

Psychological and Community Correlates of Adaptation to Water Stress among Smallholding Farmers in Sri Lanka



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CSTPR Seminar

Agricultural Decision-making and Adaptation to Precipitation Trends in Sri Lanka

ADAPT-SL Project

Climate &
Hydrological
Analyses

Longitudinal
Farmer
Surveys
(Quantitative)

Stakeholder
Interviews
(Qualitative)

Ethnography

Agent Based
Modeling



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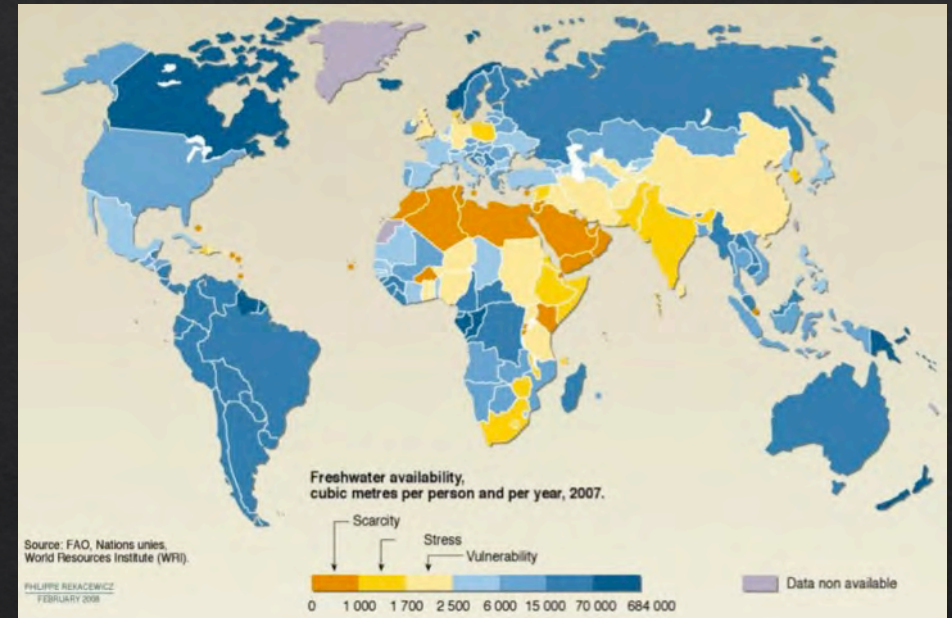
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Feeding Nine Billion

- ⌘ Pressure on freshwater resources has grown exponentially in the past century
- ⌘ Doubling of food production will be needed by 2025, requiring:
 - ⌘ Significant expansions in irrigated agriculture
 - ⌘ Dramatic improvements in the efficiency of irrigated lands
- ⌘ It will be essential for the world's farmers to grow more food with less water despite the stresses presented by climate change.

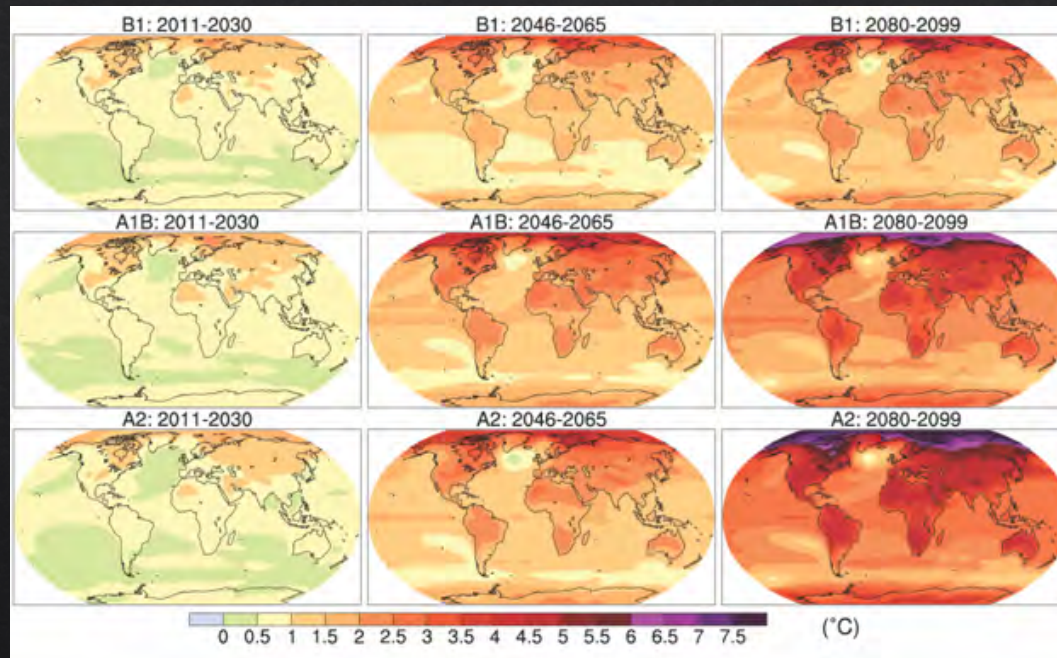


Adaptation to Drought Will Be Necessary

Early 21st
century

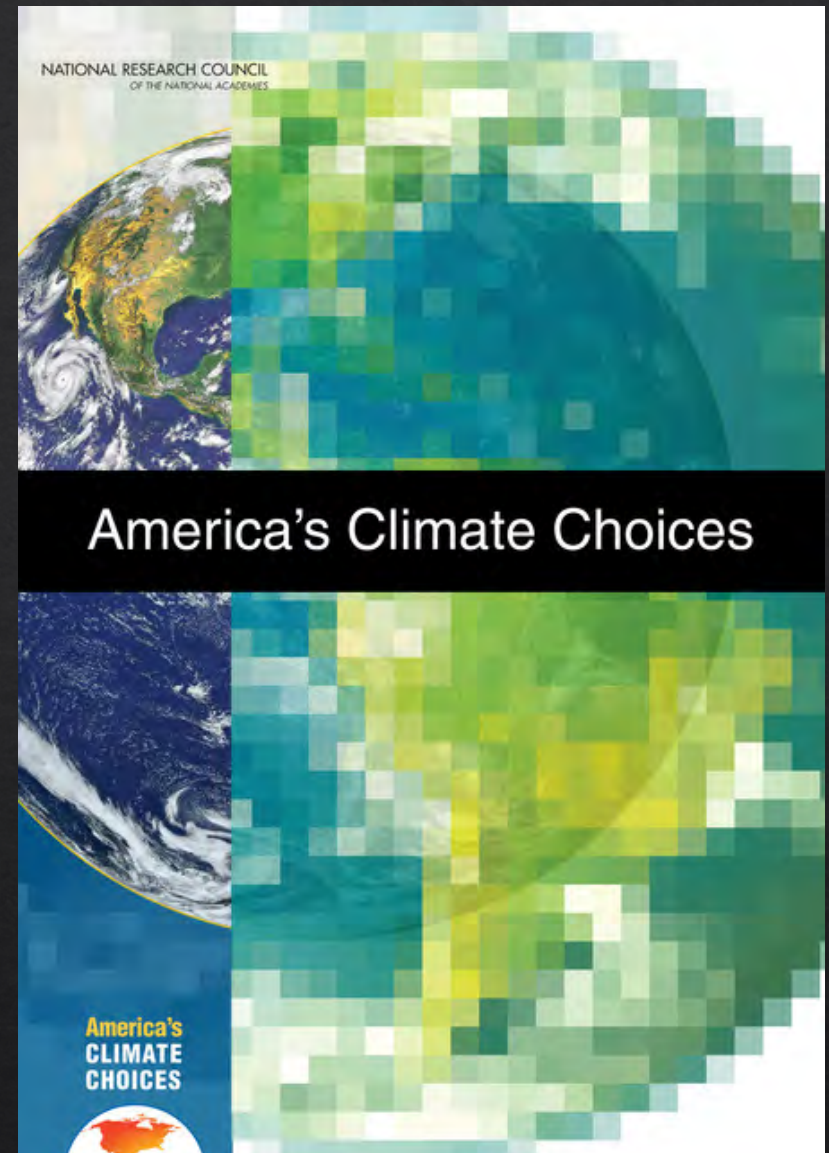
Mid 21st
century

Late 21st
century

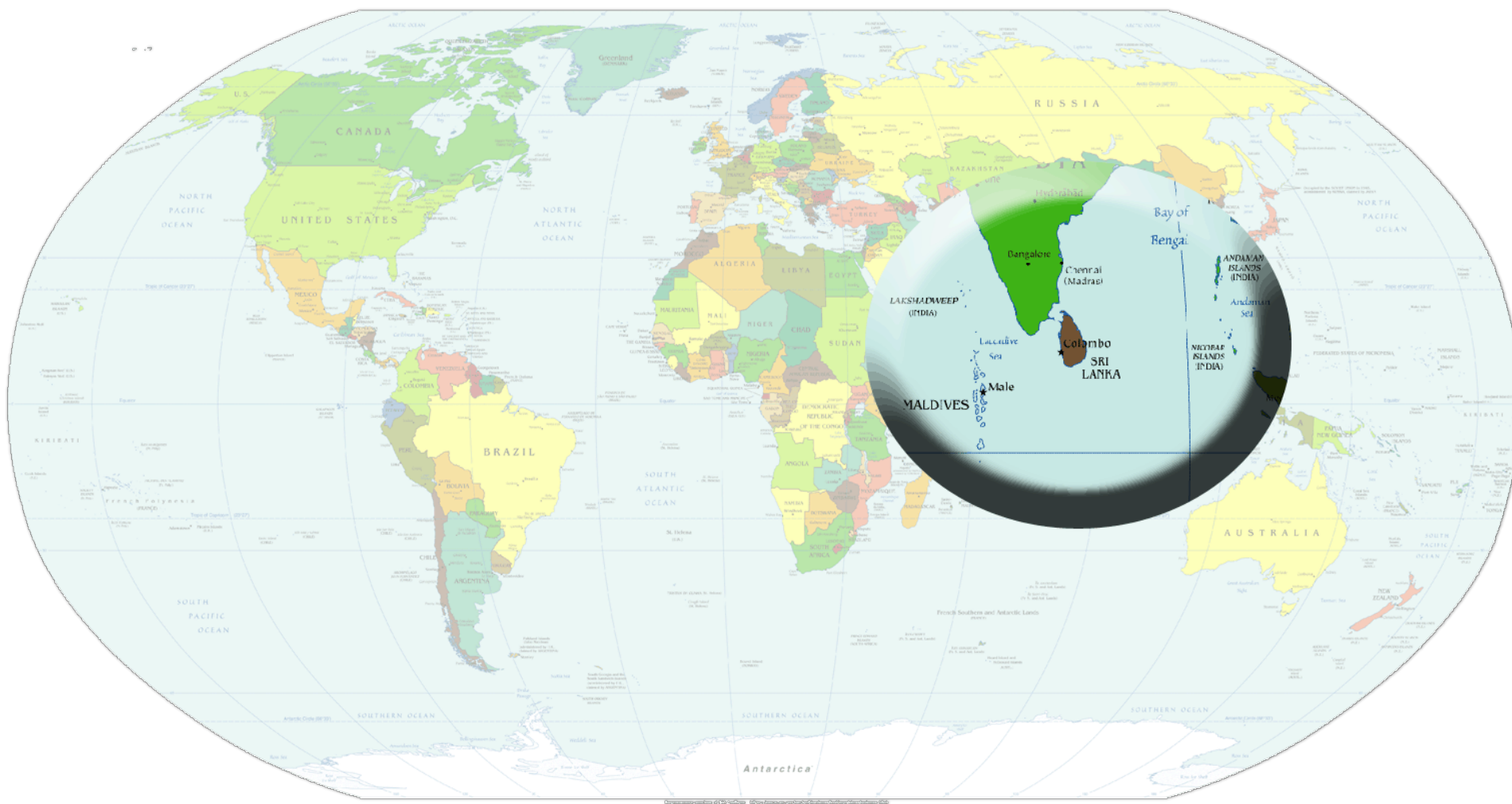


- ◇ Very dry areas more than doubled since the 1970's
- ◇ Area affected by drought is likely to increase.
- ◇ The number of dry days may also increase.
- ◇ Changes in land cover and land use will change water resource availability.

“Emerging concerns about how best to respond to climate change also bring to the fore questions about human interactions with the climate system: how human activities drive climate change; how people understand, decide, and act in the climate context; how people are affected by climate change; and how human and social systems might respond.”



National Research Council, America's Climate Choices Panel (2010). Advancing the Science of Climate Change. The National Academies Press, Washington, DC, www.NAP.edu.

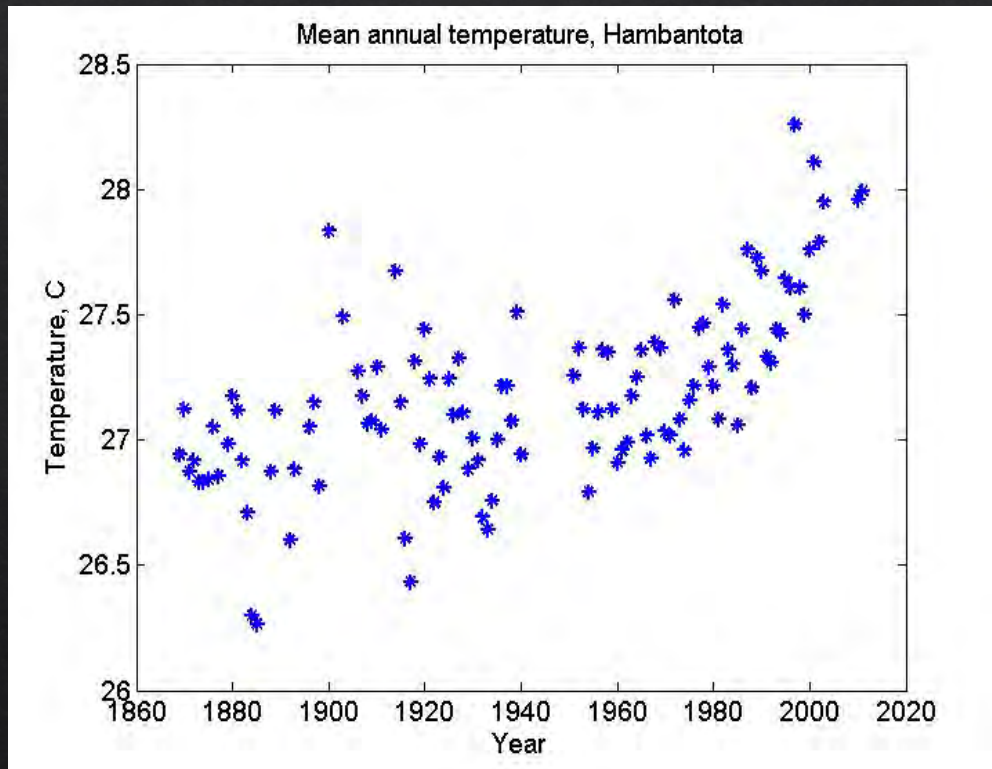


The Sri Lankan Context

- ◇ Undergoing a rapid economic, political and cultural transition.
- ◇ Agricultural production remains a significant and heavily prioritized sector.
 - ◇ 12% of GDP
 - ◇ 41% of total land area
 - ◇ Employs ~66% of the nation
- ◇ Dominated by rice production (61% of farmers)



Temperature



- ◇ Data for Hambantota show a warming of about 1C over the past 50 years.
- ◇ Result holds for the country as a whole.

Precipitation

- ❖ Rainfall in much of the country has declined by several mm/year in recent decades.
- ❖ Climate change scenarios suggest that rainfall will decrease in the future and that evapotranspiration will increase.

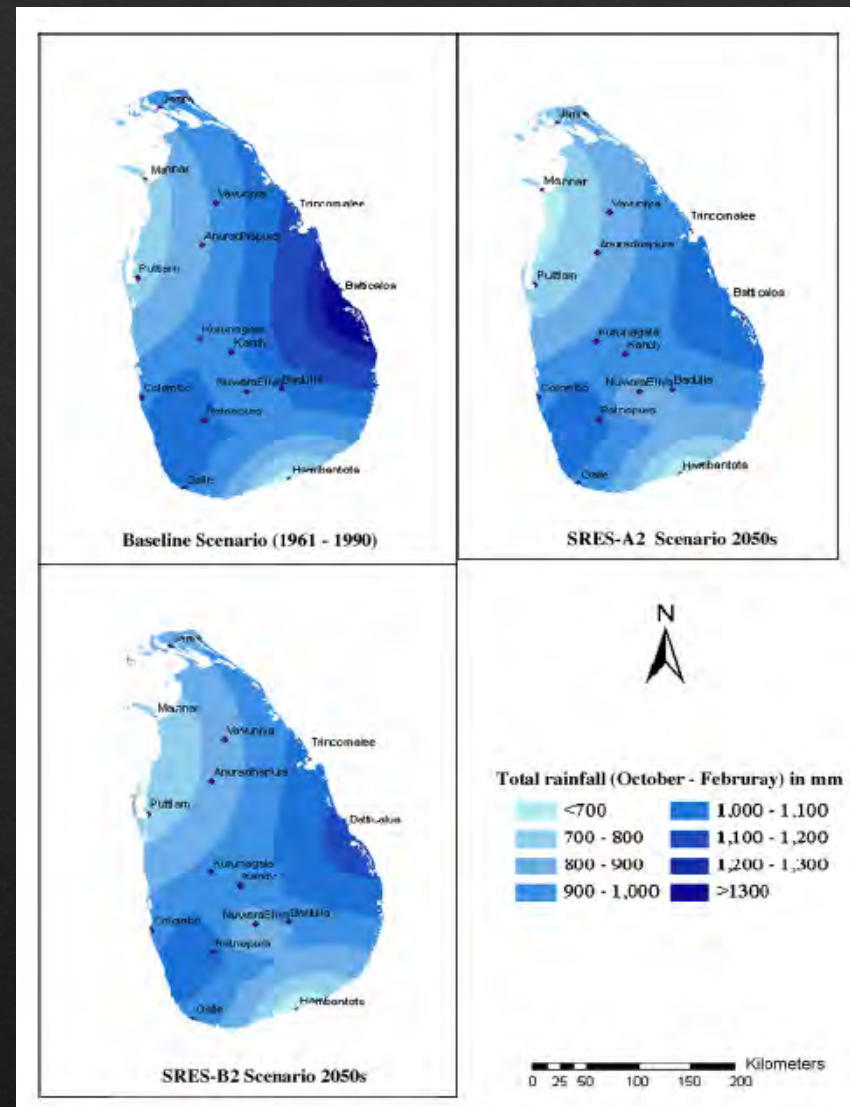
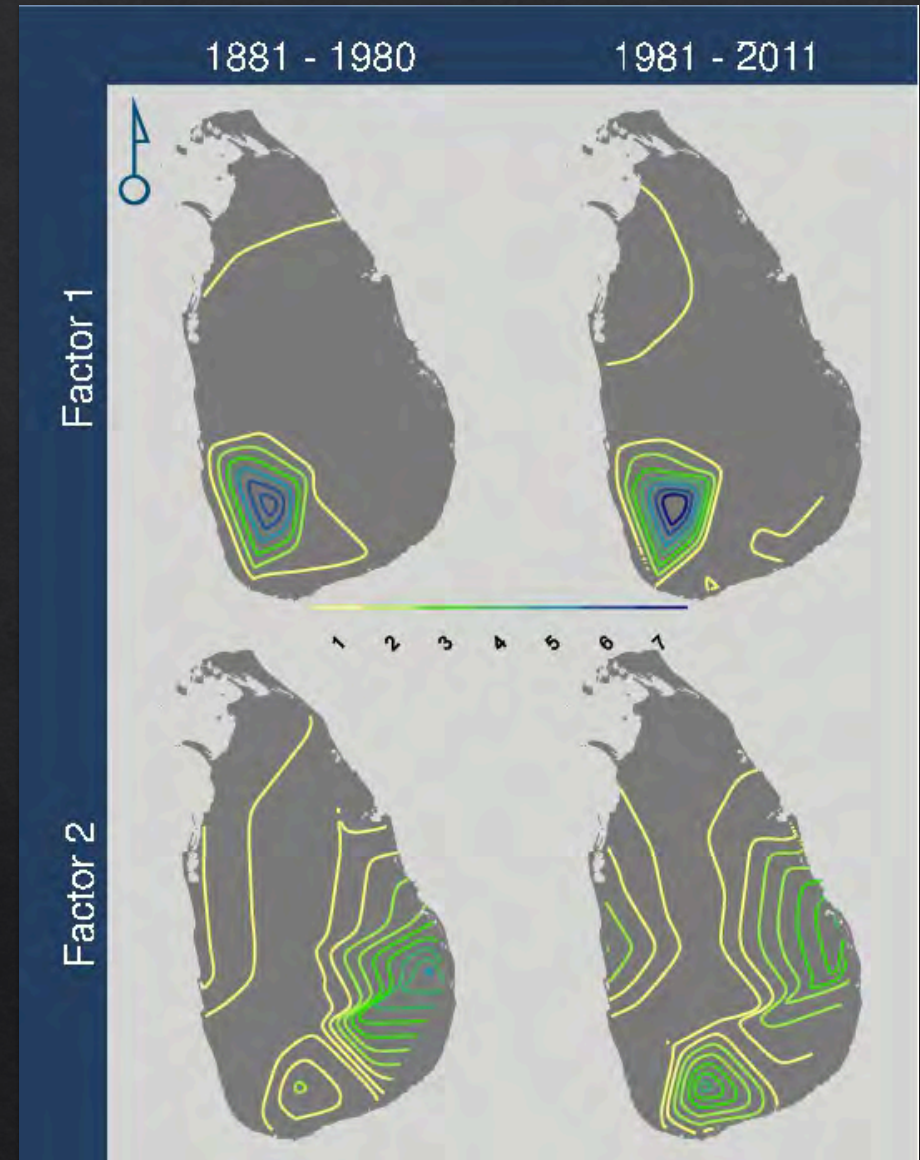


Fig. 3 – Spatial variation in rainfall from October to February for the baseline (1961-1990) and A2 and B2 scenarios for 2050's

Monsoon Shifts

Within the past 30 years:

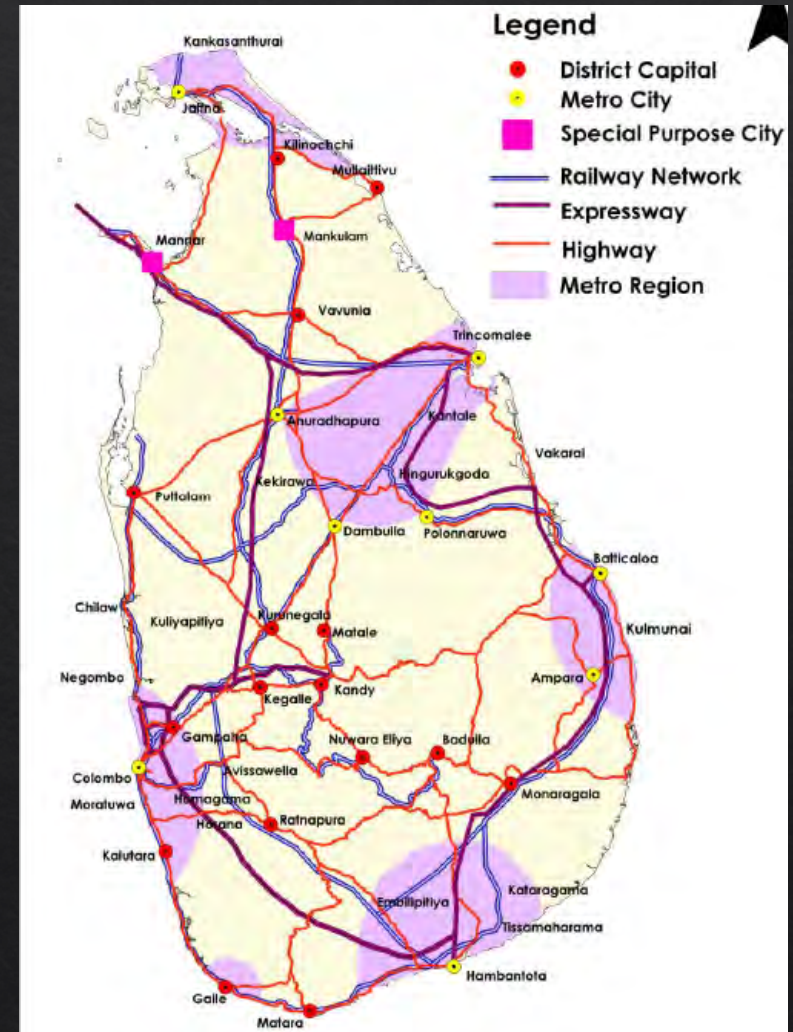
- Temporal shifts
 - Greater variability in the start and end of the monsoons
 - Yala monsoon is beginning later than its historical May start time
 - Maha monsoon is starting earlier than its historical December start time
- Spatial shifts
 - Increase in rainfall in the southern portion of the country during the Maha monsoon.



COMPETITION FOR WATER WILL INCREASE SCARCITY

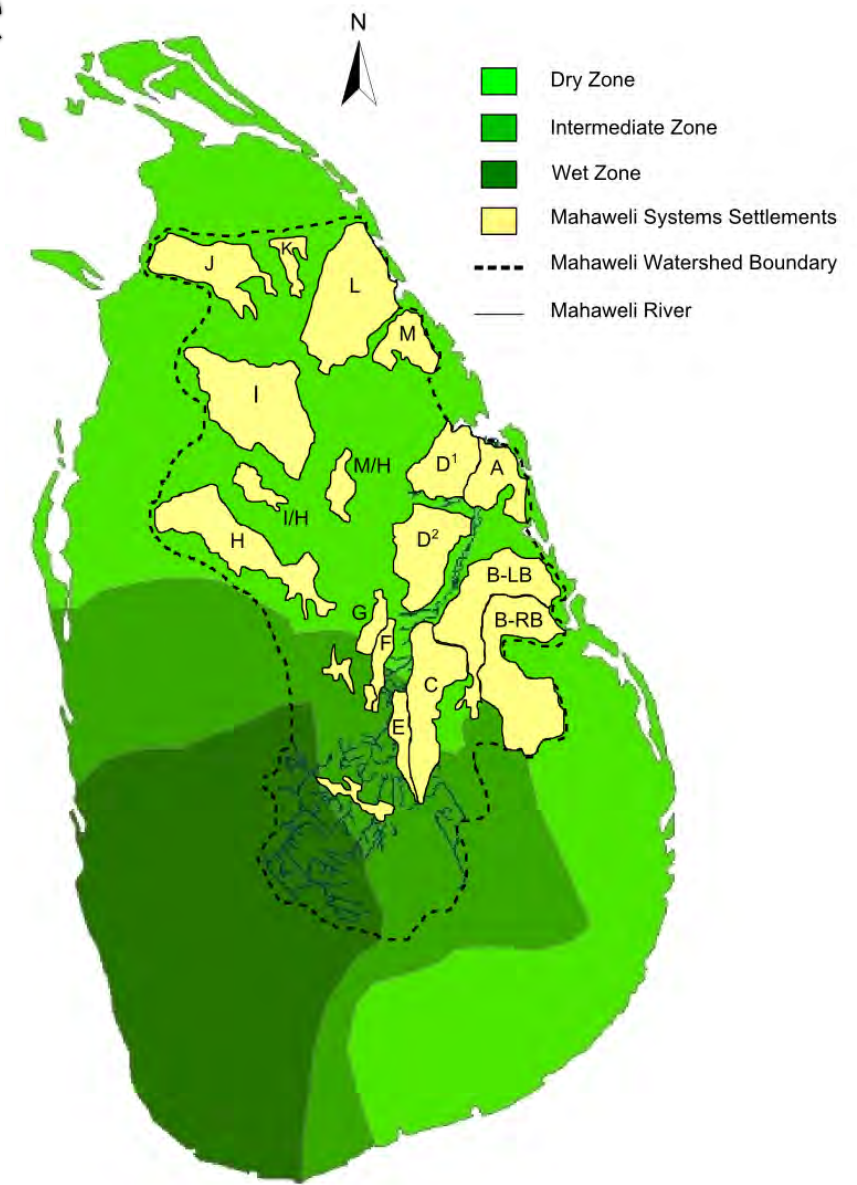


About 40% of electricity is generated through hydropower.



Dry Zone Agriculture

- Mahaweli Authority Development Program (MADP)
- Feeds 1,000 “tanks” used for irrigation with water captured in the wet and intermediate zones
- Provides irrigation water to 3,650 sq.km of land in the MADP systems
- Land allocated to ~300,000 landless families in a government resettlement project
- MADP settlements exist alongside traditional, small scale irrigation communities.



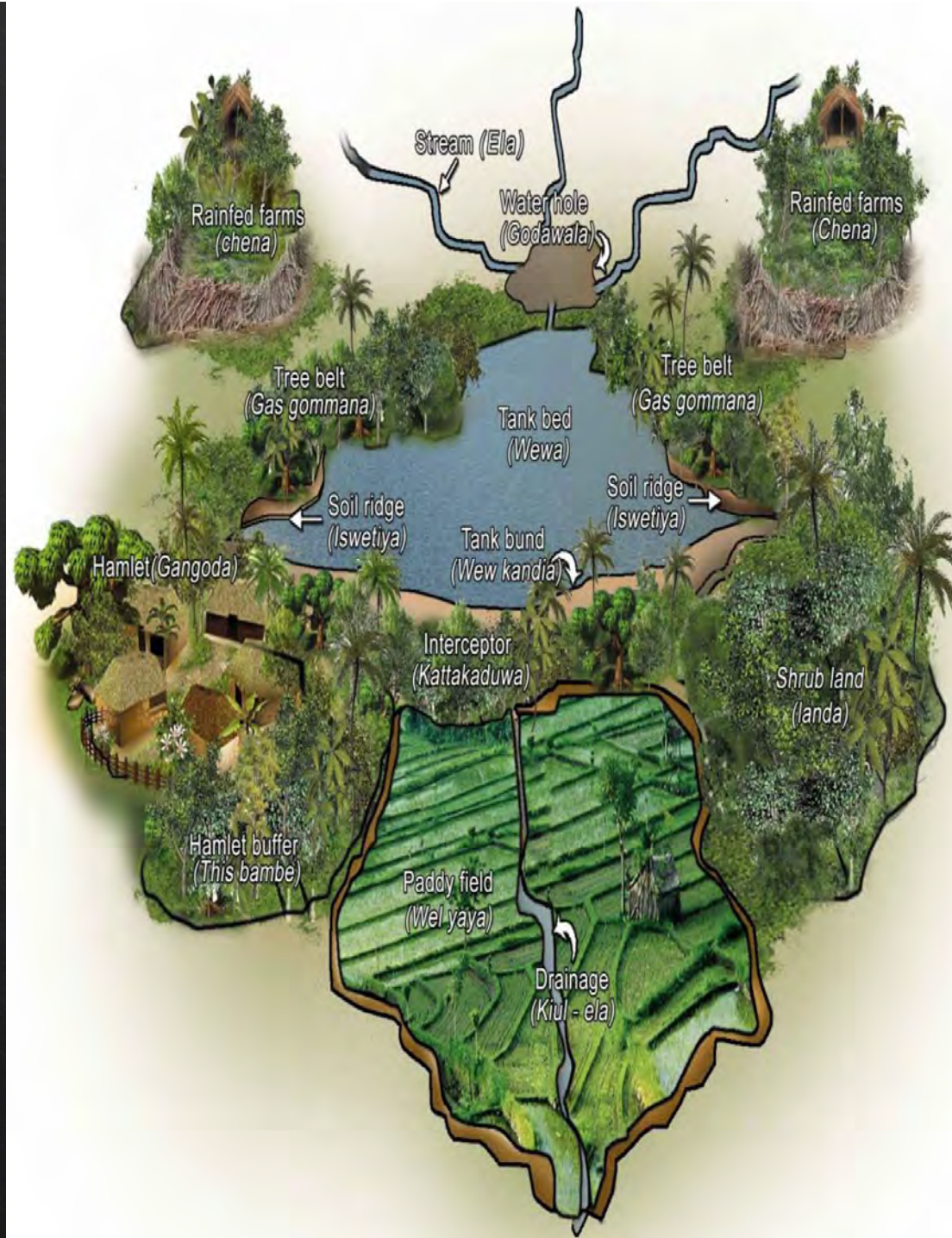


Kadulla Wewa Tank, Polonnaruwa District, Sri Lanka



Field Canal near Anuradhapura





Agricultural Adaptations

Dry Seeding

- ◇ Sowing seeds directly into dry or moist soil
- ◇ Reduces irrigation water required for land preparation and crop establishment
- ◇ Produces plants that are more resistant to water stress



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Alternate Wetting & Drying Irrigation (AWD)

- ◇ Allowing ponded water to dissipate between flooding events
- ◇ Estimated to reduce water inputs by 15-30%; preserving water for downstream users
- ◇ Can achieve equivalent yields but is more difficult to control weeds



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Bethma

- ◇ Traditional farming practice during periods of drought. Fields furthest from the reservoir are left fallow and the fields at the head-end of the canal are redistributed among the community.
- ◇ Reduces extent of cultivated land therefore reducing water inputs
- ◇ Prevents crop failure, particularly for vulnerable areas
- ◇ Reduces yields for all farmers

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Drought Resistant Seeds

- ◇ Seeds produce a more robust root system that can better withstand periods of water scarcity
- ◇ Provides assurance in the event of drought
- ◇ Can negatively impact yields; can be costly

Research Questions

- ◆ What proportion of farmers are aware of these adaptation techniques?
- ◆ What variables predict awareness?
- ◆ What proportion of farmers have adopted these techniques?
- ◆ What variables predict adoption?
- ◆ What variables predict dis-adoption?

Variables of Interest

- ◊ Settlement type (MADP or Traditional)
- ◊ First generation farmer
- ◊ Water scarcity
- ◊ Risk perceptions
- ◊ Risk aversion
- ◊ Efficacy

Methodology

- ❖ Sri Lanka Environmental and Agricultural Decision Making Survey (SEADS)
- ❖ 5-year longitudinal survey of farmers in 30 communities throughout the dry zone
- ❖ Year 1 – Pilot Cohort of 6 communities



Methodology

- ◆ Face-to-face interviews of 278 paddy farmers
 - ◆ 3 major scheme communities (n=156)
 - ◆ 3 Traditional communities (n=122)
- ◆ Semi-structured interview protocol, modeled after “ethnosurvey” methodology
- ◆ Interviews took place between planting seasons
- ◆ Community leader interviews (data collection is ongoing)

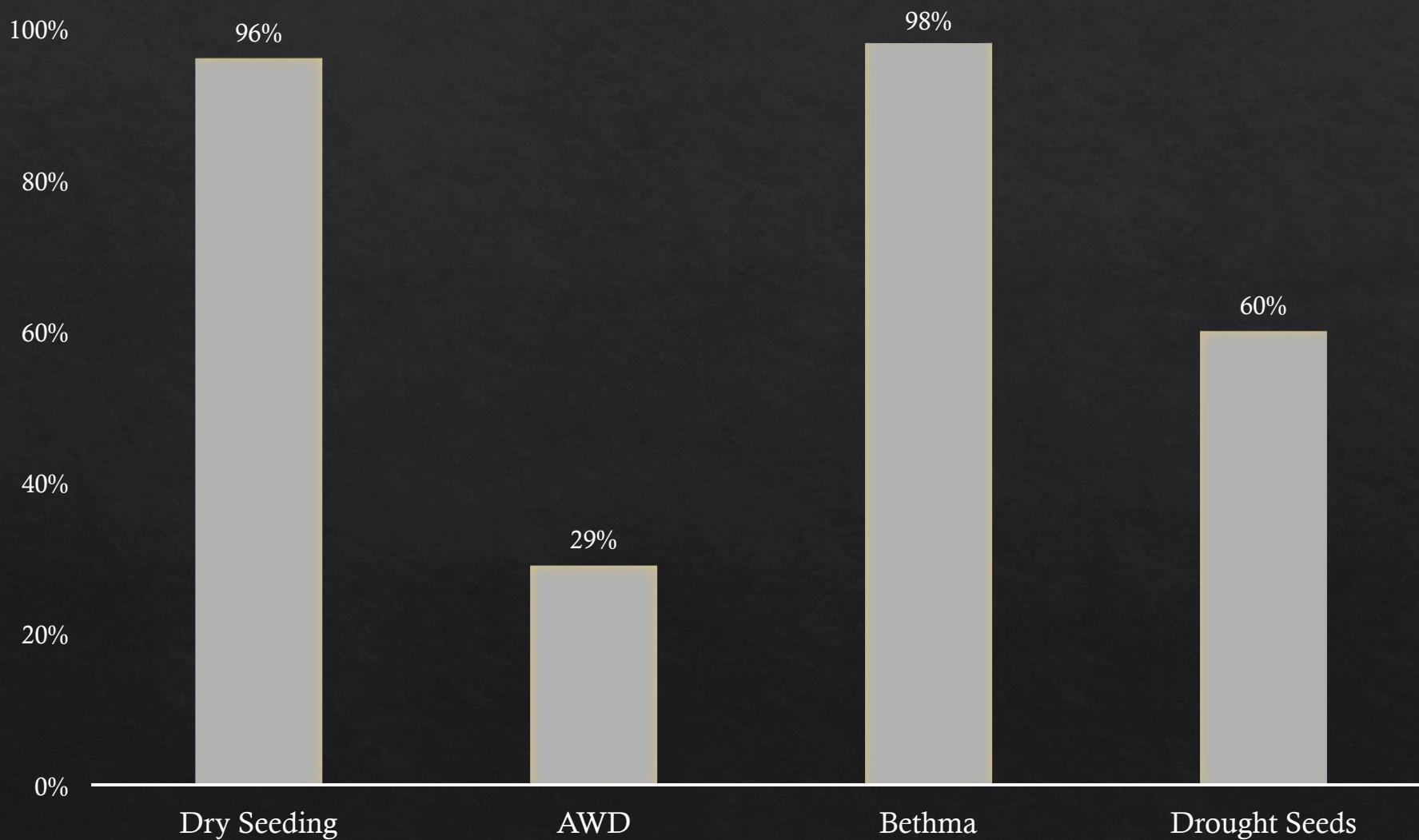


Sample Statistics

Sample	278 head farmer
Sex	80% male
Education	70% secondary degree or higher
Age	50 years
First generation farmer	8%
Primary occupation	92% farmer
Secondary occupation	54% no secondary occupation
% paddy consumed by household	34%
Religion/ethnicity	99.6% Sinhalese Buddhist

1. Awareness of Adaptation Techniques

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	AWD		Seeds	
	B	OR	B	OR
Gender (1=male)				
Education (primary or less)				
First generation farmer				
SES				
Water scarcity				
Risk perceptions				
Irrigation scheme (1=MADP)				
Risk aversion				
Efficacy				
Random Intercept				
AIC				
Correct Classification				

1. Awareness of Adaptation Techniques

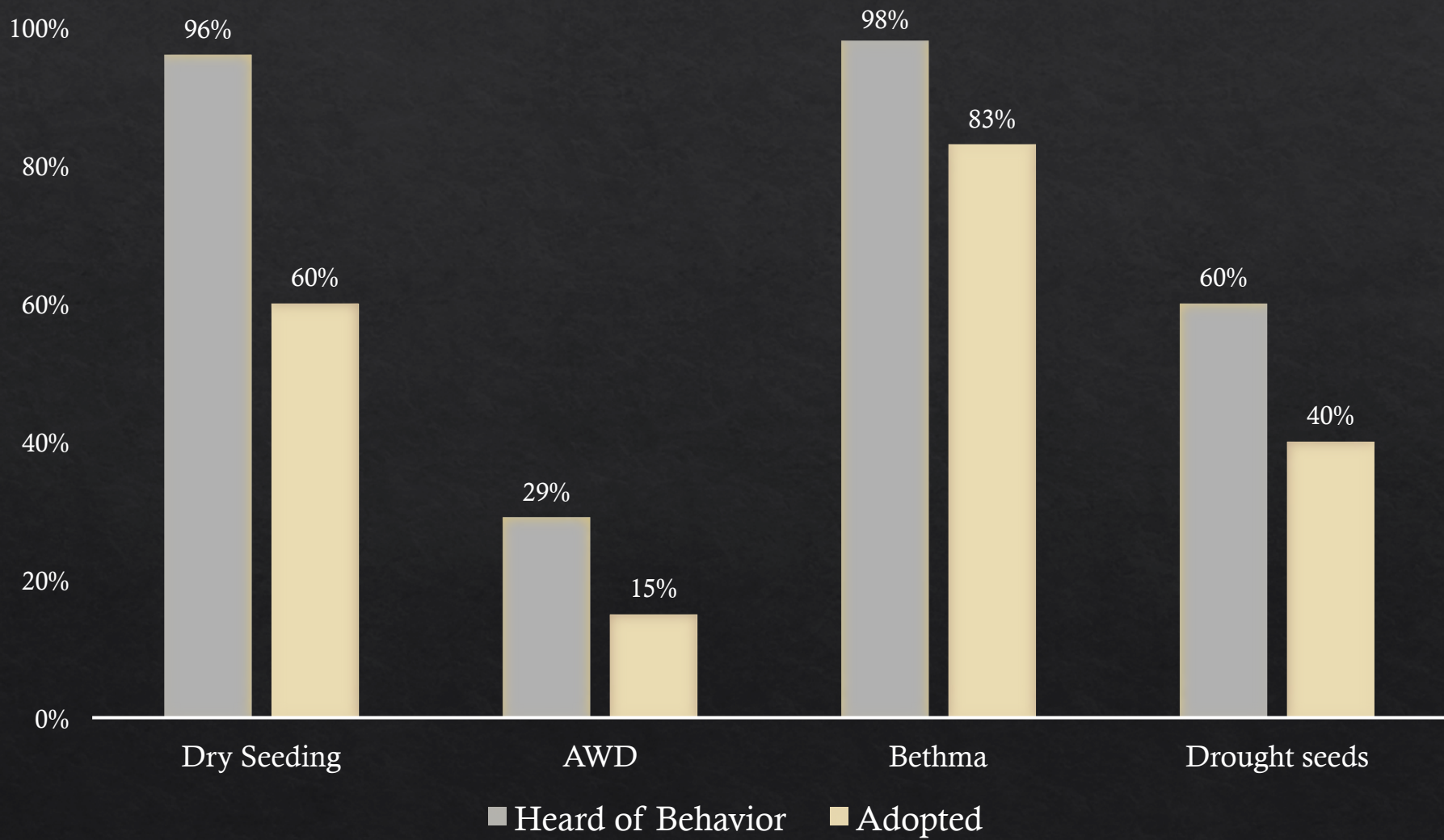
	AWD		Seeds	
	B	OR	B	OR
Gender (1=male)	1.12**	3.05	0.46	1.58
Education (primary or less)	-0.42	0.66	0.21	1.22
First generation farmer	0.30	1.35	0.14	1.17
SES	-0.06	0.94	0.16	1.18
Water scarcity	-0.03*	0.97	-0.01**	0.99
Risk perceptions	0.02	1.02	0.08	1.08
Irrigation scheme (1=MADP)	0.26*	1.30	-0.09	0.66
Risk aversion	0.33*	1.40	0.08	1.01
Efficacy	0.32	1.37	-0.11	0.94
Random Intercept	<0.01		0.42	
AIC	1280.77		1229.15	
Correct Classification	71.2%		62.6%	

1. Awareness of Adaptation Techniques

- ◆ Some evidence that women may be marginalized from the flow of information.
- ◆ Some evidence that awareness is higher among those within major scheme communities.
- ◆ Less awareness in more water scarce communities suggests that the information is not getting to those who may need it most.

2. Adoption of Adaptation Techniques

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	Dry Seeding		Bethma		Drought Seeds	
	B	OR	B	OR	B	OR
Gender (1=male)	-0.25	0.79	0.42	1.52	-0.34	0.71
Education (primary or less)	0.34	1.41	-0.29	0.74	-0.27	0.76
First generation farmer	-1.01	0.36	-0.72**	0.49	-0.36	0.70
SES	0.20	1.22	0.45**	1.58	0.04	1.04
Water scarcity	0.03**	1.03	-0.01	0.99	0.02**	1.02
Irrigation scheme (1=MADP)	-1.00*	0.37	0.17	1.19	-0.35	0.70
Risk perceptions	-0.36	1.02	0.11	1.12	0.03	1.03
Risk aversion	-0.18^	0.83	0.15	1.17	-0.15	0.86
Efficacy	0.66*	1.94	0.60	1.83	-0.18	0.84
Random Intercept	<0.01		0.42			
AIC	1218.95		1430.61		750.00	
Correct Classification	69.4%		86.0%		68.3%	

2. Adoption of Adaptation Techniques

- ◆ Those farming in water scarce conditions are more likely to adapt.
- ◆ Risk aversion & efficacy are correlated with adaptation
- ◆ Some evidence that first generation farmers may be reluctant to engage in collective drought adaptation practices
- ◆ Those in major schemes are less likely to adopt dry seeding, major scheme irrigation may constrain some adaptation opportunities

3. Likelihood of Dis-adoption

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	Dry Seeding		Bethma		Drought Seeds	
	B	OR	B	OR	B	OR
Gender (1=male)	-0.39	0.68	-0.18	0.84		
Education (primary or less)	-0.05	0.95	-0.21	0.81		
First generation farmer	-0.64	0.53	0.32	1.38		
SES	0.20	1.22	0.25**	1.25		
Water scarcity	0.00	1.00	0.01	1.01		
Irrigation scheme (1=MADP)	0.99**	2.71	1.50*	4.46		
Risk perceptions	-0.78*	0.46	0.02	1.02		
Risk aversion	-0.05	0.95	-0.25	1.28		
Efficacy	-0.12	0.89	-0.27	0.76		
Random Intercept	<0.01		0.42			
AIC	1409.87		1361.92			
Correct Classification	89.9%		81.5%			

Conclusions

- ◆ Certain groups are less likely to receive information about opportunities for coping with water scarcity
 - ◆ Women
 - ◆ Those farming in water scarce areas
 - ◆ Farmers in traditional communities
- ◆ Those most affected by water scarcity are more likely to adapt their cultivation practices
- ◆ First generation farmers are less likely to engage in collective agriculture (bethma) to cope with drought
- ◆ Adaptation is less prevalent within MADP settlements compared to traditional settlements



FUNDING

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- ✧ **Vanderbilt International Office. Category B: Project Development Grant.** *Climate Change Adaptation: A Pilot Study on Drought Impacts, Perceptions and Behavior (*[Abstract](#)*). 2010-2011.*
- ✧ **Vanderbilt International Office. Category A: Collaborative Exploratory Grant.** *Climate Change Adaptation: Climate Change Adaptation: Flood Impacts and Perceptions (*[Abstract](#)*). 2009-2010.*



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Thank You!

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