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

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Mitigating Soil Erosion and Water Scarcity,

Increasing Farmers' Adaptation Capacity to Climate Change

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Objectives

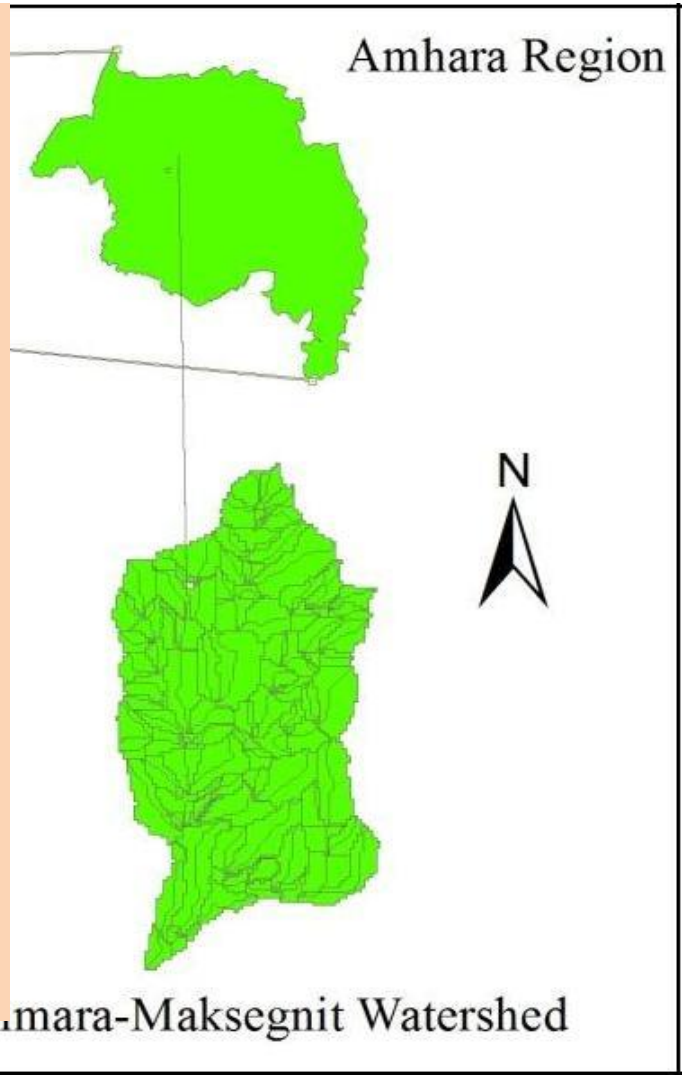
- To reduce vulnerability and increase the resilience capacity of farmers to CC and land degradation/ soil and water.
- To ensure rainfed farmers food security, livelihoods and economic well-being in the face of climate change.
- To capacitate farmers to sustainably manage their farming system resources (land, soil, water, crop and livestock).
- To identify and recommend policies and strategies to facilitate more climate change resilient production systems.

Study area

- **Location:** North Gondar zone G/Maksegnit watershed.

- 45 km southwest of Gondar town
- Area: 56 square kilometers
- Altitude:1923 to 2851 m amsl

- Mean max. temperature: 28.5 °C
- Mean min. temperature:13.3°C
- Mean annual rainfall :1052 mm
  - ❖ it is erratic and uneven in distribution



List of Research Activities Conducted in Phase-II

Output-1: Appropriate bio-economic system model at the watershed level		
1	**1.1** Maintenance of the weirs and the equipment	Achieved
	1.2 Collection and lab analysis of watershed monitoring data	Achieved
	1.4 Impact of stone bunds on soil erosion	MSc students
	1.5 Establish baseline for socio-economic evaluation and impact assessment	PhD student
	1.6 Building the bio-economic model	PhD student
Output-2: Assessing farmers' perception on climate change		
2	**2.1** Assessing farmers' perception and adaptation strategies towards CC	**Achieved**
Output-3: Integrated farm level SLM technologies		
3	**3.2** Effect of timing of ridging and tie ridging on the performance of sorghum	Achieved
	3.3 Investigating effect of green manure cover-crop on run-off, soil characteristics and yield of chickpea	Achieved
	3.4 Effect of N and P fertilizer application for tef productivity	Achieved
	3.5 Optimum planting size of Ficus thonningii Blume	failed
	3.7 Introduction of fuel saving technologies to reduce land degradation & CC, improve soil fertility, and livelihood	Achieved
	3.8 Monitoring nutrient balance in GM watershed	MSc Student

List of Research Activities Conducted in Phase-II…

Output-4: Farmers' adaptation capacity to drought /applying water harvesting and supplemental irrigation/off-season vegetable		
4	**4.1** Deficit irrigation on growth and yield of garlic	Achieved
	4.2 Deficit irrigation on growth and yield of onion	Achieved
	4.3 Modeling of the water harvesting ponds	MSc Student
	4.4 Field tour and Field experience sharing	Discontinued
Output-5: Crop and livestock feed/varieties/breeds and management practices that better adapt to climate change impacts		
5	5.1. Adaptation of hot pepper varieties in Gumara-Maksegnit watershed under irrigation	Achieved
	5.2 Determination of weeding frequency to increase production and productivity of Sorghum	Achieved
	5.3 Pre-scaling up of early maturing & drought escaping chickpea vars. & agronomic packages	Achieved
	5.4 Evaluation of the adaptability of different sweet lupine varieties in Gumara- Maksegnit watershed	Achieved
	5.5 Development and implementation of a pilot village-based goat improvement scheme	Achieved
	5.6 Evaluation of undersowing vetch in sorghum for intensifying existing production	Achieved
	5.7 Adaptation and performance evaluation of Prickly Pear	Achieved
	5.8 Demonstration of goat feeding package in community based goat improvement village	Achieved
	5.9 Demonstration and evaluation of Sheep fattening with urea treated tef straw and other	Achieved
	5.10 Participatory evaluation and selection of improved lentil varieties	Achieved

List of Research Activities Conducted in Phase-II...

Output-5: Crop and livestock feeds/varieties/breeds and management practices that better adapt to climate change impacts		
5	5.11 Response of teff row planting to sowing dates on the highland of heavy clay soils	Achieved
	5.12 Evaluation of sorghum/faba bean intercropping for intensifying existing production	Achieved
	5.13 Determination of rate and time of N application on wheat yield	Achieved
	5.14 Effect of split application of N fertilizer on sorghum yield	Achieved

Mitigating Soil Erosion and Water Scarcity…

Mitigating Soil Erosion

Sheet erosion

+

Gully erosion

=

Sediment bed load

-

Suspended sediment

Soil erosion → **Soil loss**

Reducing soil detachment, improving rainwater infiltration into soils

then ensuring safe discharge of excess runoff water in waterways.

Mitigating Soil Erosion and Water Scarcity…

Mitigating Soil Erosion…

- **Rainfall characteristics causing erosion is always there!**

❖ **Reducing soil loss caused by**

– **Slope length and steepness (SL) → bench terrace/ soil bund/ stone bund/ micro-basin**

✓ **Reducing Free animal grazing**

Developing appropriate Bio-physical SWC

Area closure

Mitigating Soil Erosion and Water Scarcity…

Mitigating Soil Erosion …

- **Rainfall characteristics causing erosion is always there!**
- **Reducing soil loss caused by**
  - **Soil erodibility → improving soil physical structure**
    - **Incorporation of chopped vetch cover crop**

Vetch incorporation to soil

Mitigating Soil Erosion and Water Scarcity…

Mitigating Soil Erosion…

- **Rainfall characteristics causing erosion is always there**
- **Reducing soil loss caused by**
  - **Reducing rainfall erosivity impact/management → applying cover crop**

Vetch cover crop to reduce soil detachment/ erosion

Mitigating Soil Erosion and Water Scarcity…

Mitigating Water Scarcity…

- **Conserving soil moisture through tied ridging**
  - **When furrows between ridges are tied, excess rainfall will stay and gets opportunity time to infiltrate to the soil**

Mitigating Soil Erosion and Water Scarcity…

Mitigating Water Scarcity…

- **Harvesting surface runoff water during excess rainfall events and:**
  - **Using for dry spell periods as supplementary irrigation**
  - **Use for full irrigation by water saving technologies and practices**
    - ✓ **Drip kit irrigation irrigation**
    - ✓ **Deficit irrigation (lesser water reasonable yield)**
    - ✓ **Crop selection (preferably fruits, …)**

Mitigating Soil Erosion and Water Scarcity…

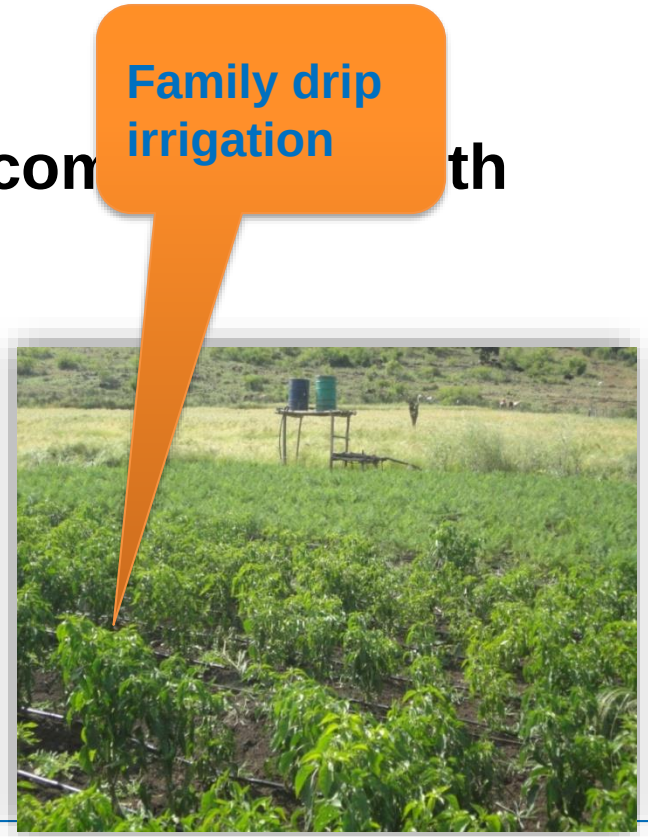
Mitigating Water Scarcity…

- **Applying water saving technologies to improve water use efficiency and water productivity**
  - **Improving water use efficiency by adopting water saving technologies**
  - **Increasing water productivity accom th proper soil fertilizer application**

❖ **2/3 full SI + 50kg/ha N gave 175% pepper yield increment**

❖ **1/3 full SI + 50kg/ha N gave 57% Cabbage yield increment**

❖ **Full SI + 50kg/ha N gave 150% Swiss chard yield increase**



Increasing Farmers' Adaptation Capacity to CC

Appropriate Adaptation strategies

- **Capacitating farmers /Building resilience to CC**
- **Watershed level responses to CC & variability**
- **Farm level responses to CC & variability**
  - Use of chemical/organic fertilizers/ bio-fertilizers
  - Crop diversification/ intercropping
  - Adopting drought tolerant crop varieties
  - Adjusting planting time (escaping the moisture stress period)
- **Improving soil and water mng't**
  - Vertisol water management
  - Access to irrigation water
- **Adapting alternative live-stock feeds**
  - Integrating livestock and crop production
  - Strengthening local animal breeds that adapt local feed system

Increasing Farmers' Adaptation Capacity to CC

Adaptation strategies→ **Capacitating farmers**

- **Building resilience to CC**
  - Brain-storming on extreme events, field days, field research evaluation and demonstration

Working together with farmers and DAs what researches are being done

What if integrated watershed management is not applied?

- Soil loss severity is high> 66ton/ha/annum
- 9ton/ha organic matter/year
- 70kg/ha Nitrogen /year

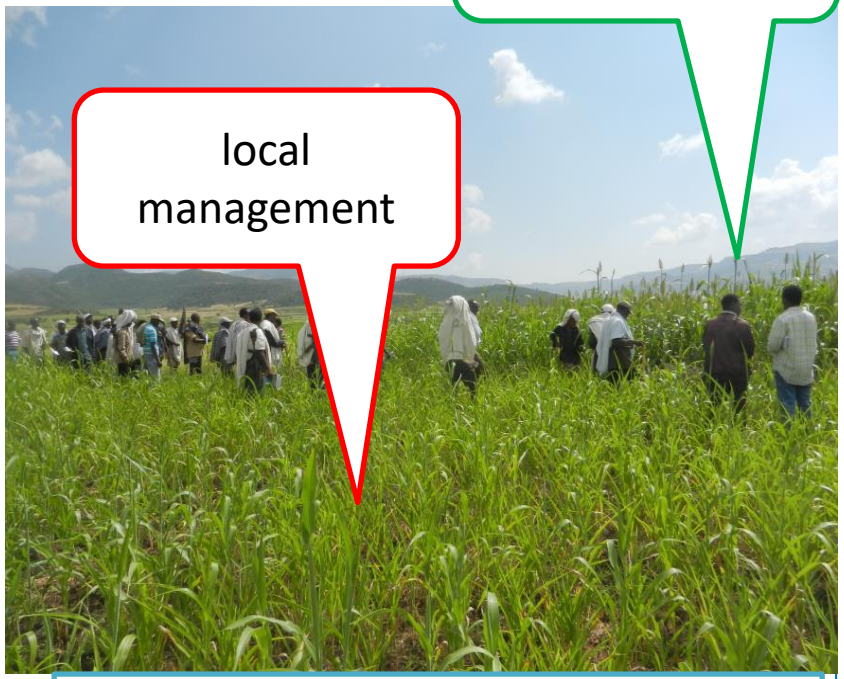
How to increase crop productivity while climate variability is there?

Increasing Farmers' Adaptation Capacity to CC

Adaptation strategies → Capacitating farmers

- **Building resilience to CC**
  - **Trainings, field days, field technology research evaluation and demonstration, experience sharing**

Farmers and DAs training



Research technology evaluation

Increasing Farmers' Adaptation Capacity to CC

Adaptation strategies→ Capacitating farmers

- **Building resilience to CC →knowledge transfer**
  - **Leaflets in local language**
  - **Medias, EBC (National TV, FBC(Local Radio), AMMA (Regional medias)**

Increasing sorghum productivity through integrated management→ 1.7ton/ha to 4ton/ha

Increasing Farmers' Adaptation Capacity to CC

Adaptation strategies→ Watershed level responses to CC & variability

- Holding excess runoff water in the watershed and reducing its impact downstream

Enriching watershed with MPT plantation

Strengthening soil faced stone bund with pigeon pea

Increasing Farmers' Adaptation Capacity to CC

Adaptation strategies→ Farm level response to CC & variability

Use of chemical/organic fertilizers…

- Increasing chemical fertilizer use efficiency i.e reducing release of nitrogen to atmosphere
- 69 kg/ha of N split in 3 crop stages i.e at planting, tillering and booting stage gave better wheat grain yield (3.2 to 3.9 ton/ha)

Improving N fertilizer use efficiency through split on wheat

Increasing Farmers' Adaptation Capacity to CC

Adaptation strategies→ Farm level response to CC & variability

Use of chemical/organic fertilizers…

- Determining economically optimal rates of N and P_2O_5 rates for sorghum and *tef*
- 87 kg/ha N fertilizer with split application and 46 kg/ha of P_2O_5 gave economically better sorghum grain yield (4ton/ha)
- 46 kg/ha N fertilizer with split application and 46 kg/ha of P_2O_5 gave economically optimal *tef* grain yield (1.8ton/ha)

a') Farmers' practice (No fertilizer)
b') research (with application of row planting + fertilizer

Increasing Farmers' Adaptation Capacity to CC

Adaptation strategies→ Farm level response to CC & variability

Use of chemical / organic fertilizers / bio-fertilizers

- **Soil organic matter enhancing technologies**
  - ✓ **compost + inorganic fertilizer for wheat**
  - ✓ **chopping vetch and incorporating to soil**
- **Nitrogen fixation through planting of organic materials**
  - ✓ **Planting legume feeds like vetch, chickpea, faba-bean, cowpea**

Increasing Farmers' Adaptation Capacity to CC

Adaptation strategies→ Farm level response to CC & variability

Crop diversification/ intercropping

- **Evaluation of sorghum/faba bean intercropping**
  - ✓ sorghum/faba bean in 1:3 and 1:1 row ratio wh
    days after sorghum planting →1.6 ton/ha faba
    significance influence on yield of sorghum

Faba-bean and sorghum

- **Evaluation of under-sowing Vetch in sorghum**
  - ✓ Sorghum in 75 cm plus Vetch planted after t
    Vetch with out significantly affecting sorgh

Sorghum

vetch

Increasing Farmers' Adaptation Capacity to CC

Adaptation strategies→ Farm level response to CC & variability

- **Adopting drought tolerant crop varieties**
  - **Adaptation of hot pepper**
    - ✓ **Earlier variety(*Mareco Fana*) is approved as early matured and high yielder**
  - **Lentil varieties' selection→ best variety selected**
    - ✓ ***Gudo (best yielder 74% yield increment, drought tolerant, early maturing)***
  - **Pre-scaling up of chickpea varieties**
- **Adjusting planting time (escaping the moisture stress period)**
  - ✓ **Sowing *tef* soon after the onset of rainfall when the soil is moist enough gave better yield (400kg/ha higher than the local planting time)**

Increasing Farmers' Adaptation Capacity to CC…

Adaptation strategies → improving soil and water mng't

- **Vertisol water management /Ridging and tied ridging**
- climate variability i.e extreme events causing yield loss of sorghum

Increasing Farmers' Adaptation Capacity to CC…

Adaptation strategies → improving soil and water mng't…

- Access to water for irrigation →harvested water
  - Supplementary irrigation and full irrigation

- Producing more food while using less water per unit of output→ deficit irrigation for garlic and onion
  - ✓ 15% Garlic bulb yield reduction, while 57% water saving by applying deficit irrigation
  - ✓ 4.1% onion bulg yield increment and 54% water saving

Increasing Farmers' Adaptation Capacity to CC

Adaptation strategies → alternative live-stock feeds

– Adapting and introducing cowpea, sweet lupin and vetch

Cow pea

Vetch

Sweet lupin

- **Improve soil, enhance preceding crops' yield,**
- **Best sweet lupin varieties selected**
  - ✓ Sweet lupin→Bora & Haags (17ton/ha)

Increasing Farmers' Adaptation Capacity to CC…

Adaptation strategies → Integrating livestock and crop production

- Vetch-under sowing of sorghum
- Evaluation and demonstration of sheep and goat feeding packages
  - Sheep fattening with urea treated tef straw and other supplements
    - 75% concentrate with 25% cow pea is effective both economically & biologically.

Increasing Farmers' Adaptation Capacity to CC…

Adaptation strategies → Strengthening local animal breeds

- **Strengthening local animal breeds that have adapted to local climatic stress and feed sources**
  - implementation of a pilot village-based goat breed improvement scheme

Increasing Farmers' Adaptation Capacity to CC…

Adaptation strategies → Adapting alternative live-stock feeds

- **Evaluation of growth performance of yearling sheep using cultivated forages**
  - ✓ **Grazing + 85Napier- 15Sesbania freshly cut mixture**
- **Adaptation evaluation of Prickly Pear cactus varieties as a feed source → three varieties selected**
  - ✓ **Sulhuna, Dilaledik and Ameudegaado Belesa**

Challenges

- Free grazing, no clear land use rights
- Expansion of cultivated fields and diminishing of natural vegetation cover

THANK YOU!