differences in soil moisture content observed**
- **Low soil infiltration in the no-till**
- **No-till on vertisols is recommended, considering power requirement & profitability**

Theme IV. Goat improvement

Subthemes	Research Activities
Feed and nutrition	Introduction of forage species in the farming system of Gumara-Maksegnit watershed.
	Forage adaptation trial (Cactus, Vetch) in the Gumara-Maksegnit watershed.
	Development of best cost forage based feed formulation for fattening goats in rainfed area
Goat health	Identification and control of major goat diseases
Community Breeding	Characterization of production system and goat population.
	Simple Sire selection and exchange scheme in Gumara-Maksegnit watershed.
Goat Market	Identifying constraints and niches of goat marketing in Gumara-Maksegnit watershed.
	Market linkage and value addition.

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Thank you for your attention

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- **Biophysical charact^{n}.**
  - **Data collected**
    - soil physical & chemical
    - properties,
    - soil depth & slope
    - land use type & vegetation
    - cover,
    - surface stoniness,
    - erosion type & status

7. Estimating soil attributes using DEM & remote sensing techniques

Results-

- **Eleven soil attributes were predicted from terrain attributes.**
  soil depth,
  clay, sand, silt,
  OM,
  bulk density,
  pH,
  total N,
  avail. P,
  stones on the surface and in the soil.