ICARDA's Watershed R4D Project in Ethiopia

- Highlight on Achievements of 1st phase
- Introduction to 2nd phase

Unlocking the Potential of Rainfed Agriculture in Ethiopia for Improved Rural Livelihoods

Duration

- From June 2009 (effective 2010) to December 2012.

Partners

- ICARDA
- ARARI
- BOKU University, Austria
- EIAR

Objectives

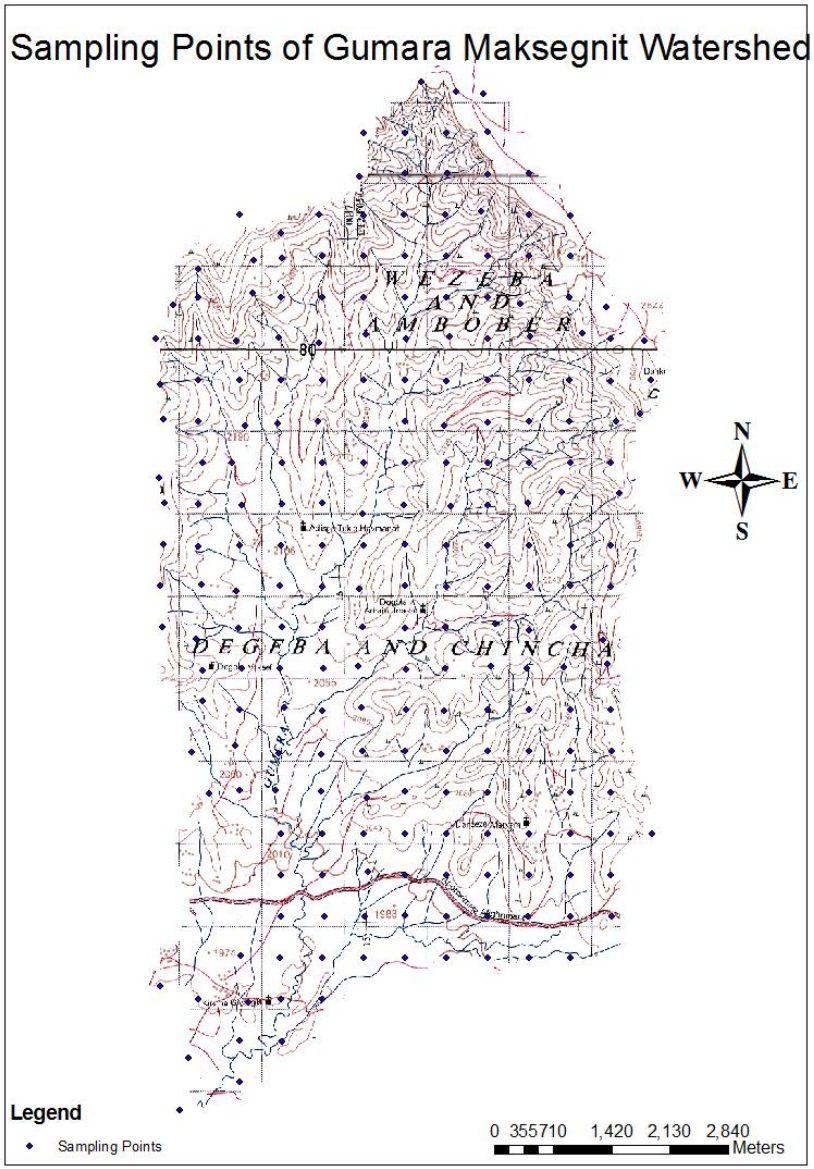
- **Improving the livelihood of rural communities in the rainfed agro-ecosystem by:**
  - **Improving agricultural productivity & land and water resources through:**
    - **Integrated & participatory watershed research (system approach)**
    - **adopting SLM strategies,**
    - **efficiently managing rainwater,**
    - **adopting improved crop & livestock technologies & management practices.**

Approach

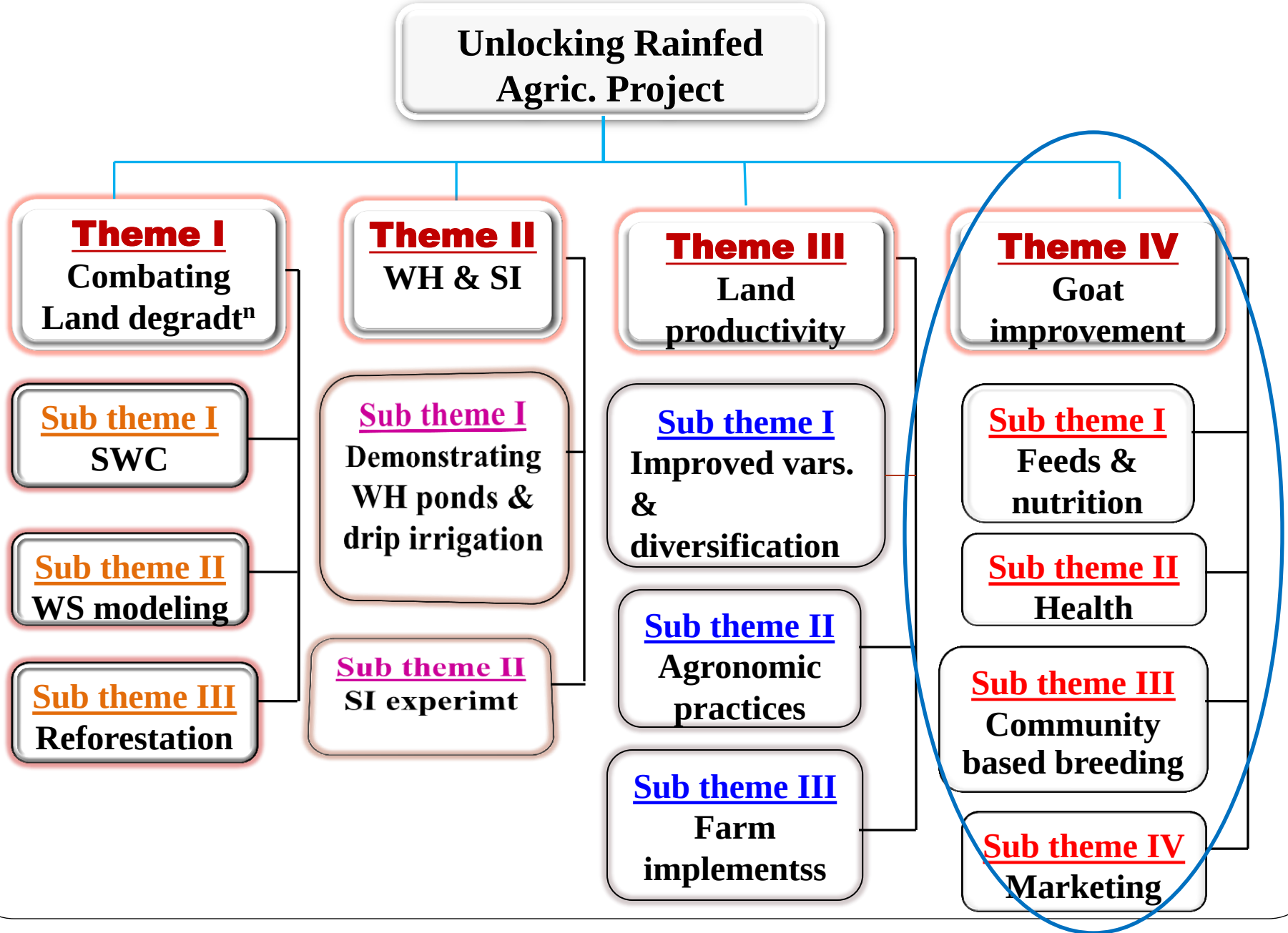
- **Integrated**
  - **Address all aspects of the farming system:**
    - **Land & water mgmt**
    - **Crop & livestock prodn.**
    - **Forestry**
- **Participatory**
  - **Watershed committee**
  - **FREG**
  - **Stakeholder planning**
- **Demand driven**
  - **Stakeholder planning**

WATERSHED CHARACTERIZATION

- **Socioeconomic characterization**
- **Biophysical characterization**
  - **Grids- 500 m X 500 m**
  - **233 grids sampled**
- **Then through these characterizations system constraints & potentials of the WS were identified & mapped.**



Implementation/Research Interventions



Theme I. Combating land degradation & watershed modeling

Subtheme I. SWC

- In Collaboration with the DOA SWC structures were constructed in the WS by the community

- Two sub-catchments
  - one treated
  - one untreated

Gauging stations

Gauging stations constructed

- ❑ **Main watershed outlet**
- ❑ **2 sub-catchments outlets**

Field level monitoring of effects of SWC

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

2. Studying spatial distribution & 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 .

❑ Results

- SWC structures were found
  - Reducing runoff & soil loss
  - Increase soil moisture content
  - Reducing soil bulk density
- Data generated from these studies are used as input data to calibrate & develop a watershed model using SWAT.

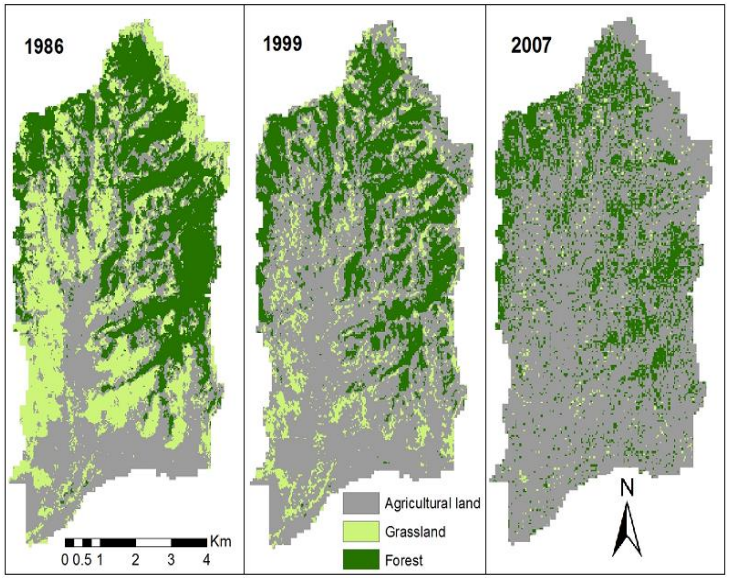
Other studies

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

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

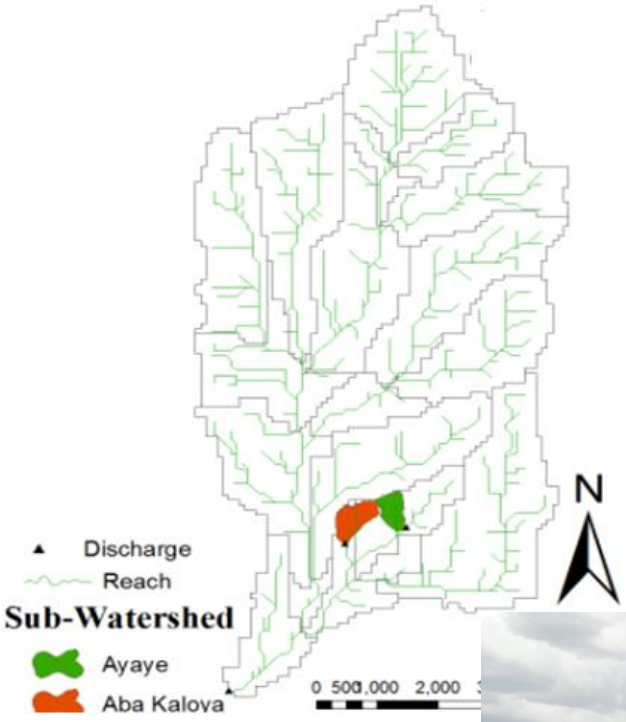
7. Estimating soil attributes using DEM & remote sensing techniques

Results

Mapping soil attributes using remote sensing techniques was found feasible & fast alternative to classical labor-intensive field surveying.

Watershed level monitoring effects of SWC

- ❑ From the 3 gauging stations
- ▪Data collected
  - • Runoff
  - • Sediment concentration
  - • Nutrient loss
- •Collected using
  - • Automatic equipments
  - • Manually
- •Automatic weather station & rain gauges are installed.



SWAT simulation

With SWAT model

Surface runoff, sediment yield, soil moisture content, nutrient cycles, crop growth & management practices are supposed to be simulated.

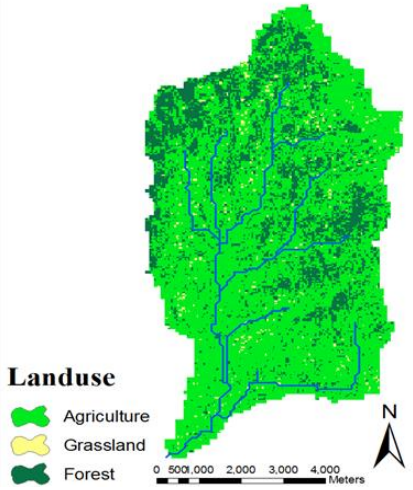
Runoff & sediment yield were simulated using 2 scenarios:

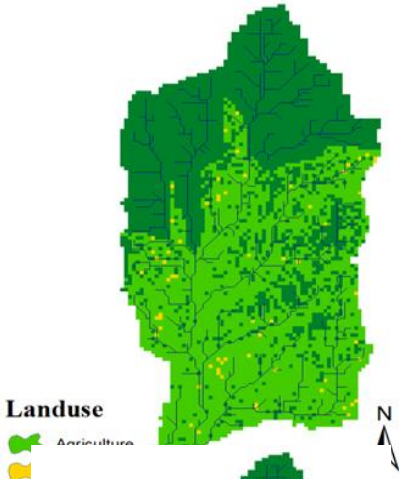
Scenario 1

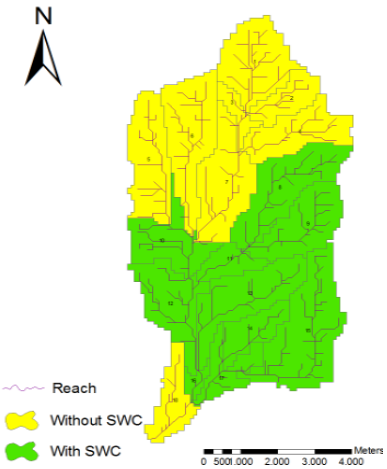
The land use of the Northern part of the WS with slope >50% is changed into forest & most of the remaining WS covered with SWC structures.

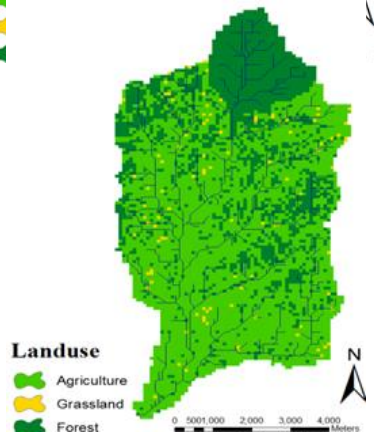
Scenario 2

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









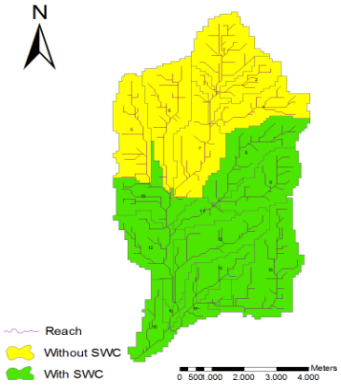


Table 1. Annual values of sediment yield and surface runoff in the WS calculated by SWAT.

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 $3 mobile nursery.
- Farmers liked it
  - low cost of investment
  - requires less space
  - easy to move from place to place

Theme II. Water Harvesting & Supplemental Irrigation

WH ponds

- 5 WH ponds constructed
- Field experiments were conducted to evaluate the effect of SI & N fertilizer on Pepper, Cabbage, Swiss Chard, and Carrot.
- Drip irrigation was used

Results

- ❑ Crops suitable for SI identified
- ❑ Water amount and frequency developed

Theme III. Land productivity

Subtheme 1. Improved vars & diversification

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

   - **Two 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 for bread wheat

Result

Compost and N & P rates which give 522% yield advantage were identified.

2. Determination of rate & time of N application on wheat productivity.

Result

Preliminary result - Splitting N fertilizer - 1/3 at planting, 1/3 at tillering & 1/3 at booting stage gave up to 126% yield increase.

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

- **No yield difference**
- **Differences in soil moisture content observed**
- **Low soil infiltration in the no-till**

❑ **For Vertisols no-till is recommended, considering power requirement & profitability**

Theme IV. Goat improvement _ Funded by IFAD

1. **Characterization of production system and goat population.**

   Result: Goat population and breeding practices of goat farmers is characterized.

2. **Introduction of forage species in the farming system of Gumara-Maksegnit watershed.**

   Result: Sesbania spp, pigeon pea & *Penisetum purpureum* forages were introduced into backyards, exclosures, & gullies and evaluated involving 54 households. *Sesbania sesban* was found most preferred forage sp.

3. **Forage adaptation trial (Cactus, Vetch) in the Gumara-Maksegnit watershed.**

   Result: 3 cactus types and 3 vetch spp are recommended.

4. **Simple Sire selection and exchange scheme in Gumara-Maksegnit watershed.**

   Result: Simple sire selection was undertaken in two round & 27 breeding bucks were selected & exchanged between the 56 participating farmers.

5. **Identification and control of major goat diseases**

Result

Major goat diseases identified are: sheep pox, CCPP and PPR and major parasitological diseases identified are: strongylosis, coccidiosis and monizia.

6. **Goat value chain analysis in Gumara-Maksegnit Watershed**

Result

Main actors in the value chain were identified and the main governor of the goat value chain is identified to be the wholesalers

7. **Development of best cost forage based feed formulation for fattening goats in rainfed area**

Result

Not conducted yet.

Capacity building

- 1 PhD student & 7 MSc students (one partly supported) have done their thesis research in the watershed with the support of the project.
- 2 MSc and 1 PhD students trained on GIS and remote sensing.
- 1 PhD student attended 6 days training in Amman on the application of SWAT model.
- 1 MSc student got hands on training on image processing, interpretation and analysis from the University of Jordan.
- 32 researchers trained on the concepts, principles & practices of integrated watershed management and harnessing the potentials of rainfed agriculture for 5 days.
- 1 researcher trained on small ruminant production for 13 days in Jordan .
- 1 researcher trained on animal husbandry for 21 days in Cairo .
- 224 farmers and extension workers were trained on the production packages of improved crop varieties, on conservation tillage, on improved tillage implements, on packages of tree mobile nursery, and on animal husbandry practices

Dissemination

- **Series of field days were held and attended by 50 people in 2010, 146 people in 2011, and 40 people in 2012**

- **In each field day about 60-70 leaflets were distributed.**

Second Phase project

Reducing land degradation and farmers' vulnerability to climate change in the highland dry areas of north-western Ethiopia

Partner Institutions & period

Partner Institutions

- BOKU University
- ARARI
- EIAR
- MoA

Duration of the project

- July 2013 to June 2016

Donors

- Austrian Development Agency (ADA)
- CRP5 (Water, Land and Ecosystem-WLE)

Finanace

- Total project costs: € 1,171,158
- ADA: €499,445
- Co-financing: 180,000 (in kind)
  - ICARDA:120,000
  - ARARI: 60,000
- CRP 5: €491713

Other collaborating partners

- Regional Bureaus of Agriculture (BoA)
- Zonal and District Offices of Agriculture
- NGOs
- Farmers Research and Extension Groups (FREGs)

More collaborators

- IWMI
- Livelihood Improvement through Sustainable Resource Management program
- SLM project
- World Vision
- CRP1.1
- IFAD

Background

- **Land degradation and climate change impacts threaten the food security, livelihood and survival of rainfed farmers in the Amhara region.**

- **The Amhara region suffers from alarming land degradation**
  - **10% of the total area of the region suffers from annual soil loss of >200 t ha^{-1}, and**
  - **29% of the total area experiences soil loss of 51-200 t ha^{-1} per year.**

- **On top of this, the rainfed crop-livestock production system is locked up by traditional low-input production practices, inefficient rainwater management, use of low yielding crop varieties and livestock breeds, increasing disease and pest prevalence and poor marketing and processing infrastructures.**

- **Thus, rainfed farmers are tied up with strong cycle of "land resources degradation, poverty, poor productivity, and food insecurity trap".**

Objectives

1. To **reduce vulnerability** and increase the resilience capacity of rainfed farmers to **climate change** and **land degradation**.

2. To **understand the strategies** adopted by farmers in their efforts to manage climate change impacts and disseminate best bet practices.

3. To ensure rainfed farmers **food security, livelihoods** and economic well-being in the face of climate change.

4. To **capacitate farmers** to sustainably manage their farming system resources (land, soil, water, crop and livestock).

5. To identify and recommend policies and strategies to facilitate more **climate change resilient production systems**.

Outputs

Output 1: Appropriate **bio-economic** system **model** at the watershed level verified and used to describe and analyze the system dynamics, productivity and the constraints to improved performance.

Output 2: **Farmers' perception on climate change**, their vulnerability to the adverse effects of climate change, and their adaptation strategies identified, documented and availed to policy makers and development practitioners.

Output 3: Integrated farm level **SLM technologies** (technologies that enhance the organic matter content of the soil, reduce erosion, enhance soil water holding capacity, restore land productivity) that build resilience to and mitigate climate change impacts, are compatible and that are affordable to resource poor farmers developed, tested, demonstrated and applied by the rainfed community in the target area.

- **Output 4:** Farmers' adaptation capacity to drought increased as a result of developing, testing, **fine-tuning and applying WH & SI**/off-season vegetable production system that are suitable and affordable to poor farmers.

Output 5: Crop & livestock types/varieties/breeds & management practices that better adapt to climate change impacts (RF variability, rising T^{o}s and evaporation rates, and drought) and reducing farmers' vulnerability developed, tested and demonstrated with the participation of local communities.

Output 6: Enhanced capacity of national researchers, farmers and service providers. Capacity building and institutional strengthening achieved through training of national scientists, extension staff and farmers, travelling workshops, field days, and scientific visits to international centers.

Output 7: Technical and policy recommendations for best climate change adaptation strategies and SLM practices, research publications and graduate research thesis produced.

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Output 1: **Appropriate bio-economic system model at the watershed level verified and used to describe and analyze the system dynamics, productivity and the constraints to improved performance.**

Indicators:

- **Rainfed system dynamics, at watershed level, productivity and constraints to improved performance analyzed and identified. People at the NARS able to use the model and conduct independent analysis.**

Activity 1.1: **Data collection, calibration and verification of the model.**

- **For this activity, data required by the model will be collected from the field. Data is likely to include historic climatic data, soil land use, topography and water data and crop yields under various conditions especially various rainfall amounts as well as socio-economic data (household surveys).**

Activity 1.2: **Model application for rainfed system analysis.**

- **The model once proved suitable and describes reasonably the system, parameters will be used to analyze the dynamics of the system.**

Output 2: Farmers' perception on climate change, their vulnerability to the adverse effects of climate change, and their adaptation strategies identified, documented and availed to policy makers and development practitioners.

Indicators:

- **By end of project 100% awareness level on the impacts of climate change is achieved among farmers in project area. Based on the research findings at least one policy brief will be developed and disseminated. The biophysical and socio-economic factors determining exposure and adaptive capacity and adaptation to climate change will be identified and documented.**

Activity 2.1: Assessing farmers' perceptions on climate change and analyze the biophysical and socio-economic factors determining exposure and adaptive capacity and adaptation to climate change.

Output 3: **Integrated farm level SLM technologies that build resilience to and mitigate climate change impacts are compatible and that are affordable to resource poor farmers developed, tested, demonstrated and applied by the rainfed community in the target area.**

Indicators: **SOM content increased by 30%, soil productivity increased by at least 50%, soil erosion decreased by 50%. Exploitative crop production approach change by 50%. Community awareness on the need for enhancing soil productivity increased by 100%.**

Activity 3.1: **Implementing conservation tillage technology that improves the physical, chemical, biological, and hydrological properties of the soil.**

Activity 3.2: **Implementing SOM enhancing technologies, such as green manure, compost, animal manure, crop residue, crop rotations, crop diversification & intercropping, & integrated plant nutrient management technologies.**

Activity 3.3: **Assessing farmers' perceptions and attitudes towards soil and water conservation, as it is an important first step in tackling the problem.**

Output 4: **Farmers' adaptation capacity to drought increased as a result of developing, testing, fine-tuning and applying water harvesting and supplemental irrigation/off-season vegetable production system that are suitable and affordable to poor farmers.**

Indicator: **Economic performance of the farmers that apply the technologies doubled. Less water will runoff downstream and more water will be used by the crops. Increased awareness of the system requirements and productivity of soil and water.**

Activity 4.1: **Implementation of water harvesting/supplemental irrigation systems and water harvesting/off-season vegetable production systems together with agronomic practices at the farm and community levels.**

Activity 4.2: **Assessing farmers' attitude towards developing water harvesting ponds for supplemental irrigation and off-season vegetable production and factors (bio-physical and socio-economic) for adopting or not adopting the system.**

Output 5: **Crop and livestock types/varieties/breeds and management practices that better adapt to climate change impacts (rainfall variability, rising temperatures and evaporation rates, and drought) and reducing farmers' vulnerability developed, tested and demonstrated with the participation of local communities.**

Indicators: **Through using adapted crop and livestock management practices productivity of the rainfed system in the target areas increased by at least 100%. Number of households using adapted crop and livestock management practices increase to 20% by end of project. Farmers' income in the target groups is expected to increase by at least 10%.**

Activity 5.1: **Implementing participatory evaluation, demonstration, and dissemination of drought and high temperature tolerant crop varieties and management practices (intercropping, cropping system and, crop/feed mixed cropping) and livestock management technologies (improved feed, nutrition, animal health, and value addition) that can improve farmers' resilience to climate change.**

Output 6: Enhanced capacity of national researchers, farmers and service providers. Capacity building and institutional strengthening achieved through training of national scientists, extension staff and farmers, travelling workshops, field days, and scientific visits to international centers.

Indicators: At least 2 graduate students will be supported. 2000 farmers will get on-the-job training through participating in the project testing and demonstration activities. At least 50 extension staff and 15 scientists will be trained.

Activity 6.1: Participating staff from the collaborating research institutions and community and watershed association leaders will receive on-the-job training in resource assessment and management through "learning by doing" in participatory approaches.

Activity 6.2: Formal short-term trainings which will include local training for the watershed association members in farm management practices, water management and crop and livestock related activities will be provided.

Output 7: Technical and policy recommendations for best climate change adaptation strategies and SLM practices.

Indicators: Comprehensive technical and policy recommendations developed. At least two thesis reports produced.

Activity 7.1: Results of the project activities will be synthesized and compiled and comprehensive technical and policy recommendations developed.

Activity 7.2: Dissemination and promotion of research results for greater impact.

Activity 7.3: Project final workshop

Activities conducted with the new project

1. Runoff, sediment loss and nutrient loss data collection for the watershed modeling
2. Investigation of the impact of stone bunds on soil water content in the Gumara-Maksegnit watershed (MSc research).
3. Investigations of the impact of stone bunds on water erosion (MSc research).
4. Effect of soil drainage and fertilizer on the productivity of sorghum on Vertisols.
5. Evaluation of sorghum/faba bean intercropping for intensifying existing production systems.
6. Response of tef row planting to sowing dates on the highland heavy clay soils.
7. Effect of split application of N fertilizer on sorghum yield
8. Determination of rate & time of N application on wheat yield

9. Participatory evaluation and selection of improved lentil varieties.

10. Demonstration and evaluation of Jab planter for planting maize.

11. Demonstration and evaluation of water harvesting and supplementary irrigation to improve agricultural productivity.#

12. Technical and socio-economic study of using small ponds water harvesting systems for supplemental irrigation

13. Prickly Pear Cactus adaptation

14. Evaluation of undersowing Stylosanthes in sorghum for intensifying existing production systems.

15. Simple Sire selection and exchange scheme

16. Identifying goat marketing constraints and niches

Thank You for Your Attention!