Evaluating the food and nutrition security impact of agricultural technologies.

Evidence from measuring the multidimensional food security impact of rainwater harvesting decision in North east Ethiopia

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LCIRAH
Leverhulme Centre for Integrative Research on Agriculture and Health

Conference on Agri-Health Research at ANH Academy Week, Addis Ababa, 20-24 June 2016

June 22, 2016
Addis Ababa

Outline

- Background and justification
- Estimation framework and methods
- Data
- Results
- Conclusion and policy recommendations

Agriculture and food production

Water availability

- Amount & distribution
- Seasonal variability of rainfall

Adverse Impact

Household livelihood and macro economic instability (eg. Figure 1)

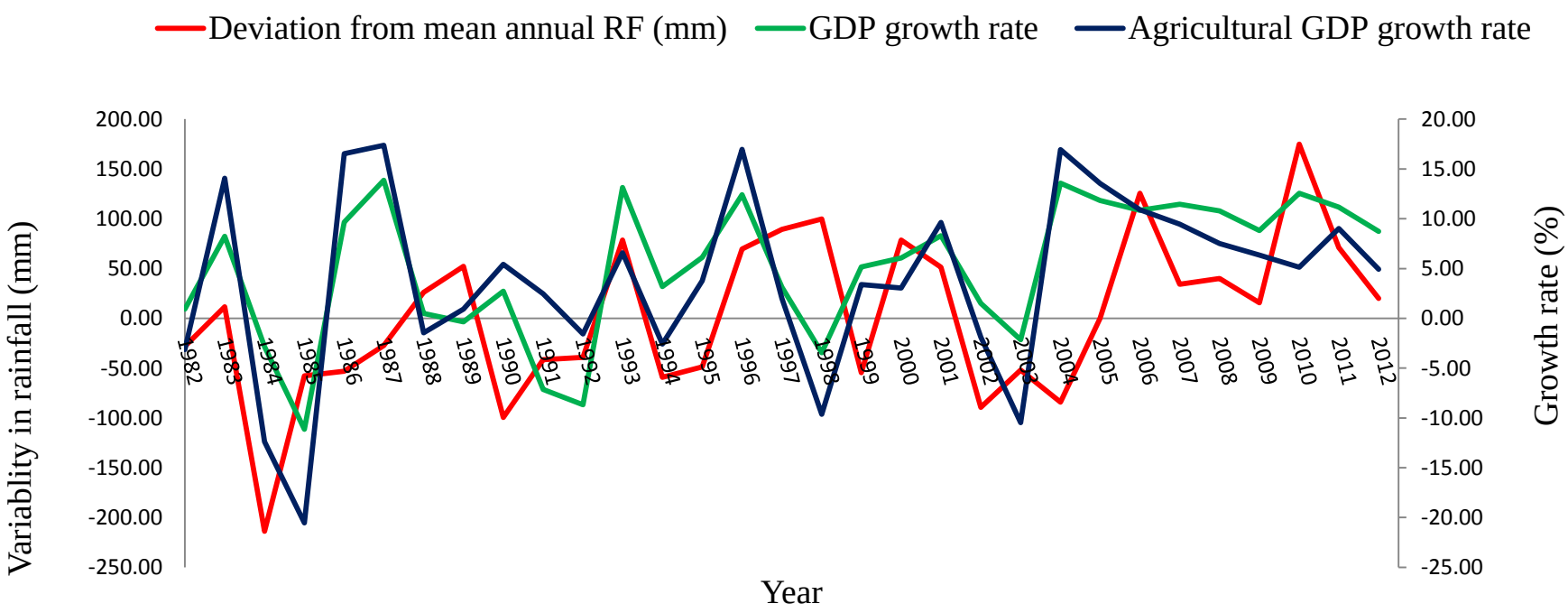


Figure 1: Ethiopian economy and rainfall variability, 1982-2012

Source: Own composition using Ethiopian Metrology Authority for the rainfall data and the World Bank for GDP

Earlier studies on land and water management

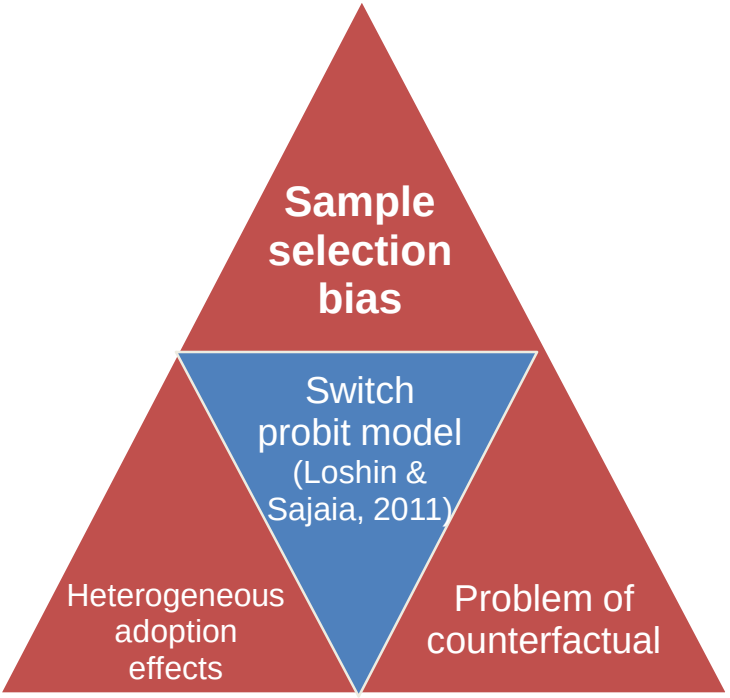
(Kassie et al; 2010, Kato et al, 2011; Gebregziabher et al., 2012; Hagos et al, 2012; Falco & Veronesi, 2013; Abdulai & Huffman, 2014)

- Examine adoption and performance of a single technology in multiple sites
  - ✓ Farmers use a combination of the practices and could provide better outcomes when they are undertaken jointly (Kassie et al., 2015)
- Examine performance from a land, not water perspective (Merrey and Gebresilasie, 2011).
  - ✓ The water scarcity is often considered as a rainwater storage problem
  - ✓ Soil erosion and land degradation affect the local hydrology
  - ✓ Irrigated agriculture based on blue water (Falkenmark and Rockstrom, 2010)
- Impact evaluations focused on direct benefits (farm income, productivity, income based poverty) (Qaim, 2014)
  - ✓ Food security are multidimensional (Coates, 2013).

Initiated this research

- Understanding the factors and rigorous measure the impacts of IRWHP on household food security
  - ✓ Selection bias and heterogeneous adoption impacts
  - ✓ Multidimensional food security
    - ✓ Lack of a single measure which captures the multidimensional aspects of food and nutrition security concept (Coates, 2013).
  - ✓ Model the mechanisms and pathways more explicitly (Chege et al. 2014).

Econometric framework and estimation strategy



Two stage and three equations model

First stage

- Regime determination rule : decision to use IRWHP and interpreted as treatment variable

Second stage

- Two outcome function, condition on the selection equation
- Probability of multidimensional food secure

Endogenous switching probit regression model in a counterfactual framework

Multivariate Tobit for impact mechanism and pathway analysis

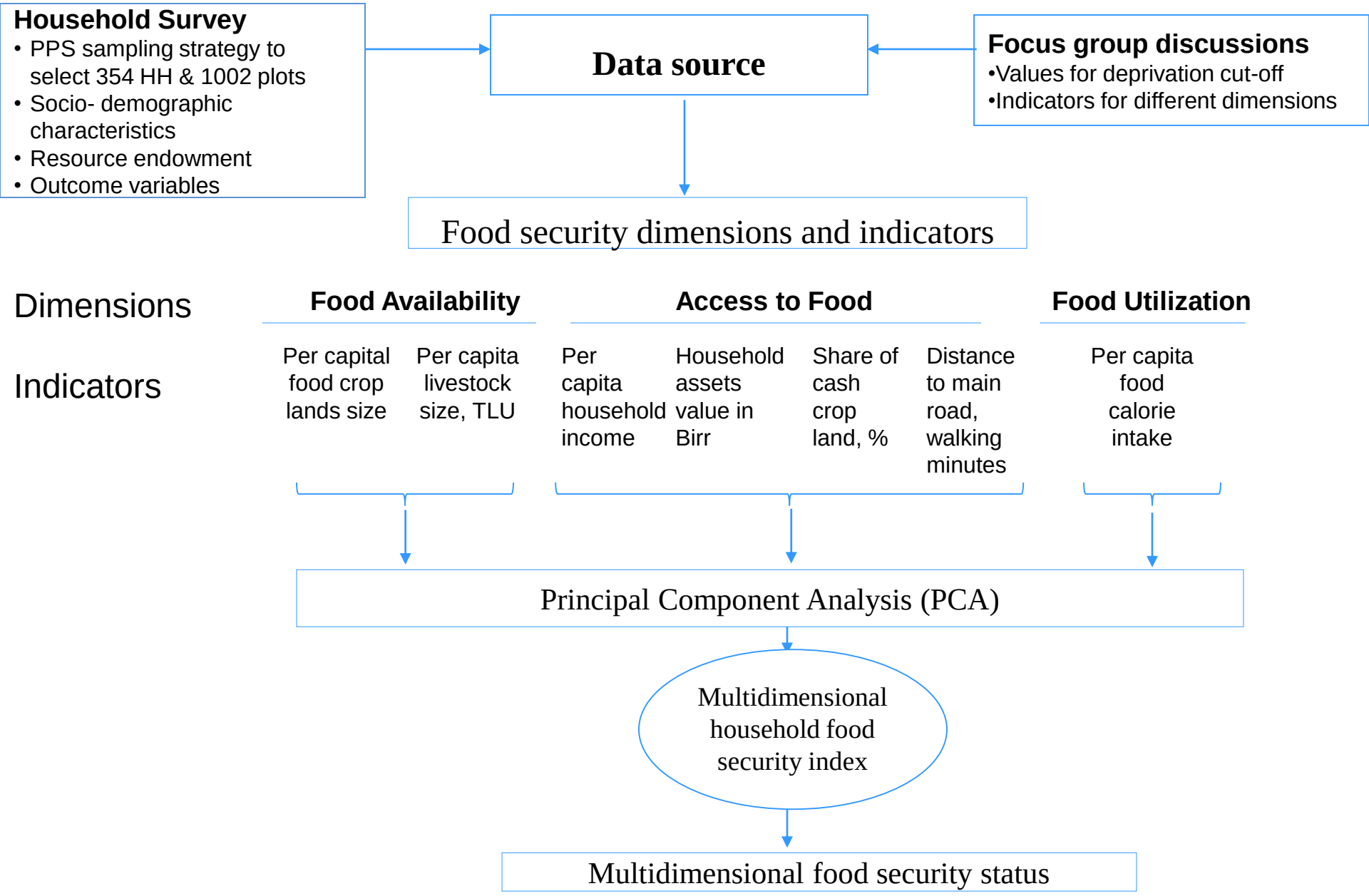


Figure 1. Flow chart of multidimensional indexes to measure household food security

Table 1. Endogenous switching probit regression estimation for impact of IRWHP use decision on probability of multidimensional food security

Explanatory variables	Use decision	Probability of multidimensional food secure	
		Users of IRWH	Non-users
Household head Age	-0.041 (0.043)	- 0.033 (0.078)	0.004 (0.075)
Household head Age sq	0.000 (0.000)	0.000 (0.000)	0.000 (0.001)
Household head sex	0.535* (0.300)	-0.709 (0.789)	0.244 (0.466)
Household head education status	-0.514 (0.324)	0.028 (0.442)	-0.078 (0.475)
Household family labor	0.203** (0.085)	-0.215** (0.087)	-0.791*** (0.121)
Household non farm income source	-0.412 (0.255)	1.261*** (0.439)	0.107 (0.402)
Government food insecurity support	-1.015*** (0.261)	-0.407 (0.763)	- 0.483 (0.588)
Farm size	-0.313 (0.225)	5.476*** (1.886)	3.362* (1.895)
Livestock size	0.054 (0.094)	0.725***(0.182)	1.160***(0.267)
Share of own cultivated land	0.506 (0.090)	1.035 (1.155)	0.586 (0.958)
Share of cash crop land	0.749**(0.325)	2.617* (1.588)	1.090(1.674)
Top landscape	-0.729*** (0.180)	0.768*** (0.237)	0.580(0.449)
Lower landscape	- 0.707** (0.328)	-0.324 (0.406)	0.603(0.642)
Household income#		0.000(0.000)	0.000 (0.000)
Use of government extension service	0.376** (0.169)		
Share of plain slope plot of land	-0.606*** (0.166)		
Share of sloppy plot of land	0.128 (0.305)		
Share of high fertile soil land	0.049 (0.177)		
Share of poor fertile soil land	0.261 (0.394)		
Constant	-0.087 (1.199)	1.658(2.359)	-2.910(2.206)
Model diagnosis			
Log-likelihood		-279.58	
Wald chi2(18)		71.65***	
N	354	120	234
Likelihood ratio test of independent equation $chi^2(2)$	8.35***		

Note: *, **, and *** denotes significance level at 10, 5, and 1%; robust standard errors in parentheses; # Predicted value

Table 2 . Impacts of IRWHP on household livelihood: Endogenous switching probit results

Outcome variable	Farm household IRWHP use status	Decision stage: To use	Decision stage: Not to use	Average treatment effect(ATT/ATU)	Impact (%)
Multidimensional food security status(MFS) (1=Food secure and 0= Food insecure)	IRWHP users	(a1) 0.546(0.020)	(c1)0.326(0.021)	0.220 ***(0.026)	22.0
	IRWHP non-users	(d1) 0.620(0.015)	(b1)0.374(0.018)	0.246***(0.020)	25.0
	Heterogeneity effects (BH)	0.074***(0.026)	-0.048(0.029)	TH=-0.026*(0.033)	

Note: *, **, and *** denotes significance level at 10, 5, and 1%; standard errors in parentheses;

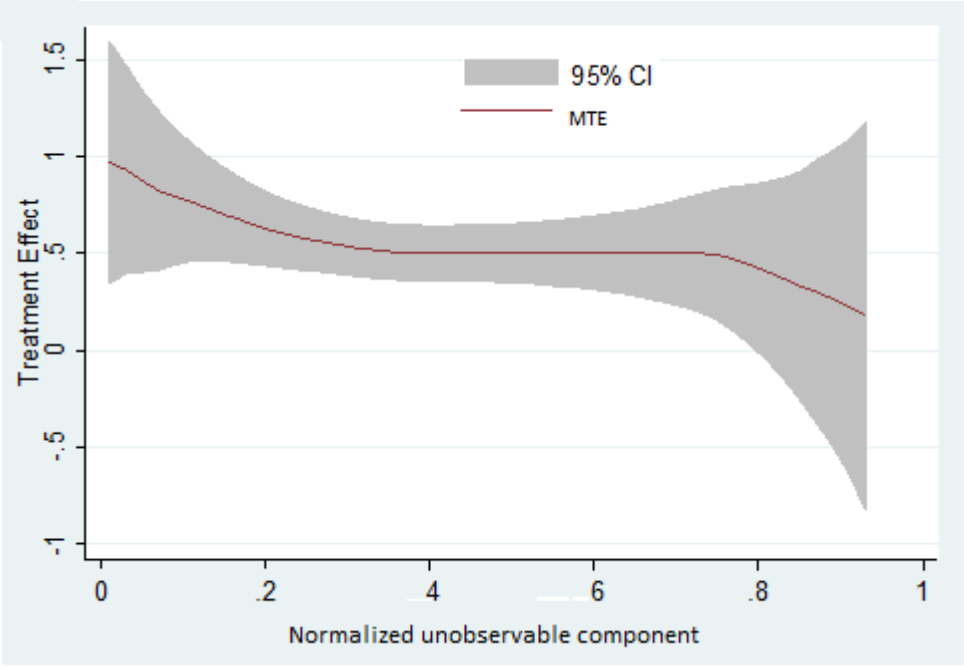


Figure 2. Heterogeneity impact of IRWHP on probability of multidimensional food security status

Table 3. Effect of IRWH practice use decision on the components of multidimensional food security index-Maximum simulated likelihood estimates of multivariate tobit model

	Food security dimension		
Explanatory Variables	**Availability**	**Access**	**Utilization**
Propensity IRWH practices#	**-3.010 (1.993)**	**6.188** (2.936)**	**13.539***(5.049)**
Household head Age	0.005 (0.021)	-0.031 (0.030)	0.083 (0.054)
Household head Sex	-1.929** (0.929)	-0.216 (1.365)	-1.258 (2.434)
Household head Education	-0.590 (1.135)	2.672 (1.632)	-0.314 (2.956)
Nonfarm income source	-0.240 (0.750)	0.596 (1.096)	-1.386***(1.992)
Livestock size	6.849*** (0.320)	1.741*** (0.464)	2.334***(0.843)
Family size	-2.157***(0.203)	-0.506* (0.296)	-1.960***(0.535)
Farm size	6.536** (2.665)	3.449 (3.843)	-0.907 (6.162)
Share cash crop land	-2.669 (2.515)	26.506***(3.635)	-6.575 (6.387)
Household income#	- 0.000 (0.000)	0.000 (0.000)	0.002*** (0.000)
Top landscape	-1.836** (0.801)	5.242***(1.180)	5.292*** (1.946)
Lower landscape	-3.061** (1.300)	6.423*** (1.906)	3.200 (2.989)
Constant	12.773***(1.951)	24.456***(2.863)	13.461***(5.176)
Model diagnosis			
rho12		0.160***(0.053)	
rho13		0.029 (0.054)	
rho23		0.139** (0.056)	
Log-likelihood		-3637.35	
Likelihood ratio test of rho12 = rho13 = rho23 = 0:		**chi2(3) = 16.121***	

Note: *, **, and *** denotes significance level at 10, 5, and 1%; standard errors in parentheses

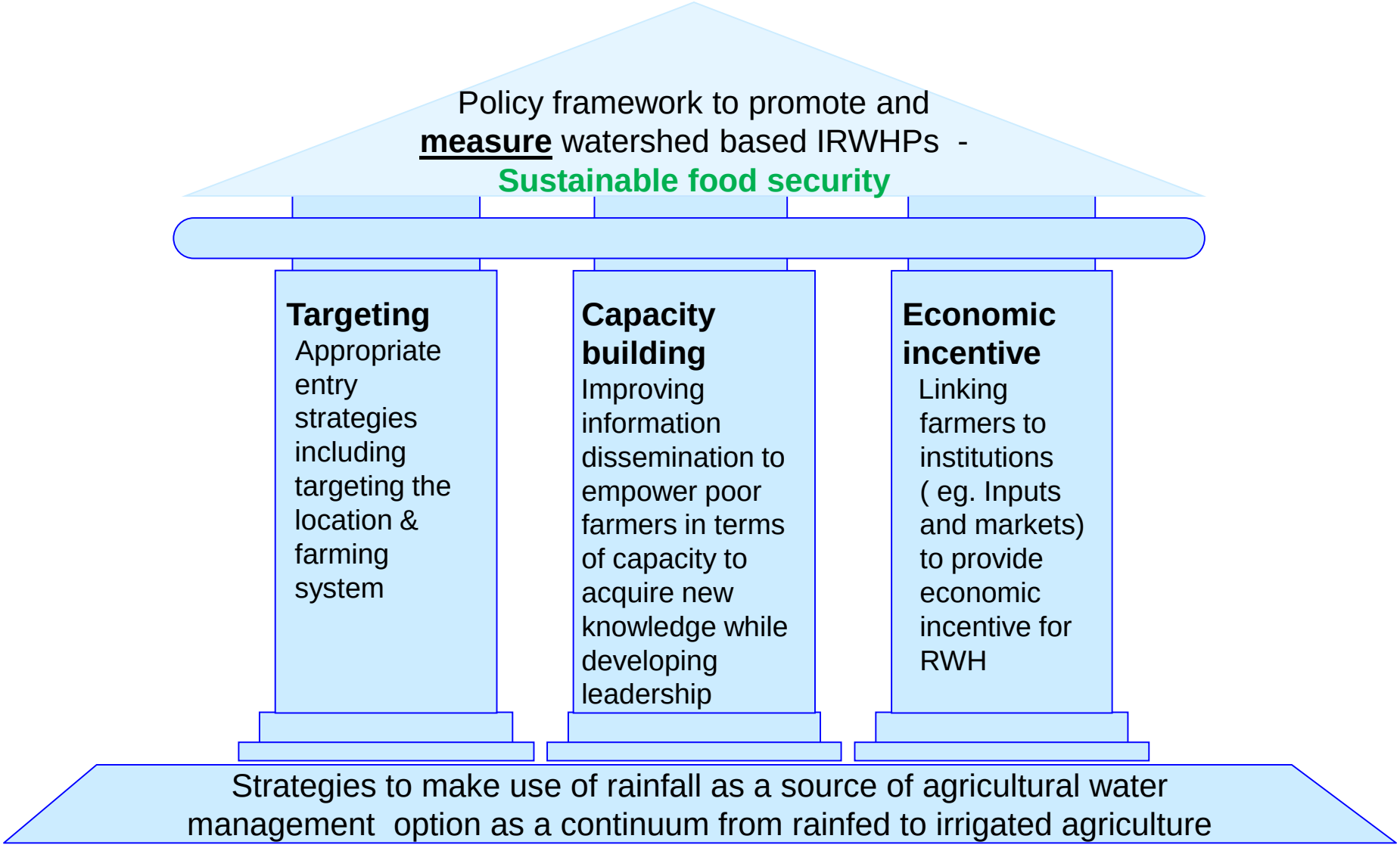
Different factors are required for successful IRWHP use **(resource system, household characteristics, Institutional environment & organizational set up)**

IRWHP have significant positive impacts to improve household livelihood through increasing the probability of multidimensional food security

IRWHP is more important for non users food security; would have benefited more and confirms that non-users are constrained to use IRWHP & enhance food security

Public policies can play an important role in helping farm households to use IRWHP and improve HH food security .

Multidimensional food security index can be used to rigorously evaluate impacts of agricultural technologies and practices, explicitly depicting the impact mechanism and pathways


Policy framework to promote and
measure watershed based IRWHPs -
Sustainable food security
Targeting
Appropriate entry strategies including targeting the location & farming system
Capacity building
Improving information dissemination to empower poor farmers in terms of capacity to acquire new knowledge while developing leadership
Economic incentive
Linking farmers to institutions (eg. Inputs and markets) to provide economic incentive for RWH
Strategies to make use of rainfall as a source of agricultural water management option as a continuum from rainfed to irrigated agriculture

I thank you all