Progress on Socio-Economic Research in the Gumera-Maksegnit Watershed

International Workshop organized in the framework of the project "*Reducing land degradation and farmers' vulnerability to climate change in the highland dry areas of north-western Ethiopia*"

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Three Major Components

1. Bio-economic modeling of the watershed to simulate system/watershed outcomes under different scenarios
   a. Aggregation based on detailed modeling of decisions by different farm household typologies
   b. Assuming a single optimizing agent
2. Understanding Farmers' perceptions of CC and explaining their adaptation strategies
3. Analysis of Farmers' willingness to pay for SWC measures

Part I

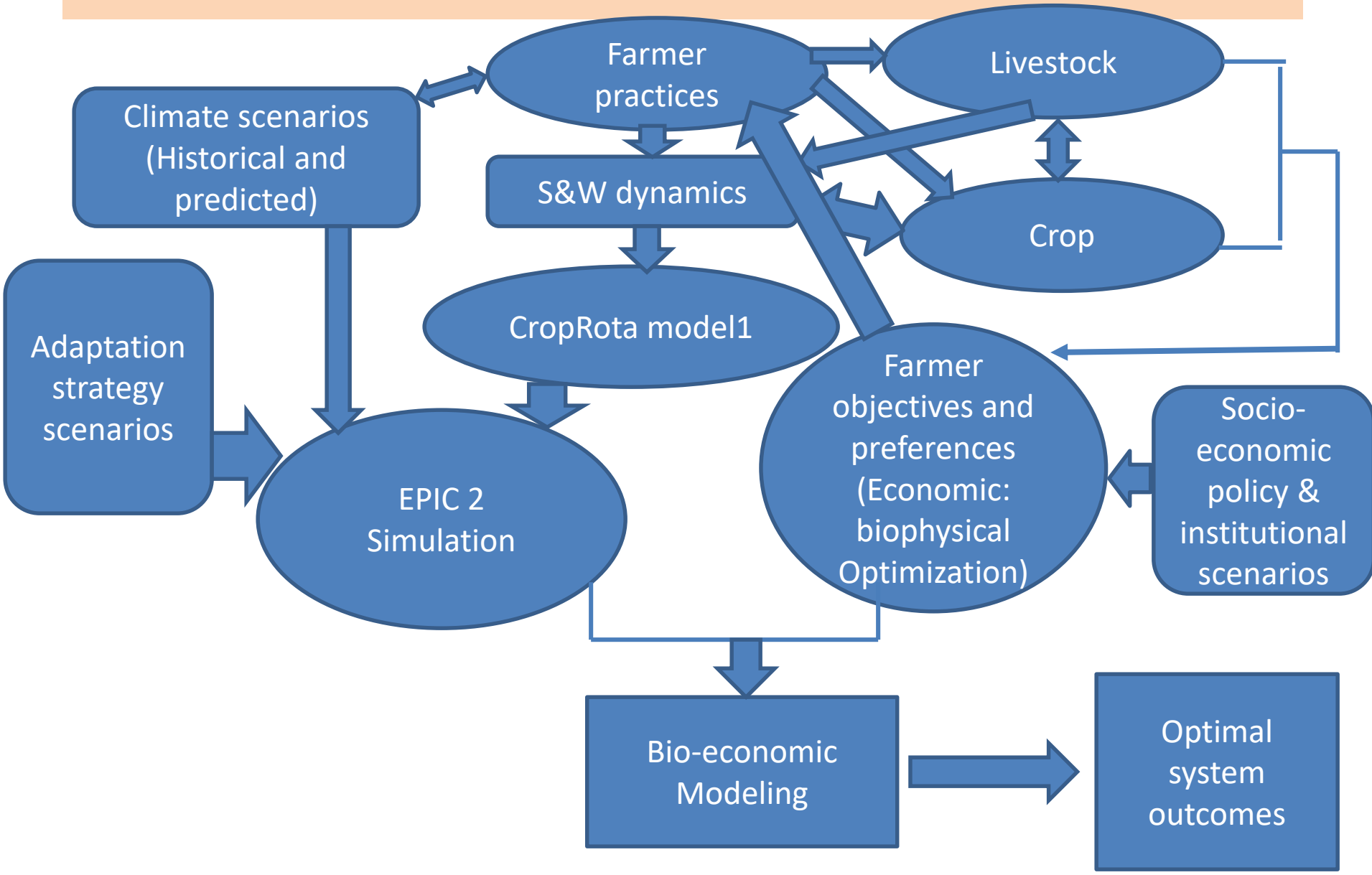
Bio-economic Modeling

Background

Premise: Farmers think and make decisions in a systems context

- The bio-economic and climate change modelling work aims at intermarrying the biophysical simulations with socioeconomic decision tools to analyse system/watershed dynamics;
- Expected outputs:
  - Prediction of likely outcomes under several combinations of different social, economic, bio-physical, policy, institutional, market, and technological interventions under climate change scenarios:
    - At the system (watershed) level
    - At household level by farm typology.
- Comparison of optimum model results with current and suggested farmer adaptation strategies under different scenarios;

The structure of the Bio-economic Model



Bio-economic Models

Two different methods are used

1. **Integrated Bio-economic Farm Model**
   - Single benevolent dictator scenario
     - Theoretically best outcome (compare with land suitability maps)
2. **Bottom up integrated land use Optimization Model**
   - Starts from farm household models
   - Aggregated into the watershed level with number of households of each typology as weights;
   - Incorporate interactions (synergies/tradeoffs, competition, complementarities) among agents
   - Simulations under different scenarios for the whole watershed
   - Model results compared with current practices and farmer and researcher-stated adaptation strategies.

Progress so far

Large datasets assembled

- Input and output prices
- Production inputs and outputs for different crops and varieties
- Farm labor supply
- Livestock and other assets
- Observed land use
- Spatially explicit field data
- Climate change scenarios and CCAP
- Topography
- Soil characteristics…..etc.

More data will be needed (especially on interactions)

Progress so far

- PhD student currently in an intensive course work
- Base model developed using a sequential LP model
- General Algebraic Modeling Systems -GAMS
- Optimal solution (Preliminary)
  - Wheat and teff for the main cropping season
  - Chickpea for the second cropping season
- Currently trying to include irrigation, livestock, inter cropping;
- Gradually to include nonlinearities, dynamics and risk programing.

Part II

Understanding Farmers' perceptions of CC and Identifying Determinants of Farmers' Choice of Adaptation Strategies to Climate Change

1. Introduction

Premises:

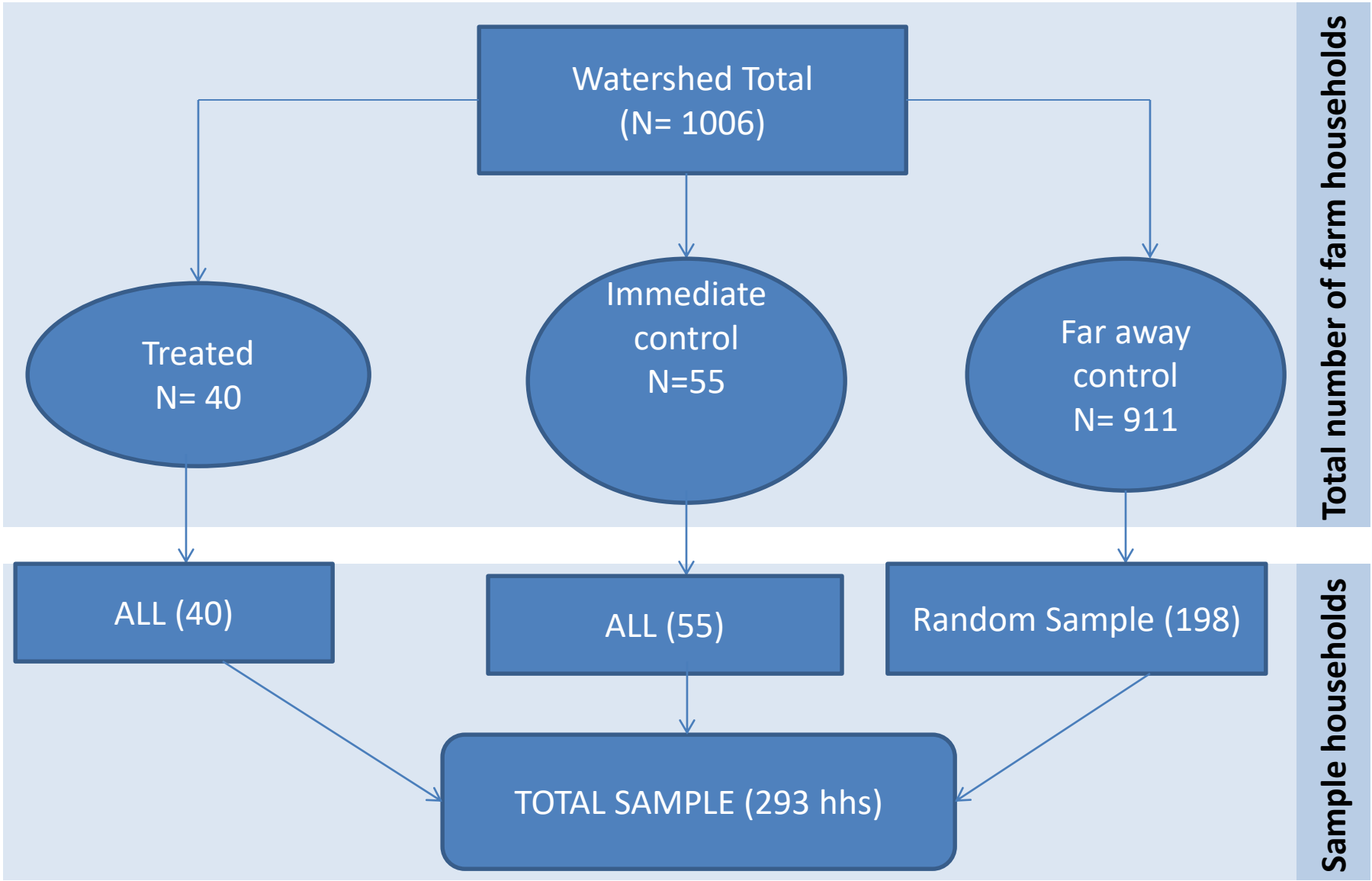
1) Implementation of adaptation strategies reduce CC impacts;
2) Farmer adaptations directly related to level of their perception and understanding of CC and impacts

- Droughts in Ethiopia can:
  - Shrink farm production by up to 90% (World Bank, 2003, Deressa *et al*, 2007)
  - Lead to largescale death of people and livestock – signaling low level of adaptation measures
- Evidence: farmers consciously or unconsciously adapt to perceived changes (Mertz *et al*., 2009; Deressa et al, 2009, Ishaya and Abaje, 2008; David *et al*., 2007)

… Introduction Cont'd

- Government and NGOs in Ethiopia introduced different adaptation strategies:
  - To increase adaptive capacity
  - Reduce adverse impacts;
- Despite the efforts, adoption levels of adaptation strategies is low
- Hence, a need for understanding farmers' perceptions & strategies for adaptation to CC

2. Data and Methods



… Data and Methods cont'd

2.1.Data

- Farmer interviews using structured questionnaire
- Focused group discussion
- Secondary data

2.2 Data Analysis

- Descriptive statistics
- Multinomial logit regression model

$$\text{logit}(y=1) = \log\left(\frac{p(y=1)}{1-(p=1)}\right) = \beta_0 + \beta_1 \cdot x_{i2} + \beta_2 \cdot x_{i2} + \ldots + \beta_p \cdot x_{in} \text{ for } i = 1 \ldots n .$$

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III. Preliminary findings

A) Farmer's perceptions of climate change

- In the study area most (95.9%) of the respondent farmers perceive the presence of CC
- Farmers gradually started noticing CC in the area since 1950's
  - Erratic nature of rainfall (80%)
  - Late onset and early offset of rainfall (83%)
  - Untimely rain (eg. harvesting and dry season rain) (65%)
  - Reduction in both amount and during of rainfall (previously up to 6 months of rain but in recent years only 3 months) (75%)
  - Increase in frequency of drought (90%)
  - Increased temperature (98%)
  - Frequent weather variation (97%)
  - Flooding (42%)

Findings Cont….

- **About 62% of farmers believe that CC is manmade and can be mitigated**
- The mitigation strategies suggested by farmers:
  - ✓Afforestation of the non-agricultural lands and mountains
  - ✓Stopping free grazing through area closure
  - ✓Establishing soil and water conservation structures
- **The remaining 38% believe that climate change is a from GOD - punishment for their sins. Nothing can be done except prayer.**
- A need or awareness raising and farmer education.

Results Cont…..

B) Adaptation and Coping Strategies

- Households adopted wide range of adaptation and coping strategies for different risk factors at different degrees
- Adaptation (Long run, planned)
  - ✓ From none, praying/respecting religious holidays, SWCS, varietal choice, diversification, saving, non/off-farm work …. to a combination of several strategies
- Coping (short run)
  - ✓ From none, selling of livestock (mainly goats), borrowing, eating less, reliance on food aid, … to temporary migration for off/non-farm work
- Farmers identified sorghum and chickpeas and goats and equines as drought tolerant

Results Cont…..

More on adaptation strategies…

- Almost all of the farmers have saving in the form of cash, livestock or crop from the good year by reducing current consumption and utility in preparation for potential bad years;
- Given their tolerance to weather extremes, land races of crops such as sorghum and barley are used by farmers for minimizing risks of CC
- Farmers use short season improved varieties of crops such as wheat, chickpea and teff as a way of adaptation for CC

Results Cont…..

Farmers respond to short-term cash shortage using the following coping strategies (in ranks)

1. Livestock selling (mainly goats);
2. Borrowing from relatives and friends;
3. Off/non-farm employment (selling fire wood in nearby markets or youngsters going to Humera to work as ag daily laborers)
4. Reducing frequency and/or quantity of food
5. Relying on food aid

Explanatory variables	crop variety	SWCS	Adjusting planting date	Crop diversification	SWCS + crop var + Diver.
	Coefficients	Coefficients	Coefficients	Coefficients	Coefficients
Sex	0.014**	-0.812	-0.989	19.946***	-0.506
Age	-0.020**	-0.021**	-0.038	-0.019	-0.0934**
Education	1.223	0.185	-0.468	0.888	0.324*
Family size	-0.067*	-0.143	0.147	0.0001	-0.088*
Distance to market	0.185	0.055**	0.095	0.107	-0.009
Livestock holding	0.015**	0.043**	-0.117	-0.026	0.0006
Off/non farm income	0.014***	0.014***	0.014***	0.015***	0.011
Farm income	0.012***	0.012***	0.013	0.012***	-0.0185
Extension contact	0.0313**	0.0401**	0.0367	-0.0243***	-0.9802
Elevation	0.4934	1.4054	1.6584*	0.9411	1.0465*
Credit	0.4490	0.531	1.449*	1.449*	1.449*
Farmer to farmer extension	0.0294	0.01949	0.0271	-0.0114	1.8317**
Access to C info	-0.1215	1.2795	0.7457	-0.449	0.0394*
Land holding	-0.1837	0.2567	-0.0112	-0.3534	-0.5061

Conclusions

- Age and levels of farm and off-farm income important criterial for targeting;
- Extension (formal or FtF) have significant effect on all adaptation strategies except planting dates.
    - Result is in contrast with other previous findings
    - A need to understand how formal extension or FtF contacts are defined
    - Could meetings with GARC/ARARI/ICARDA researchers be confused with extension?
- The successful experience from GM to inform the new project.

Part III

Estimating farmers' willingness to pay for soil and water conservation structures:

A comparison between Contingent Valuation and conjoint analysis

1. Farmers perceptions of SWCS

- Almost all farmers agree on the presence of soil erosion and land degradation in the area
- 82.7% acquired new knowledge from the project on benefits and how to construct SWCS
- Farmers' opinion on impacts of SWCS
  - ✓Decrease in soil erosion (82.7%)
  - ✓Increase in moisture (88.9%)and
  - ✓Increase in yield (90.1%)

2. Measuring farmers' willingness to pay

2.1 Contingent Valuation Method

- Farmers asked how much they are willing to contribute:
  - 100% willing to make in kind contribution of labor
  - 89.7% of the farmers were willing to make a one-time financial contribution for SWCS

Variables	WTP for SWCS			Std.dev
	min	max	mean	
Labor in days	7	100	25.87	15.72
Max payment in birr	0	5000	972.81	1162.36

- The typical farmer is willing to make a one-time contribution for constructing/maintaining SWCS of:
- 973 ETB
- 25 days of labor

… farmers' willingness to pay cont'd

2.2 Choice Experiment using conjoint Analysis

- Five Land Attributes
  - ✓Slope (Flat, Gentle slope, steep)
  - ✓Fertility (low, Medium, High)
  - ✓Distance (Near, Average, Far)
  - ✓Presence of SWCS (No, Yes)
  - ✓Prices (20,000 ETB, 30,000 ETB, 40,000 ETB)
- 3*3*3*2*2*4= 432 different combinations
- Using orthogonal fractional factorial design =16 choices for the experiment

… farmers' willingness to pay cont'd

The Choice Experiment

No	Soil fertility	Slope	Distance from residence	Presence of soil and water conservation structures	Land prices (Birr/t'imad)	Would you purchase this land? 1=Definitely not purchase 3= I am indifferent 5=Definitely purchase				
						1	2	3	4	5
1	low	Flat	Near	No	20,000					
2	low	Flat	Near	Yes	20,000					
3	low	Flat	Average	Yes	20,000					
4	low	Flat	Far	No	20,000					
5	low	Gentle slope	Near	No	40,000					
6	low	Gentle slope	Near	Yes	30,000					
7	low	Steep	Average	Yes	40,000					
8	low	Steep	Far	No	30,000					
9	medium	Flat	Near	No	40,000					
10	medium	Flat	Average	No	30,000					
11	medium	Gentle slope	Far	Yes	20,000					
12	medium	Steep	Near	Yes	20,000					
13	high	Flat	Near	Yes	30,000					
14	high	Flat	Far	Yes	40,000					
15	high	Gentle slope	Average	No	20,000					
16	high	Steep	Near	No	20,000					

Results of Ordered Logistic Regression

		Number of obs = 3194	
		LR chi2(5) = 667.22	
		Prob > chi2 = 0.0000	
Log likelihood = -4147.3365		Pseudo R2 = 0.0745	
Ratings	Coef.	Std. Err.	z
Age	-0.063**	0.051	-2.88
Labor availability	0.75**	0.49	3.11
education	0.345**	0.871	2.59
sex	-0.305	0.641	-0.725
TLU	-0.404*	0.176	-2.13
Soil fertility	0.77***	0.015	18.94
Slope	-0.223***	0.049	-13.59
Distance	-0.214***	0.044	-12.34
SWCS	0.28***	0.067	7.31
Land_Price	-0.00023***	0.000037	-9.75

WTP for SWCS from CA result

$$\partial WTP/\partial(Land_{Price}) = -0.00023$$

$$\partial WTP/\partial SWCS = 0.28$$

$$-\frac{\partial WTP/\partial SWCS}{\partial WTP/\partial(Land_{price})} = -\left(\frac{0.28}{-0.00023}\right)$$

$$\partial(Land_{price})/\partial SWCS = 1217.39 \text{ ETB per ha}$$

- Results from CV and Conjoint Analysis comparable
- Clear evidence that farmers appreciate SWCS and are willing to pay for it.

THANK YOU

Results Cont…..

- Different crops and livestock species affected differently by the various risk factors
  - **Vulnerable to drought**
    - ✓Crops: wheat, barley, faba bean and teff
    - ✓Livestock: Cattle
  - **Drought tolerant**
    - ✓Crop: sorghum and chick peas
    - ✓Livestock: goats and equines
- Farmers expect most risk factors to occur with increased intensity and adverse impacts

Explanatory variables	crop variety	SWCS	Adjusting planting date	Crop diversification	SWCS + crop variety + Diveresifcn.
	Marginal Effect	Marginal Effect	Marginal Effect	Marginal Effect	Marginal Effect
Sex	0.0610**	-0.186	-0.093	0.205***	-0.131
Age	0.005*	0.010**	-0.005	-0.0001	0.0018**
Education	0.320	-0.1387	-0.1795	0.008	0.456*
Family size	-0.0499*	0.0229	0.0268	-0.0008	0.0037
Distance to market	0.0256	-0.0159**	-0.007	-0.0007	-0.0059
Livestock holding	0.004**	0.0285**	-0.0241	-0.0005	-0.0056
Off/non farm income	0.0085***	-0.0051***	0.0017***	0.0024***	0.0046
Farm income	0.0027***	0.001***	0.002	0.0013***	0.001
Extension contact	0.0005**	0.0023**	-0.0003	-0.002***	-0.001
Altitude	-0.158	0.1200	0.0582*	-0.0017	-0.0395*
Credit	0.0618	0.1454	0.1032*	0.0080	0.0087*
Farmer to farmer extension	-0.0008	0.0009	0.0015	-0.0013	0.0010*
Access to C info	-0.2382	0.1932	0.0705	-0.0196	0.0268**

… Introduction Cont'd

- No earlier studies in the area on farmer perceptions and adaptation strategies for CC
- This study aims at answering the following questions:
  - ✓ Do the farmers notice that there is climate change?
  - ✓ If they do, how do they understand it?
  - ✓ Do farmers consider climate change as being man made?
  - ✓ Do they consider that it can be mitigated?
  - ✓ What factors affect their perception strategies?
  - ✓ What copping/adaptation mechanisms are they using/think are good?
  - ✓ What factors determine their choice of CC adaptation strategies?