TWO ESSAYS ON PERCEIVED CLIMATE CHANGE AND ADAPTATION OF RURAL LIVELIHOODS

by

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Climate variability and change exert tremendous influence on the livelihoods and well-being of rural households, such that livelihoods would be heavily dependent on how communities manage the risks and opportunities associated with climate change. This dissertation examines the impact of households' perceived climate change on the adaptation of livelihoods in drought and flood-prone regions. Earlier literatures have explored the many facets of climate adaptations; however, this study is a specific and systematic attempt to understand climate adaptations in response to perceived climate change. A survey of 6,600 rural households was collected from drought and flood-prone districts of the Indian state of Bihar. A stratified random sampling technique was used. The survey collected data on a wide range of attributes, however, this study used, the sections of the survey of households perceived climate change, and climate adaptations.

In the first Essay, we empirically investigate the impacts of households perceived climate change on the adaptation of livelihoods in drought-prone region. A multivariate probit regression suggests that households' perceived climate change significantly determine the rural household adaptation strategies, for example, households that perceive an increase in rain were less likely to adopt by changing crop type, building water harvest scheme, irrigating more, reducing the number of livestock units, choosing to migrate another area, and finding off-farm jobs. The association between households' perceived climate change and climate adaptation choices dependence upon certain demographic and other characteristics of households are analyzed, for

example, other things constant, a household with male head were more likely to adopt by choosing off-farm jobs, older household head were less likely to adopt by planting shade trees, a household head with high school or higher education level were less likely to adopt by building water harvesting scheme, and a household with increased family size were more likely to adopt by changing crop type, irrigating more, and reducing the number of livestock units. Households that owns a farm land were more likely to adapt by irrigating more, whereas less likely to migrate another area and find off-farm jobs. Access to information such as about onset of monsoon and the amount of rain increases the likelihood and also widen the livelihood adaptation choices. More than half of the sampled households had chosen for either seasonal migration or found off-farm jobs.

In the second Essay, we analyze the impacts of households perceived climate change on the adaptation of livelihoods in flood-prone region. A multivariate probit regression suggests that households' perceived climate change significantly determine the rural household adaptation strategies, for example, households that perceived delay in the monsoon season were more likely had adopted measures such as planted shade trees, increased irrigation, reduced the number of livestock units, chosen for seasonal migration, and found off-farm jobs. Other things constant, for example a household with male head was more likely founded off-farm jobs. A household that owns a farmland had positive relationships with adaptive measures such as changed crop type, irrigated more, changed from crop to livestock, and reduced the number of livestock units. The landholding size had a positive relationship with adaptive measures such as the increased number of livestock units, while negative association with reduced number of livestock units. Access to information such as about onset of monsoon and the amount of rain increases the likelihood and also widen the livelihood adaptation choices.

Taken together, the empirical results suggest that the rural livelihood adaptations are different for different perceived climate change changes. Each essay investigates perceived climate change specific to the different climate context that is drought and flood-prone regions. These research findings can be important to policy responses to support and promote livelihood related adaptations in drought as well as flood-prone regions.

Essay 1

Perceived Climate Change and Adaptation of Rural Livelihoods: Results from a Drought-Prone Region of India

Abstract

Using a survey data on 3,300 representative rural households from a drought-prone region of India, we examine the links between the households' livelihoods adaption choices and perceived climate change. The livelihoods adaptation choices are jointly modeled as the multivariate probit regression, estimated by the simulated likelihoods procedure of Cappellari and Jenkins (2003). We find that households who chose one adaptation strategy were more likely to choose another one. The adaptation choices of the households are strongly determined by their perceived climate change and the results are robust to multicollinearity among the measures of the perceptions of climate change. Among the control variables, access to information on the onset date of monsoon and the amount of rainfall influences adaption choices. Finally, households who own farmland are more likely to irrigate and are less likely to seasonally migrate to another area and find off-farm jobs.

Keywords: Climate change perceptions; climate adaptation; drought-prone regions; Bihar, India

1. Introduction

Climate change and variability exert tremendous influence on the livelihoods and well-being of rural households. Rural livelihoods, therefore, will be tied to the extent to which communities are able to manage the risks and opportunities associated with climate variability and extreme climatic events (IPCC, 2007, 2012). Climate services are seen as an important part of improving climate-related risks management. Climate services usually provide historical information (Gupta et el., 2011), seasonal forecasts (Meza et al., 2008; Hansen et al., 2011) and long-term climate projections (Street, 2007; Ranger el al., 2010; Scott et al., 2011) on the promise that such information would improve decision making under climate uncertainty. This assumption, however, would have validity if households were to adapt livelihoods decisions in response to their perception of climate change and variability. A household's perception of climate change may be shaped by the past experiences, climate services and access to information from other sources.

Livelihoods adaptation to climate change is poorly understood (Abidoye, Kurukulasuriya, and Mendelsohn, 2017). The existing empirical studies on climate adaptation has largely focused on farming decisions (Thoai et al., 2018; Abidoye et al., 2017; Mulwa et al., 2017; Ashraf et al., 2009; Gbetibouo, 2009; Nhemachena and Hasan, 2007), which have examined the chanages in farming practices due to perceived changes in climate. While agricultural is the dominant source of livelihoods in rural communities, it increasingly accounts for a decreasing share of household incomes. The impacts of climate change on off-farm sources of rural livelihoods has received little attention, which is an equally important dimension of rural livelihoods directly affected by climate change and variability.

In this paper, we systematically investigate the impacts of rural households' perceived climate change on adaptation choice in a drought-prone region of India. We contribute to the existing literature in the following ways. First, we use data on 3,300 rural households drawn from 132 villages distributed across the districts of Jehanabad and Nawada in Bihar. This is relatively a large sample compared to the existing literature and the sample is representative of drought-prone agro-climate zones of Bihar. Thus, we provide insights into rural households' perception of climate change and their livelihoods adaptation in a drought-prone agro-climatic environment. While these insights cannot be generalized to other agro-climatic regions, they are potentially useful to other drought-prone regions. This is an important consideration since the risks of climate change and opportunities for the livelihoods adaptations vary across agro-climatic regions. Second, climate change and variability pose risks not only to farm-based sources of livelihoods, but also off-farm livelihoods sources and decisions are affected. Unlike previous studies, our sample of households is representative of all rural communities, where farming is one of the many sources of the livelihoods. Thus, we consider the impacts of perceived climate change on both farm and off-farm related livelihood decisions (e.g., crop choices, livestock, mixed farming, and seasonal labor migration). Third, all drought-prone regions share some common agro-climatic characteristics, there are sub-regional variations (e.g., intensity and frequent of droughts, and institutional and cultural characteristics). We account for such sub-regional variations by including block fixed effects (since sampling is stratified by blocks) and similarities among the households by clustering of standard errors at the village-level (since we randomly sample 25 households from a village). The previous studies were unable to account for sub-regional variations and similarities among the farmers because of relatively sample sizes, drawn from agro-climatic zones. Fourth, it has been common practice in the literature to simultaneously include multiple indicators of farmers' perception of climate change in the determination of their adaptation choices (e.g., see Abidoye, Kurukulasuriya and Mendelsohn, 2017). This is partly motivated by the consideration that perceptions of climate change cannot be adequately captured by any single indicator. Therefore, a combination of perception measures may serve as better proxies for households' perceptions of climate change. However, multiple measures of households' perception of climate change are highly correlated, which may lead to incorrect inferences about their statistical significance in the determination of adaptation choice, which is examined in this paper.

We estimate the multivariate probit regression of livelihoods adaptation choice (i.e., nine adaption choices) by the simulated maximum likelihood procedure. The main findings of the paper are following. First, households who chose one adaptation measure were often more likely to choose another. For example, households who changed crop type almost always adopted other adaptation measures except leasing farm land and buying insurance.

Second, households' adaptation choices are affected by their perception of climate change. Controlling for other factors, households who perceived increase in rainfall were less likely to change crop type, build water harvesting scheme, irrigate, reduce number of livestock, seasonally migrate to another area and find off-farm jobs. Households who perceived more frequent droughts were *more likely* to build water harvesting scheme, change from crop to livestock and increase number of livestock, but were less likely to plant shaded trees, irrigate more, reduce number of livestock, seasonally migrate, and find off-farm jobs. Households who perceived delay in monsoon season were more likely to change from crop to livestock, increase number of livestock and find off-farm jobs, but were less likely to change crop variety and irrigate. Households who perceived monsoon season ending sooner were more likely to change crop type, seasonally migrate and find off-farm jobs, but were less likely to plant shade trees. Households who perceived an increase in number of hot days were more likely to build water harvesting scheme, plant shade trees and find off-farm jobs, but were less likely to increase the number of livestock. Similarly, households who perceived more frequent cyclone were more likely to build water harvesting scheme, plant shade trees, change from crop to livestock, increase number of livestock, and seasonally migrate.

Third, as expected, measures of households' perceptions of climate change are highly correlated. Therefore, we check the sensitivity of the preceding results by estimating an alternative specification of the multivariate probit model, where only uncorrelated climate change perception variables are included. We find that except for adaptation choices of building water harvesting scheme and planting shade trees, the results regarding other seven adaptation choices remain the same. Fourth, access to information on the onset date of monsoon and the amount of rainfall influenced some of the adaption decisions of households. Fifth, households who owned farmland were more likely to irrigate more and were less likely to seasonally migrate to another area and find off-farm jobs.

The remainder of the paper is organized as follows. In section 2, we discuss the context and sample design. In section 3, we present the empirical framework. The results are presented in section 4. Finally, conclusions and policy implications are presented in section 5.

2. Context and Data

We study rural households' perception of climate change and livelihoods adaption choice in a drought-prone region, which is located in Bihar, India. Bihar is a northeastern state of India (Figure 1). South Bihar (south of the River Ganga)'s agro-climatic conditions are characterized as drought-prone, where frequent droughts are one of the main reasons for low agricultural productivity. Also, there is an increasing perception that the regional climate is changing and becoming less predictable, resulting in changes in the monsoon pattern and the intensity of extreme weather events (GOB, 2014). Bihar is the poorest state of India. Because of poor socioeconomic status, and other cultural, institutional and geographical constraints to adaptations, the rural livelihoods in Bihar is particularly vulnerable to climate shocks. At the household level, poverty, illiteracy among adults, limited access to formal credit institution, and inadequate and untimely access to climate information have hindered households' ability to confront the climate shocks.

The sample of households are drawn from two drought-prone districts of Bihar, Jehanabad and Nawada. Nawada has geographical area of 2494 square kilometers. The average annual rainfall is 1,037 millimeters (Ministry of Water Resource, Government of India, 2013).

The maximum amount of rainfall is attributed to southwest monsoon during the months of June-September. The maximum temperature in Nawada varies from 33 to 46 degrees Celsius and the minimum temperature varies from 4 to 16 degrees Celsius.[1] In 2011, the literacy rate in Nawada was 59.76 percent. Nawada accounts for 2.14 percent population of Bihar. About 90% of the population in Nawada lives in rural areas and the workforce participation rate is about 36.82%. Table 1 and 2 contains workforce participation rates in Jehanabad and Nawada respectively. Individuals who are part of the workforce could be working for at least 6 months a year, or 3–6 months a year or 0-3 months a year. Any individual who works for at least a year is considered to be a main worker while those working for less than 6 months a year are considered marginal workers. Only about 19% of the workforce as main workers in Nawada work as cultivators and approximately 26% of the main workers are work as agricultural labor.

Jehanabad with geographical area of 1569 square kilometers is much smaller than Nawada, but in climatic conditions it is very similar to Nawada. For example, Jehanabad receives approximately as much of annual rainfall (1052 millimeter) as Nawada. Adult literacy rate (76.33 percent) in Jehanabad is greater than Nawada (59.76 percent). On the other hand, Jehanabad's population is about half of the population of Nawada. Together, Jehanabad and Nawada are representative of drought-prone agro-climatic region Bihar.

2.1. Sample Design and Data

A comprehensive household survey questionnaire was used to collect data. Data collected was during 2016-2017 by a local agency, 7Even Consultancy, under the supervision of Tauhidur

[1] Government of Bihar; Available at: http://krishi.bih.nic.in/introduction.htm

Rahman of the University of Arizona and JEEViKA, an anti-poverty program of the government of Bihar and the World Bank.[2]

The households were selected by the stratified sampling technique in the districts of Jehanabad and Nawada. The district-level sampling was stratified by blocks.[3] In each district, six blocks were selected. From each block, 11 villages were selected. Then from each village a random sample 25 households were surveyed, with the total sample size of 3,300 households from the two districts.

Detailed data was collected on households' demographics, income generating activities, living environment, production and consumption assets, cropping pattern, consumption exigencies (food and health securities), debt and saving habits, perceptions of climate change, access to weather and climate information, and social network and capital.

Table 4 presents basic household characteristics. Approximately 90 percent of the households are male-headed, with 46 years as the average of the household heads. The average household (family) size is 6, which is greater than the average household size (5 persons) of Bihar (Census of India, 2011). Only about 26 percent of the household head had an education level greater than high school. Approximately one-third of the households own farmland. The average land holding size is 11.22 *kathas* that is approximately 0.14 hectares and thus the average household is a marginal farmer[4]. About one-tenth of households are members of farmers' union and over one-fifth of households are members of the local credit group. About 68 percent of households have perceived increase in rain in recent five years. Approximately one-

[2] Data was collected as a part of a joint project between the University of Arizona and the International Research Institute (IRI), affiliated with Columbia University, funded by the International Research Application Program (IRAP) of National Oceanic and Atmospheric Administration (NOAA).
[3] A block is administrative sub-division of a district.
[4] Households with marginal (< 1 ha), small (1 – 2 ha), large (> 4 ha) land holdings; Agricultural Census Commissioner, Government of India, 2010 – 2011.

third of the households perceived more frequent flooding, about a quarter perceived more frequent droughts, and approximately one-fifth of the households perceived more increased incidences of cyclone. About 46 percent of respondents perceived an increase in hot days. The neighbors or relatives (33 percent) and agricultural extension agency (31 percent) were the main sources of climate-related information. Less than a quarter of households received their information from television or radio. Overall, about 69 percent of the households received information about the onset of monsoon season and about 61 percent of the households received information about the amount of rain before planting season.

3. Empirical Strategy

Following Cappellari and Jenkins (2003), we estimate the following regression model.

$y^*_{ivbm} = a'_m PCC_{ivbm} + \beta'_m Z_{ivbm} + \alpha_b + \epsilon_{ivbm}$; *i* = 1,…,25; *v* = 1,…,132; *b* = 1,…,12; *m* = 1,…,9.

$y_{ivbm} = 1$ if $y^*_{ivbm} > 0$ and 0 otherwise. ϵ_{ivbm} are error terms distributed as multivariate normal, each with a mean of zero, and variance-covariance matrix *V*, where *V* has a value of 1 on the leading diagonal and correlations $\rho_{jk} = \rho_{kj}$ as off-diagonal elements. The y_{ivbm} represents households' livelihoods adaptation choices. The PCC_{ivbm}represent perceived climate change, $a_m$is a vector of coefficients associated with perceived climate change, Z_{ivbm} represent a matrix of control variables, β_m represent a vector of coefficients associated with control variables, $\alpha_b$is the block fixed effects, and ϵ_{ivbm} is clustered at village-level.

Since we have 9 adaptation choices as outcome variables that are correlated with one or more choices, the multivariate probit model is employed to analyze the link between households' livelihoods adaption with their perception of climate change. Because of correlations among adaptation choices, error terms across equations are also correlated (Belderbos et al., 2004).

Multivariate probit model accounts for such correlations across equations (Hugenin, Pelgrin and Holly, 2009; Nhemachema and Hassan, 2008). In multivariate probit model, simultaneously the influence of the set of explanatory variables are modeled on each of the different outcome variables and allows error terms to be freely correlated (Golob and Regan, 2002; Lin, Jensen and Yen, 2005). Furthermore, the multivariate probit model allows a flexible correlation structure for the unobservable variables.

3.1. Dependent variables

Table 3 present lists households' farm and off-farm related livelihoods adaptation choices along with their descriptive statistics. We observe that seasonal migration to another is the most frequently reported adaptation choice of households, followed by finding off-farm jobs, more irrigation, and reduced the number of livestock. The least frequently adapted adaptation choices are leasing land and purchasing insurance.

3.2. Explanatory variables

In Table 4, we list the explanatory variables along with their descriptive statistics. Our primary set of explanatory variables are households' perception of climate change. The control variables include households' demographics, access to information, asset ownership, social network, and social capital.

3.2.1. Households' Perceptions of Climate Change

Households were asked whether they perceived a change in a specific climate variable such as increase in rain, more frequent droughts, more frequent floods, delay in monsoon season, monsoon season ending sooner, increase in number of hot days, and more frequent cyclone.

Thus, the measures of the perception of climate change are binary variables. Table 5 presents households' perception of climate change.

3.2.2. Control variables

The control variables include access to information, household demographics, asset ownership, social capital, and block fixed effects. Access to information is captured by two binary variables representing a household's access to information about the onset of monsoon season and the forecasted amount of rainfall. Household attributes are captured by gender, age, educational attainment of household head, household size, household asset ownership including land, access to irrigation, and household's membership to farmers and credit groups, among others.

Long-term investments in land are positively correlated with the ownership of land. The adaptation strategies such as changing crop variety, building water harvesting scheme, and more irrigation would likely depend upon the tenure status of land. Livestock is a form of saving and insurance for many rural households (Bosman et al., 1997; Doran et al., 2014). Households with a higher livestock unit can afford to take risks and rely on the livestock in times of climate shocks (Jones and Thornton, 2009).

Social capital is captured by households' reported confidence in government, membership of farmers' union and credit group. Effective local adaptation requires responsive and flexible local institutions[5] that in turn play an important role in reducing the costs of adaptation (Agrawal et al., 2009). Members of a certain group (including neighbors) are able to

[5] Local institutions such as local government, farmers' groups, community based organizations, local association and NGOs, etc.

share information among themselves, which accelerates the process of technology adoption and diffusion (Munasib and Jordan, 2011). Credit access relaxes liquidity constraints thus increasing technology adoption (Simtowe and Zeller, 2006).

4. Results

Table 7 presents the results the multivariate probit regression of households' adaptation choice. A household that perceived increase in rainfall were less likely to undertake adaptive measures such as changing crop variety, building water harvesting scheme, irrigating more, reducing the number of livestock, choosing for migration, and finding off-Farm jobs. A household that perceived more frequent droughts were more likely to adapt by building water harvesting scheme, changing from crop to livestock, and increasing the number of livestock whereas, less likely to adapt by planting shade trees, irrigating more, reducing the number of livestock, choosing for migration, and finding off-Farm jobs. The coefficient is the highest in the case of choosing for migration. Households that perceived more frequent floods have shown similar by choosing similar adaptive measures as households that perceived more frequent droughts except they were more likely to plant shade trees. Households that perceived delay in the start of monsoon season were more likely to adapt by changing from crop to livestock, increasing the number of livestock, and finding off-Farm jobs, whereas, less likely to adapt by changing crop variety, irrigating more, and reducing the number of livestock. Households that perceived monsoon season ending sooner were more likely to adapt by changing crop variety, choosing for migration, and finding off-Farm jobs whereas, less likely to adapt by planting shade trees. Households that perceived increased hot days were more likely to adapt by building water harvesting scheme, planting shade trees, and finding off-Farm jobs, whereas, less likely to adapt by increasing the number of livestock. Households that perceived more frequent cyclone were more likely to adapt by building water harvesting scheme, planting shade trees, changing from crop to livestock, increasing the number of livestock, and choosing for migration.

Among the control variables, access to information on onset of monsoon and the amount of rainfall are statistically associated with most of the adaptation choices. Access to information about the onset of monsoon season increases the likelihood that the household adapt by changing crop variety, irrigating their farmland more, migrating to another area, and finding off-Farm jobs. Households with access to information about the amount of rain were more likely to plant shade trees and reduced number of livestock.

Households with male head were more likely to adapt by finding off-Farm jobs. Household with the older male head were less likely to adapt by planting shade trees. Household head with an education, higher than high school were less likely to adapt by building water harvesting scheme. *Household family size* has a positive and significant relationship with adaptive measures such as changed crop variety, irrigated more, and reduced number of livestock.

A household that own farmland was more likely to adapt by irrigating it more and less likely to adapt by choosing migration and finding off-Farm jobs. A household that has access to irrigation facility were more likely to adapt by reducing the number of livestock such as cows and goats. *Household agricultural land holding size* is positive and significant for adaptive measures such as planted shade trees, changed from crop to livestock, and either increased or decreased the number of livestock.

Household with strong confidence in government were more likely to adapt by changing crop variety, irrigating more, and reducing the number of livestock whereas less likely to adapt by increasing the number of livestock and finding off-Farm jobs. Households that were members of the local farmers' union were more likely to adapt by building water harvesting scheme, planting shade trees, and changing from crop to livestock. Households that were a member of a local credit group were more likely to adapt by either increasing or decreasing the number of livestock and choosing to migrate to another area.

4.1. Robustness

It is a common practice in the literature to simultaneously include multiple measures of households' perception of One limitation of this study is that all the perceived climate change variables are used in the multivariate probit regression simultaneously to analysis the association between perceived changes and adaptation strategies. The data points collected on the perceived climate change variables are based on the survey question that asked whether household have noticed climate change over 5 years? The response to each perceived climate change variable might not be mutually exclusive, for example a household that responded having noticed a change in increased in rainfall might have also responded to have noticed delays in the start of monsoon season. Theoretically, the responses to the perceived climate change variable are highly interrelated and interdependent. Table 8 shows the correlation matrix of climate change perceptions. The variable perceived increase in the rain is highly correlated with other perceptions such as more frequent droughts, more frequent floods, delay in the start of monsoon season, shortening of monsoon season, and more frequent cyclones, however, not correlated to perceived increased number of hot days. In other words, there do not seem to addition information available in the above highly correlated perceived variables.

Table 9 shows the robustness to perceived climate variable. We estimate the reduced model with including only two perceived climate variability that is perceived increase in rain and increased number of hot days and maintaining all other control variables same as full model and for all the adoption strategies. The comparison between full and reduced model suggests that the estimate parameters are not sensitive for adaptation strategies except built water harvesting scheme and planted shade trees.

Appendix Table 2 shows the univariate probit model clustered at village level results of the most frequent adapted strategy that is migrated to another area. Furthermore, Appendix Table 3.1 – 3.9 are the multivariate probit regression results with the perceived climate change.

The simulated maximum likelihood estimation is equal to corresponding maximum likelihood estimation (SML), conditional on the number of random variates used to calculate SML, Cappellari and Jenkins (2003) . Appendix Table 4 shows the results after setting the number of draws value at 60.

5. Conclusions and Policy Implications

The variables related to perceptions about climate change significantly determine the rural household adaptation strategies. The empirical analysis suggests that each reported perception about climate change by households have different adaptive strategies. A household that perceived increase in rainfall were less likely had undertaken adaptive measures such as changed crop type, built water harvesting scheme, irrigated more, reduced the number of livestock, chosen seasonal migration, and found off-farm jobs. A household that perceived more frequent droughts were more likely had adopted measures such as built water harvesting scheme, changed from crop to livestock, and increased the number of livestock units, whereas less likely had adopted measures such as planted shade trees irrigated more, reduced the number of livestock units, chosen for seasonal migration, and found off-farm jobs. Households that perceived more frequent floods had shown similar adaptation strategies as households that had perceived more frequent droughts except that they were more likely to have planted shade trees. Households that perceived delay in the start of monsoon season were more likely to have adopted measures such as changed from crop to livestock, increased the number of livestock, and found off-farm jobs, whereas were less likely to have adopted measures such as changed crop type, irrigated more, and reduced the number of livestock units. Households that perceived shortening of monsoon season were more likely had adopted measures such as changed crop type, chosen seasonal migration, and found off-farm jobs, whereas were less likely had adopted measures such as planted shade trees. Households that perceived increased number of hot days were more likely had adopted measures such as built water harvesting scheme, planted shade trees, and found off-farm jobs, whereas were less likely had adopted measures such as the increased number of livestock units. Households that perceived more frequent cyclones were more likely had adopted measures such as built water harvesting scheme, planted shade trees, changed from crop to livestock, increased the number of livestock units, and chosen seasonal migration. Other important factors were access to information from sources such as agricultural extension, neighbors or relatives, etc. Household characteristics played an important role to determine what adaptation strategies the household adopted, for example a household with male head were more likely had adapted measure such as found off-farm jobs. Household agricultural land holding size had positive relationships with adaptive measures such as planted shade trees, and changed from crop to livestock. A household with a strong confidence in government were more likely had adopted measures such as changed crop type, irrigated more, and reduced the number of livestock units, whereas, less likely had adopted measures such as the increased number of livestock units, and found off-farm jobs. The findings from the empirical investigation can be important to policy.

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Table 1. Workforce participation rate in Jehanabad, 2011

	Rural	Urban	Total
Total Population	990,117 (87.99%)	135,196 (12.01%)	1,125,313 (100.00%)
Total number of workers	328,412 (89.88%)	36,966 (10.12%)	365,378 (100.00%)
Total number of main workers working as Cultivators	67,151 (20.45%)	2,877 (7.78%)	70,028 (19.17%)
Total number of main workers working as Agricultural Laborers	104,772 (31.90%)	4,385 (11.86%)	109,157 (29.88%)
Total number of marginal workers working as Cultivators	15,695 (4.78%)	394 (1.07%)	16,089 (4.40%)
Total number of marginal workers working as Agricultural Laborers	66,669 (20.30%)	3,705 (10.02%)	70,375 (19.26%)

Source: Census of India, 2011

Table 2. Workforce participation rates in Nawada, 2011

	Rural	Urban	Total
Total Population	2,003,567 (90.29%)	215,579 (9.71%)	2,219,146 (100.00%)
Total number of workers	755,371 (92.45%)	61,670 (7.55%)	817,041 (100.00%)
Total number of main workers working as Cultivators	159,294 (21.09%)	3,645 (5.91%)	162,938 (19.94%)
Total number of main workers working as Agricultural Laborers	204,133 (27.02%)	7,542 (12.23%)	211,675 (25.91%)
Total number of marginal workers working as Cultivators	52,867 (7.00%)	582 (0.94%)	53,449 (6.54%)
Total number of marginal workers working as Agricultural Laborers	181,578 (24.04%)	4,224 (6.85%)	185,802 (22.74%)

Source: Census of India, 2011[6]

[6] Available: *http://www.shram.org/datahub*

Table 3. Descriptive statistics of Households' adaptation choice

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Changed crop variety	3247	0.34	0.47	0	1
Built water harvesting scheme	3245	0.18	0.38	0	1
Planted shade trees	3245	0.33	0.47	0	1
Irrigated more	3240	0.49	0.50	0	1
Changed from crop to livestock	3226	0.20	0.40	0	1
Increased number of livestock	3216	0.18	0.38	0	1
Reduced number of livestock	3211	0.44	0.50	0	1
Migrated another area	3210	0.66	0.47	0	1
Found off-Farm jobs	3208	0.52	0.50	0	1
Leased your land	3204	0.06	0.23	0	1
Brought Insurance	3170	0.08	0.27	0	1

Table 4. Descriptive characteristics of households

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Increase in rain	3282	0.68	0.47	0	1
More frequent droughts	3274	0.25	0.43	0	1
More frequent floods	3269	0.37	0.48	0	1
Delay in the start of monsoon season	3265	0.59	0.49	0	1
Monsoon season end sooner	3258	0.54	0.50	0	1
Increase in number of hot days	3250	0.46	0.50	0	1
More frequent cyclones	3227	0.15	0.36	0	1
Information about onset of monsoon	3298	0.69	0.46	0	1
Information about amount of rain	3298	0.61	0.49	0	1
Male-headed household	3298	0.90	0.29	0	1
Age of Household Head	3298	46.20	14.18	10	95
High school	3298	0.26	0.44	0	1
Family size	3298	6.42	2.97	1	20
Own Farm land	3298	0.36	0.48	0	1
Access to Irrigation	3179	0.29	0.45	0	1
Cow	3298	0.31	0.46	0	1
Buffalo	3298	0.23	0.42	0	1
Goat	3298	0.23	0.42	0	1
Farm land holding size (*Kathas*)	3298	11.22	31.55	0	800
Strong confidence in government	3298	0.38	0.48	0	1
Member of farmers' union	3298	0.10	0.29	0	1
Member of local credit group	3194	0.20	0.40	0	1

Table 5. Households' perception of climate change by districts

	Nawada	Jehanabad	Overall
Increase in rain	80.35	56.35	68.35
More frequent droughts	29.66	20.53	25.09
More frequent floods	39.57	35.30	37.44
Delay in the start of monsoon season	55.09	62.79	58.94
Monsoon season end sooner	44.99	63.38	54.18
Increase in number of hot days	43.66	49.23	46.44
More frequent cyclones	7.36	23.40	15.38

Table 6. Correlation among adaptation choices

	Changed crop variety	Built water harvesting scheme	Planted shade trees	Irrigated more	Changed from crop to livestock	Increased number of livestock	Reduced number of livestock	Migrated another area	Found off-Farm jobs	Leased your land	Brought Insurance
Changed crop variety	1	0.285***	0.083***	0.358***	-0.139***	-0.131***	0.272***	0.168***	0.136***	0.053	0.013
Built water harvesting scheme		1	0.217***	0.120***	-0.061***	-0.027	-0.022	0.024	0.053	0.034	0.064***
Planted shade trees			1	0.283***	-0.032	-0.050	0.0001	0.091***	0.043	0.044	0.085***
Irrigated more				1	-0.144***	-0.199***	0.272***	0.131***	0.086***	0.012	-0.003
Changed from crop to livestock					1	0.401***	0.032	-0.105***	-0.027	0.031	0.047
Increased number of livestock						1	0.027	-0.043	-0.067***	0.031	0.008
Reduced number of livestock							1	0.047	-0.170***	-0.055	-0.091***
Migrated another area								1	0.430***	-0.091***	-0.006
Found off-Farm jobs									1	-0.001	0.044
Leased your land										1	0.102***
Brought Insurance											1

*** significance at 1 percent

Table 7. Multivariate probit regression of household adaptation choice

Variables	(1) Changed crop variety.	(2) Built water harvesting scheme	(3) Planted shade trees	(4) Irrigated more	(5) Changed from crop to livestock	(6) Increased number of livestock	(7) Reduced number of livestock	(8) Migrated another area	(9) Found off-farm jobs
Perceived climate variable									
Increase in rain	-0.361***	-0.258**	-0.138	-0.325***	0.020	-0.032	-0.405***	-0.378***	-0.347***
	(0.107)	(0.110)	(0.105)	(0.092)	(0.098)	(0.101)	(0.096)	(0.118)	(0.090)
More frequent droughts	0.084	0.244**	-0.351***	-0.309***	0.255***	0.230**	-0.208**	-0.801***	-0.473***
	(0.119)	(0.121)	(0.096)	(0.095)	(0.087)	(0.095)	(0.100)	(0.104)	(0.100)
More frequent floods	-0.137	0.431***	0.533***	-0.050	0.225***	0.149*	-0.006	-0.189**	-0.177**
	(0.096)	(0.082)	(0.079)	(0.071)	(0.084)	(0.084)	(0.084)	(0.077)	(0.089)
Delay in monsoon season	-0.551***	0.002	-0.033	-0.300***	0.277***	0.188**	-0.536***	-0.057	0.217***
	(0.098)	(0.087)	(0.076)	(0.071)	(0.082)	(0.076)	(0.067)	(0.078)	(0.072)
Monsoon season end sooner	0.198**	-0.077	-0.164**	0.055	-0.121	-0.072	0.100	0.365***	0.381***
	(0.092)	(0.086)	(0.072)	(0.073)	(0.074)	(0.079)	(0.072)	(0.075)	(0.089)
Increase in number of hots day	0.006	0.259***	0.246***	-0.010	-0.051	-0.341***	-0.013	0.076	0.351***
	(0.092)	(0.098)	(0.090)	(0.080)	(0.091)	(0.090)	(0.091)	(0.087)	(0.090)
More frequent cyclone	0.024	0.265**	0.317***	-0.151	0.400***	0.436***	-0.150	0.342***	0.040
	(0.135)	(0.118)	(0.121)	(0.107)	(0.126)	(0.110)	(0.121)	(0.108)	(0.130)
Access to Information									
Information about **onset** date of	0.491***	0.006	-0.050	0.400***	-0.086	-0.161	-0.041	0.345***	0.401***
monsoon	(0.123)	(0.116)	(0.093)	(0.101)	(0.104)	(0.105)	(0.117)	(0.117)	(0.104)
Information about **amount** of rain	0.127	0.117	0.264***	0.256***	0.082	0.173	0.395***	0.051	0.047
	(0.105)	(0.120)	(0.088)	(0.087)	(0.111)	(0.106)	(0.108)	(0.102)	(0.081)

Household characteristics									
Male head	0.054	-0.093	-0.332**	0.022	0.032	0.093	-0.126	0.123	0.272***
	(0.099)	(0.116)	(0.130)	(0.113)	(0.098)	(0.101)	(0.110)	(0.103)	(0.097)
Head age	0.006	-0.004	-0.033***	0.008	0.005	-0.021	0.004	0.006	0.011
	(0.012)	(0.014)	(0.011)	(0.011)	(0.013)	(0.014)	(0.012)	(0.012)	(0.012)
Age square	-0.0001	0.0001	0.0003**	-0.0001	-0.00005	0.0002	-0.0001	-0.00004	-0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
High school	-0.001	-0.218***	-0.049	-0.042	-0.034	0.036	-0.005	0.033	0.010
	(0.078)	(0.076)	(0.073)	(0.075)	(0.072)	(0.072)	(0.067)	(0.071)	(0.065)
Family size	0.040***	0.014	0.008	0.017*	0.007	-0.001	0.028***	0.011	-0.011
	(0.011)	(0.013)	(0.011)	(0.010)	(0.012)	(0.011)	(0.010)	(0.010)	(0.011)
Asset Ownership									
Farm-land	0.117	0.077	0.125	0.309**	-0.015	0.195	0.018	-0.251*	-0.336**
	(0.167)	(0.177)	(0.132)	(0.140)	(0.160)	(0.161)	(0.129)	(0.139)	(0.147)
Access to Irrigation	0.217	-0.062	-0.035	0.063	0.168	-0.245	0.325**	0.043	0.015
	(0.159)	(0.168)	(0.142)	(0.149)	(0.161)	(0.164)	(0.128)	(0.138)	(0.149)
Cow	-0.001	0.012	0.076	0.015	-0.041	0.024	-0.154**	0.070	0.071
	(0.068)	(0.072)	(0.061)	(0.070)	(0.062)	(0.066)	(0.071)	(0.064)	(0.071)
Buffalo	-0.001	-0.112	-0.110	0.090	0.077	-0.031	-0.025	-0.042	-0.022
	(0.066)	(0.084)	(0.069)	(0.064)	(0.067)	(0.072)	(0.072)	(0.068)	(0.072)
Goat	-0.080	0.051	0.028	-0.163**	-0.034	0.105	-0.121**	-0.030	-0.029
	(0.067)	(0.077)	(0.065)	(0.066)	(0.079)	(0.072)	(0.055)	(0.068)	(0.060)
Agricultural land size (*Kathas*)	0.001	0.002	0.002**	-0.001	0.002***	0.003**	0.002**	-0.0005	-0.0004
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)

Social Capital									
Strong confidence in government	0.297***	-0.080	0.094	0.318***	-0.135	-0.164*	0.256***	-0.018	-0.294***
	(0.110)	(0.096)	(0.097)	(0.086)	(0.086)	(0.091)	(0.072)	(0.082)	(0.087)
Member of farmers' union	-0.033	0.192*	0.177*	0.098	0.215**	-0.089	-0.155	-0.027	-0.037
	(0.094)	(0.100)	(0.093)	(0.101)	(0.109)	(0.119)	(0.095)	(0.110)	(0.100)
Member of a local credit group	0.126	0.058	0.114	-0.126	0.144	0.239***	0.147*	0.160**	0.120
	(0.097)	(0.079)	(0.082)	(0.089)	(0.088)	(0.078)	(0.086)	(0.081)	(0.075)
Block fixed effects									
Rajauli	0.054	0.081	0.140	-0.221	0.627***	0.526***	-0.003	0.103	-0.006
	(0.315)	(0.262)	(0.211)	(0.210)	(0.237)	(0.149)	(0.188)	(0.190)	(0.177)
Roh	-0.404	0.230	0.145	-0.367*	0.342*	0.075	-0.340	-0.311	-0.400*
	(0.285)	(0.249)	(0.154)	(0.216)	(0.180)	(0.143)	(0.212)	(0.225)	(0.241)
Koakol	-0.236	0.463*	0.389*	-0.197	0.333	0.070	-0.816***	0.146	0.082
	(0.316)	(0.254)	(0.200)	(0.244)	(0.223)	(0.278)	(0.217)	(0.219)	(0.239)
Pakribarawan	-0.194	0.074	0.569**	0.277	-0.276	-0.190	-0.570***	0.484***	-0.177
	(0.226)	(0.212)	(0.187)	(0.192)	(0.183)	(0.128)	(0.192)	(0.168)	(0.204)
Kashichak	-0.104	0.144	-0.001	-0.231	-0.127	-0.033	-0.673***	-0.132	-0.399**
	(0.230)	(0.195)	(0.182)	(0.154)	(0.191)	(0.140)	(0.178)	(0.209)	(0.169)
Ghoshi	-0.461*	-0.423	-0.539***	-0.425*	0.564***	0.473**	-0.287	-0.393	-0.799***
	(0.276)	(0.259)	(0.184)	(0.243)	(0.167)	(0.190)	(0.314)	(0.276)	(0.234)
Hulasganj	-0.355	-0.889***	-1.208***	-0.907***	0.490**	0.651***	0.245	0.382	-0.782***
	(0.397)	(0.320)	(0.209)	(0.268)	(0.208)	(0.229)	(0.253)	(0.241)	(0.164)
Jehanabad	-0.902***	-0.565**	-1.056***	-0.904***	0.142	0.269*	-0.434**	-0.370**	-0.729***
	(0.270)	(0.259)	(0.224)	(0.212)	(0.192)	(0.157)	(0.217)	(0.164)	(0.154)

Ratni Faridpur	-0.825***	-0.807***	-1.039***	-0.996***	0.260	0.021	-0.452*	-0.275	-0.742***
	(0.266)	(0.221)	(0.178)	(0.192)	(0.195)	(0.156)	(0.232)	(0.167)	(0.163)
Makhdumpur	-0.758***	-0.982***	-0.329	-0.133	0.608***	0.509***	-0.269	-0.567***	-0.807***
	(0.262)	(0.236)	(0.258)	(0.254)	(0.175)	(0.162)	(0.238)	(0.188)	(0.209)
Modanganj	-0.184	-0.646***	-0.867***	-0.472**	0.435**	0.366*	-0.069	-0.267	-0.650***
	(0.296)	(0.216)	(0.164)	(0.215)	(0.187)	(0.201)	(0.205)	(0.179)	(0.165)
Constant	-0.752*	-0.939**	0.498	-0.054	-1.733***	-0.955***	0.296	0.244	-0.218
	(0.402)	(0.414)	(0.362)	(0.336)	(0.357)	(0.349)	(0.350)	(0.333)	(0.308)
Observations	2977	2977	2977	2977	2977	2977	2977	2977	2977

Notes: Robust standard errors (in parentheses) are clustered at the village level, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 7. Continued

	Rho1	Rho2	Rho3	Rho4	Rho5	Rho6	Rho7	Rho8
Rho2	0.454***							
Rho3	0.123***	0.182***						
Rho4	0.369***	0.189***	0.297***					
Rho5	-0.158***	-0.063	-0.030	-0.182***				
Rho6	-0.147***	-0.0005	-0.055	-0.266***	0.548***			
Rho7	0.248***	0.076*	0.086*	0.327***	0.040	0.035		
Rho8	0.231***	0.026	0.130***	0.209***	-0.194***	-0.155***	0.003	
Rho9	0.165***	0.002	0.044	0.081*	-0.062	-0.134***	-0.268***	0.547***

Likelihood ratio test of rho21 = rho31 = rho41 = rho51 = rho61 = rho71 = rho81 = rho91 = rho32 = rho42 = rho52 = rho62 = rho72 = rho82 = rho92 = rho43 = rho53 = rho63 = rho73 = rho83 = rho93 = rho54 = rho64 = rho74 = rho84 = rho94 = rho65 = rho75 = rho85 = rho95 = rho76 = rho86 = rho96 = rho87 = rho97 = rho98 = 0: $\chi^2(36)$ = 1659.97
Prob. > χ^2= 0.0000; Robust standard errors (in parentheses) are clustered at the village level;
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 8. Correlation among the measures of households' perceived climate change

	Increase in rain	More frequent droughts	More frequent floods	Delay in monsoon season	Monsoon season ending sooner	Increase in the number of hot days	More frequent cyclone
Increase in rain	1						
More frequent droughts	-0.104***	1					
More frequent floods	0.215***	-0.154***	1				
Delay in monsoon season	-0.032*	0.143***	0.153***	1			
Monsoon season ending sooner	-0.298***	0.125***	-0.125***	0.326***	1		
Increase in the number of hot days	-0.026	0.066***	-0.135***	0.004	0.020	1	
More frequent cyclone	-0.044**	0.036**	0.174***	0.084***	0.118***	0.037**	1

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 9. Sensitivity of results to multicollinearity among the measures of households' perceived climate change

Variable	(1) Changed crop type		(2) Built water harvesting scheme		(3) Planted shade trees		(4) Irrigated more		(5) Changed from crop to livestock	
	(1) Full	(2) Reduced	(1) Full	(2) Reduced	(1) Full	(2) Reduced	(1) Full	(2) Reduced	(1) Full	(2) Reduced
Perceived climate variable										
Increase in rain	-0.361***	-0.432***	-0.258**	-0.194	-0.138	0.111	-0.325***	-0.292***	0.020	0.076
	(0.107)	(0.106)	(0.110)	(0.123)	(0.105)	(0.111)	(0.092)	(0.092)	(0.098)	(0.097)
Increase in number of hots day	0.006	0.048	0.259***	0.225**	0.246***	0.105	-0.010	-0.037	-0.051	-0.066
	(0.092)	(0.087)	(0.098)	(0.100)	(0.090)	(0.089)	(0.080)	(0.078)	(0.091)	(0.086)
More frequent droughts	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
More frequent floods	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Delay in monsoon season	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Monsoon season end sooner	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
More frequent cyclone	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No

Table 9. Continued

Variable	(6) Increased number of livestock		(7) Reduced number of livestock		(8) Migrated another area		(9) Found off-farm jobs	
	(1) Full	(2) Reduced	(1) Full	(2) Reduced	(1) Full	(2) Reduced	(1) Full	(2) Reduced
Increase in rain	-0.032	0.014	-0.405***	-0.393***	-0.378***	-0.358***	-0.347***	-0.384***
	(0.101)	(0.098)	(0.096)	(0.091)	(0.118)	(0.122)	(0.090)	(0.095)
Increase in number of hots day	-0.341***	-0.329***	-0.013	-0.023	0.076	0.040	0.351***	0.338***
	(0.090)	(0.091)	(0.091)	(0.091)	(0.087)	(0.098)	(0.090)	(0.092)
More frequent droughts	Yes	No	Yes	No	Yes	No	Yes	No
More frequent floods	Yes	No	Yes	No	Yes	No	Yes	No
Delay in monsoon season	Yes	No	Yes	No	Yes	No	Yes	No
Monsoon season end sooner	Yes	No	Yes	No	Yes	No	Yes	No
More frequent cyclone	Yes	No	Yes	No	Yes	No	Yes	No
Access to Information controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household characteristics controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Asset Ownership controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Social Capital controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Block Fixed Effects controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2977	2997	2977	2997	2977	2997	2977	2997

Notes: Robust standard errors (in parentheses) are clustered at the village level, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

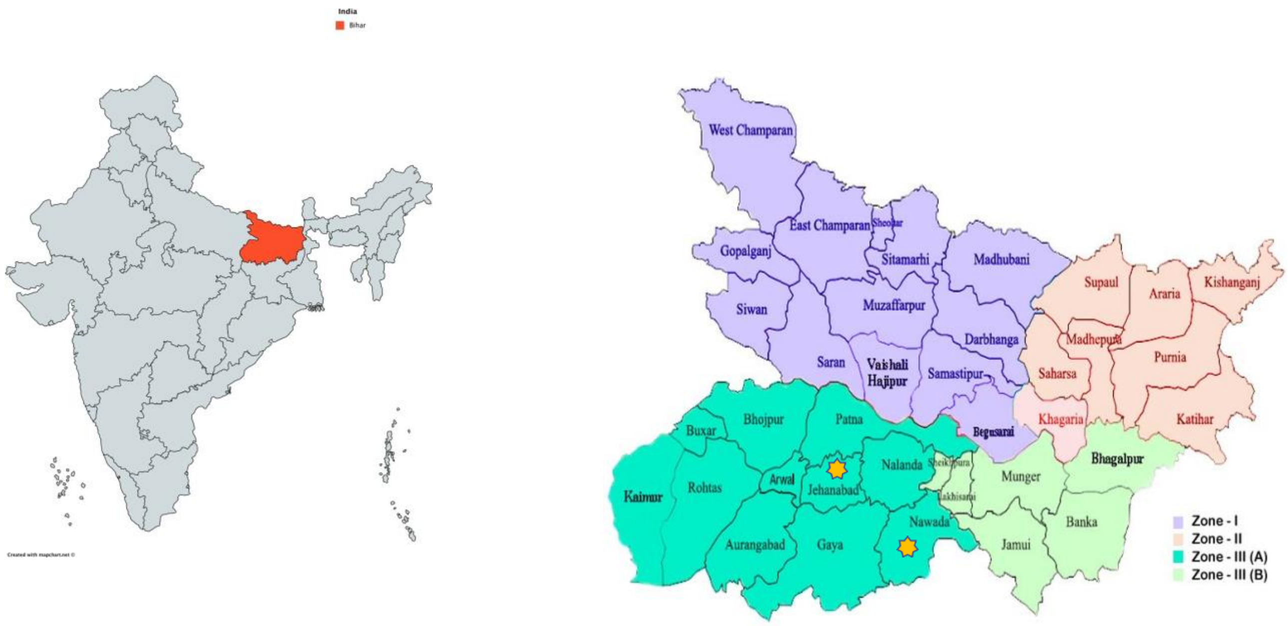


Figure 1. Location of the study area.

Two drought-prone districts of Jehanabad and Nawada are indicated by stars.

Appendix A. Variable Definitions

Variable	Definition
Adaptation choices	
Changed crop variety	Binary
Built water harvesting scheme	Binary
Planted shade trees	Binary
Irrigated more	Binary
Changed from crop to livestock	Binary
Increased number of livestock	Binary
Reduced number of livestock	Binary
Seasonally migrated to another area	Binary
Found off-farm jobs	Binary
Leased your land	Binary
Brought Insurance	Binary

Appendix A. Continued

Variable	Definition
Perceived climate change	
Increase in rain	Binary
More frequent droughts	Binary
Delay in monsoon season	Binary
Monsoon season end sooner	Binary
Increase in the number of hot days	Binary
More frequent cyclone	Binary
Access to Information	
Information about onset of monsoon	Binary
Information about amount of rain	Binary
Demographics	
Male-headed household	Binary
Age of household Head	Years
Education level of Head	Binary. 1 if Head's education is at least high school
Family size	Number of people
Asset Ownership	
Own Farm land	Binary
Access to Irrigation	Binary
Cow	Binary
Buffalo	Binary
Goat	Binary
Agricultural land holding size	In *Kathas*

Social capital	
Strong confidence in government	Binary
Member of farmers union	Binary
Member of a local credit group	Binary

Appendix 2. Robustness of perceived climate variable for adaptation strategy *Migrated to another area*.

Variable	1	1b	1c	1d	1e	1f	1g	Jointly
Perceived climate variable								
Increase in rain	-0.362***	-0.364***	-0.294**	-0.290**	-0.288**	-0.359***	-0.366***	-0.378***
	(0.126)	(0.126)	(0.125)	(0.126)	(0.127)	(0.123)	(0.125)	(0.118)
Delay in monsoon season		-0.008	-0.114	-0.114	-0.112	-0.012	-0.004	-0.057
		(0.080)	(0.080)	(0.081)	(0.083)	(0.078)	(0.077)	(0.078)
Monsoon season end sooner			0.305***	0.304***	0.303***	0.374***	0.346***	0.365***
			(0.079)	(0.077)	(0.077)	(0.078)	(0.076)	(0.075)
Increase in number of hots day				0.055	0.054	0.095	0.085	0.076
				(0.100)	(0.100)	(0.088)	(0.088)	(0.087)
More frequent floods					-0.010	-0.106	-0.181**	-0.189**
					(0.076)	(0.078)	(0.080)	(0.077)
More frequent droughts						-0.767***	-0.794***	-0.801***
						(0.101)	(0.103)	(0.104)
More frequent cyclone							0.394***	0.342***
							(0.116)	(0.108)
Access to Information controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household characteristics controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Asset Ownership controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Social Capital controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Block Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3007	3003	3001	2998	2998	2998	2978	2977

Notes: Columns 1a – 1g computed as a univariate probit model clustered at village level and 1g is the full model, whereas, Jointly refers to multivariate probit full model and here results are presented only for the most frequent adaptation choice Migrated to another area; Robust standard errors (in parentheses) are clustered at village level, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Appendix 3.1. Multivariate probit regression of adaptation choice *Changed crop type*.

Variable	I	II	III	IV	V	VI	VII
Perceived climate variable							
Increase in rain	-0.430***	-0.460***	-0.394***	-0.404***	-0.379***	-0.358***	-0.361***
	(0.106)	(0.109)	(0.105)	(0.104)	(0.108)	(0.107)	(0.107)
Delay in monsoon season		-0.484***	-0.567***	-0.561***	-0.535***	-0.540***	-0.551***
		(0.101)	(0.099)	(0.100)	(0.102)	(0.100)	(0.098)
Monsoon season end sooner			0.216**	0.212**	0.203**	0.195**	0.198**
			(0.094)	(0.093)	(0.092)	(0.091)	(0.092)
Increase in number of hots day				0.044	0.028	0.009	0.006
				(0.089)	(0.094)	(0.093)	(0.092)
More frequent floods					-0.133	-0.141	-0.137
					(0.101)	(0.101)	(0.096)
More frequent droughts						0.097	0.084
						(0.119)	(0.119)
More frequent cyclone							0.024
							(0.135)
Access to Information controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household characteristics controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Asset Ownership controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Social Capital controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Block Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3006	3002	3000	2997	2997	2997	2977

Notes: Columns I – VII are multivariate probit model with VII as full model and here results are presented for only adaptation choice *Changed crop type*; Robust standard errors (in parentheses) are clustered at the village level, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Appendix 3.2. Multivariate probit regression of adaptation choice *Built water harvesting scheme*.

Variable	I	II	III	IV	V	VI	VII
Perceived climate variable							
Increase in rain	-0.214	-0.207	-0.210*	-0.193*	-0.291***	-0.250**	-0.258**
	(0.132)	(0.126)	(0.122)	(0.114)	(0.112)	(0.108)	(0.110)
Delay in monsoon season		0.080	0.109	0.113	0.016	-0.007	0.002
		(0.085)	(0.084)	(0.083)	(0.089)	(0.087)	(0.087)
Monsoon season end sooner			-0.062	-0.077	-0.030	-0.050	-0.077
			(0.084)	(0.084)	(0.086)	(0.086)	(0.086)
Increase in number of hots day				0.234**	0.315***	0.285***	0.259***
				(0.099)	(0.102)	(0.099)	(0.098)
More frequent floods					0.465***	0.474***	0.431***
					(0.089)	(0.085)	(0.082)
More frequent droughts						0.229*	0.244**
						(0.117)	(0.121)
More frequent cyclone							0.265**
							(0.118)
Access to Information controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household characteristics controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Asset Ownership controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Social Capital controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Block Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3006	3002	3000	2997	2997	2997	2977

Notes: Columns I – VII are multivariate probit model with VII as full model and here results are presented for only adaptation choice *Built water harvesting scheme*; Robust standard errors (in parentheses) are clustered at the village level, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Appendix 3.3. Multivariate probit regression of adaptation choice *Planted shade trees.*

Variable	I	II	III	IV	V	VI	VII
Perceived climate variable							
Increase in rain	0.096	0.100	0.043	0.056	-0.074	-0.119	-0.138
	(0.111)	(0.108)	(0.108)	(0.108)	(0.106)	(0.103)	(0.105)
Delay in monsoon season		-0.012	0.065	0.066	-0.061	-0.025	-0.033
		(0.082)	(0.080)	(0.079)	(0.079)	(0.077)	(0.076)
Monsoon season end sooner			-0.215***	-0.217***	-0.173**	-0.152**	-0.164**
			(0.074)	(0.073)	(0.072)	(0.071)	(0.072)
Increase in number of hots day				0.120	0.211**	0.246***	0.246***
				(0.088)	(0.090)	(0.088)	(0.090)
More frequent floods					0.585***	0.563***	0.533***
					(0.082)	(0.080)	(0.079)
More frequent droughts						-0.345***	-0.351***
						(0.094)	(0.096)
More frequent cyclone							0.317***
							(0.121)
Access to Information controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household characteristics controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Asset Ownership controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Social Capital controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Block Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3006	3002	3000	2997	2997	2997	2977

Notes: Columns I – VII are multivariate probit model with VII as full model and here results are presented for only adaptation choice *Planted shade trees*; Robust standard errors (in parentheses) are clustered at the village level, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Appendix 3.4. Multivariate probit regression of adaptation choice *Irrigated more*.

Variable	I	II	III	IV	V	VI	VII
Perceived climate variable							
Increase in rain	-0.284***	-0.318***	-0.297***	-0.296***	-0.285***	-0.314***	-0.325***
	(0.092)	(0.093)	(0.092)	(0.092)	(0.092)	(0.092)	(0.092)
Delay in monsoon season		-0.333***	-0.340***	-0.338***	-0.325***	-0.289***	-0.300***
		(0.065)	(0.069)	(0.069)	(0.070)	(0.071)	(0.071)
Monsoon season end sooner			0.016	0.022	0.014	0.032	0.055
			(0.073)	(0.072)	(0.073)	(0.073)	(0.073)
Increase in number of hots day				-0.042	-0.051	-0.034	-0.010
				(0.079)	(0.078)	(0.078)	(0.080)
More frequent floods					-0.062	-0.093	-0.050
					(0.070)	(0.070)	(0.071)
More frequent droughts						-0.307***	-0.309***
						(0.095)	(0.095)
More frequent cyclone							-0.151
							(0.107)
Access to Information controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household characteristics controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Asset Ownership controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Social Capital controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Block Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3006	3002	3000	2997	2997	2997	2977

Notes: Columns I – VII are multivariate probit model with VII as full model and here results are presented for only adaptation choice *Irrigated more*; Robust standard errors (in parentheses) are clustered at the village level, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Appendix 3.5. Multivariate probit regression of adaptation choice *Changed from crop to livestock*.

Variable	I	II	III	IV	V	VI	VII
Perceived climate variable							
Increase in rain	0.068	0.080	0.053	0.051	0.008	0.029	0.020
	(0.097)	(0.096)	(0.097)	(0.097)	(0.097)	(0.098)	(0.098)
Delay in monsoon season		0.314***	0.344***	0.350***	0.307***	0.275***	0.277***
		(0.076)	(0.078)	(0.078)	(0.079)	(0.078)	(0.082)
Monsoon season end sooner			-0.088	-0.098	-0.074	-0.087	-0.121
			(0.072)	(0.072)	(0.071)	(0.073)	(0.074)
Increase in number of hots day				-0.052	-0.016	-0.025	-0.051
				(0.089)	(0.088)	(0.089)	(0.091)
More frequent floods					0.261***	0.294***	0.225***
					(0.083)	(0.085)	(0.084)
More frequent droughts						0.260***	0.255***
						(0.086)	(0.087)
More frequent cyclone							0.400***
							(0.126)
Access to Information controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household characteristics controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Asset Ownership controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Social Capital controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Block Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3006	3002	3000	2997	2997	2997	2977

Notes: Columns I – VII are multivariate probit model with VII as full model and here results are presented for only adaptation choice *Changed from crop to livestock*; Robust standard errors (in parentheses) are clustered at the village level, $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Appendix 3.6. Multivariate probit regression of adaptation choice *Increased number of livestock*.

Variable	I	II	III	IV	V	VI	VII
Perceived climate variable							
Increase in rain	0.020	0.040	0.020	-0.005	-0.041	-0.023	-0.032
	(0.098)	(0.096)	(0.102)	(0.100)	(0.103)	(0.102)	(0.101)
Delay in monsoon season		0.240***	0.247***	0.245***	0.208***	0.177**	0.188**
		(0.071)	(0.074)	(0.074)	(0.075)	(0.072)	(0.076)
Monsoon season end sooner			-0.055	-0.058	-0.037	-0.049	-0.072
			(0.074)	(0.074)	(0.074)	(0.075)	(0.079)
Increase in number of hots day				-0.322***	-0.296***	-0.306***	-0.341***
				(0.091)	(0.090)	(0.088)	(0.090)
More frequent floods					0.205**	0.239***	0.149*
					(0.084)	(0.085)	(0.084)
More frequent droughts						0.255***	0.230**
						(0.093)	(0.095)
More frequent cyclone							0.436***
							(0.110)
Access to Information controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household characteristics controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Asset Ownership controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Social Capital controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Block Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3006	3002	3000	2997	2997	2997	2977

Notes: Columns I – VII are multivariate probit model with VII as full model and here results are presented for only adaptation choice *Increased number of livestock*; Robust standard errors (in parentheses) are clustered at the village level, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Appendix 3.7. Multivariate probit regression of adaptation choice *Reduced number of livestock*.

Variable	I	II	III	IV	V	VI	VII
Perceived climate variable							
Increase in rain	-0.372***	-0.407***	-0.384***	-0.395***	-0.395***	-0.413***	-0.405***
	(0.093)	(0.094)	(0.094)	(0.093)	(0.095)	(0.096)	(0.096)
Delay in monsoon season		-0.534***	-0.569***	-0.565***	-0.563***	-0.541***	-0.536***
		(0.067)	(0.067)	(0.067)	(0.069)	(0.068)	(0.067)
Monsoon season end sooner			0.079	0.082	0.081	0.094	0.100
			(0.073)	(0.074)	(0.073)	(0.073)	(0.072)
Increase in number of hots day				-0.032	-0.033	-0.021	-0.013
				(0.092)	(0.090)	(0.090)	(0.091)
More frequent floods					-0.004	-0.025	-0.006
					(0.084)	(0.080)	(0.084)
More frequent droughts						-0.204**	-0.208**
						(0.101)	(0.100)
More frequent cyclone							-0.150
							(0.121)
Access to Information controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household characteristics controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Asset Ownership controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Social Capital controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Block Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3006	3002	3000	2997	2997	2997	2977

Notes: Columns I – VII are multivariate probit model with VII as full model and here results are presented for only adaptation choice *Reduced number of livestock*; Robust standard errors (in parentheses) are clustered at the village level, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Appendix 3.8. Multivariate probit regression of adaptation choice *Migrated to another area*.

Variable	I	II	III	IV	V	VI	VII
Perceived climate variable							
Increase in rain	-0.355***	-0.369***	-0.301**	-0.288**	-0.280**	-0.356***	-0.378***
	(0.121)	(0.121)	(0.120)	(0.119)	(0.120)	(0.116)	(0.118)
Delay in monsoon season		-0.045	-0.157*	-0.157*	-0.147*	-0.056	-0.057
		(0.079)	(0.080)	(0.080)	(0.081)	(0.077)	(0.078)
Monsoon season end sooner			0.313***	0.320***	0.315***	0.388***	0.365***
			(0.078)	(0.077)	(0.077)	(0.075)	(0.075)
Increase in number of hots day				0.026	0.021***	0.066	0.076
				(0.096)	(0.096)	(0.087)	(0.087)
More frequent floods					-0.043	-0.137*	-0.189**
					(0.074)	(0.076)	(0.077)
More frequent droughts						-0.776***	-0.801***
						(0.102)	(0.104)
More frequent cyclone							0.342***
							(0.108)
Access to Information controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household characteristics controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Asset Ownership controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Social Capital controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Block Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3006	3002	3000	2997	2997	2997	2977

Notes: Columns I – VII are multivariate probit model with VII as full model and here results are presented for only adaptation choice *Migrated to another area*; Robust standard errors (in parentheses) are clustered at the village level, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Appendix 3.9. Multivariate probit regression of adaptation choice *Found Off-farm Jobs.*

Variable	I	II	III	IV	V	VI	VII
Perceived climate variable							
Increase in rain	-0.413***	-0.413***	-0.322***	-0.289***	-0.270***	-0.313***	-0.347***
	(0.091)	(0.093)	(0.093)	(0.094)	(0.094)	(0.091)	(0.090)
Delay in monsoon season		0.250***	0.107	0.116	0.141*	0.210***	0.217***
		(0.076)	(0.079)	(0.079)	(0.077)	(0.074)	(0.072)
Monsoon season end sooner			0.378***	0.377***	0.364***	0.403***	0.381***
			(0.096)	(0.095)	(0.095)	(0.091)	(0.089)
Increase in number of hots day				0.321***	0.304***	0.343***	0.351***
				(0.090)	(0.092)	(0.088)	(0.090)
More frequent floods					-0.120	-0.177**	-0.177**
					(0.082)	(0.086)	(0.089)
More frequent droughts						-0.504***	-0.473***
						(0.099)	(0.100)
More frequent cyclone							0.040
							(0.130)
Access to Information controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household characteristics controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Asset Ownership controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Social Capital controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Block Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3006	3002	3000	2997	2997	2997	2977

Notes: Columns I – VII are multivariate probit model with VII as full model and here results are presented for only adaptation choice *Found Off-farm Jobs;* Robust standard errors (in parentheses) are clustered at the village level, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Appendix 4. Multivariate probit regression of adaptation choices.

Variable	(1) Changed crop type	(2) Planted shade trees	(3) Irrigated more	(4) Changed from crop to livestock	(5) Increased number of livestock	(6) Reduced number of livestock	(7) Migrated another area	(8) Found off-farm jobs
Perceptions about climate variable								
Increase in rain	-0.345***	-0.140	-0.318***	0.018	-0.020	-0.396***	-0.375***	-0.326***
	(0.105)	(0.105)	(0.092)	(0.098)	(0.102)	(0.096)	(0.118)	(0.090)
More frequent droughts	0.080	-0.349***	-0.298***	0.249***	0.235**	-0.199**	-0.793***	-0.465***
	(0.120)	(0.097)	(0.095)	(0.087)	(0.094)	(0.099)	(0.104)	(0.099)
More frequent floods	-0.139	0.531***	-0.057	0.223***	0.152*	-0.002	-0.199**	-0.170*
	(0.098)	(0.079)	(0.070)	(0.085)	(0.084)	(0.084)	(0.077)	(0.087)
Delay in monsoon season	-0.547***	-0.039	-0.302***	0.287***	0.187**	-0.539***	-0.058	0.222***
	(0.099)	(0.076)	(0.071)	(0.081)	(0.075)	(0.066)	(0.078)	(0.073)
Monsoon season end sooner	0.190**	-0.162**	0.058	-0.125*	-0.084	0.098	0.365***	0.379***
	(0.092)	(0.071)	(0.072)	(0.075)	(0.077)	(0.071)	(0.075)	(0.090)
Increase in number of hots day	-0.002	0.240***	-0.009	-0.054	-0.340***	-0.009	0.064	0.336***
	(0.091)	(0.090)	(0.079)	(0.091)	(0.089)	(0.092)	(0.086)	(0.089)
More frequent cyclone	0.023	0.321***	-0.149	0.405***	0.439***	-0.152	0.334***	0.046
	(0.134)	(0.121)	(0.106)	(0.126)	(0.110)	(0.121)	(0.108)	(0.130)
Access to Information								
Information about **onset** of monsoon	0.494***	-0.053	0.396***	-0.078	-0.161	-0.053	0.348***	0.394***
	(0.123)	(0.093)	(0.100)	(0.104)	(0.105)	(0.118)	(0.118)	(0.106)
Information about **amount** of rain	0.118	0.265***	0.253***	0.080	0.179*	0.408***	0.056	0.054
	(0.107)	(0.089)	(0.087)	(0.109)	(0.107)	(0.109)	(0.100)	(0.084)

Household characteristics								
Male head	0.046	-0.321**	0.025	0.036	0.109	-0.130	0.107	0.259***
	(0.100)	(0.129)	(0.115)	(0.097)	(0.100)	(0.109)	(0.103)	(0.096)
Head age	0.004	-0.032***	0.009	0.004	-0.021	0.005	0.006	0.010
	(0.012)	(0.011)	(0.011)	(0.013)	(0.013)	(0.012)	(0.012)	(0.012)
Age square	-0.00004	0.0003**	-0.0001	-0.00003	0.0002	-0.00007	-0.00003	-0.00005
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Education	-0.004	-0.053	-0.036	-0.040	0.019	-0.001	0.036	0.001
	(0.078)	(0.073)	(0.075)	(0.073)	(0.072)	(0.067)	(0.071)	(0.065)
Family size	0.039***	0.007	0.016	0.007	-0.001	0.026***	0.011	-0.010
	(0.011)	(0.011)	(0.010)	(0.012)	(0.011)	(0.010)	(0.011)	(0.011)
Asset Ownership								
Farm-land	0.111	0.135	0.311**	-0.023	0.187	0.022	-0.251*	-0.321**
	(0.163)	(0.130)	(0.141)	(0.157)	(0.156)	(0.128)	(0.140)	(0.149)
Access to Irrigation	0.226	-0.042	0.070	0.170	-0.254	0.321**	0.058	0.010
	(0.156)	(0.140)	(0.148)	(0.159)	(0.162)	(0.126)	(0.140)	(0.149)
a) Cow	0.002	0.066	0.012	-0.043	0.026	-0.151**	0.073	0.068
	(0.068)	(0.060)	(0.069)	(0.062)	(0.066)	(0.070)	(0.064)	(0.070)
b) Buffalo	0.007	-0.111	0.082	0.090	-0.035	-0.026	-0.046	-0.023
	(0.066)	(0.068)	(0.064)	(0.066)	(0.071)	(0.072)	(0.068)	(0.072)
c) Goat	-0.090	0.025	-0.165**	-0.031	0.106	-0.120**	-0.034	-0.027
	(0.068)	(0.065)	(0.066)	(0.080)	(0.071)	(0.054)	(0.069)	(0.061)
Agricultural land size (*Kathas*)	0.001	0.002**	-0.001	0.002***	0.003**	0.002**	-0.001	-0.0003
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)

Social Capital								
Strong confidence in government	0.296***	0.089	0.321***	-0.139	-0.173*	0.261***	-0.007	-0.293***
	(0.111)	(0.097)	(0.085)	(0.085)	(0.091)	(0.071)	(0.082)	(0.088)
Member of farmers' union	-0.036	0.166*	0.074	0.224**	-0.057	-0.181*	-0.052	-0.015
	(0.095)	(0.092)	(0.100)	(0.110)	(0.116)	(0.093)	(0.109)	(0.102)
Member of a local credit group	0.134	0.116	-0.115	0.139	0.236***	0.161*	0.169**	0.134*
	(0.096)	(0.082)	(0.089)	(0.086)	(0.077)	(0.087)	(0.083)	(0.074)
Block fixed effects								
Rajauli	0.059	0.140	-0.209	0.629***	0.524***	0.003	0.115	-0.001
	(0.312)	(0.213)	(0.210)	(0.232)	(0.143)	(0.187)	(0.189)	(0.171)
Roh	-0.401	0.144	-0.367*	0.338*	0.052	-0.314	-0.299	-0.418*
	(0.280)	(0.156)	(0.209)	(0.179)	(0.141)	(0.205)	(0.224)	(0.233)
Koakol	-0.233	0.384*	-0.195	0.329	0.067	-0.790***	0.170	0.087
	(0.311)	(0.201)	(0.244)	(0.221)	(0.275)	(0.213)	(0.220)	(0.235)
Pakribarawan	-0.200	0.573***	0.285	-0.297	-0.229*	-0.549***	0.494***	-0.173
	(0.222)	(0.187)	(0.190)	(0.182)	(0.127)	(0.189)	(0.168)	(0.205)
Kashichak	-0.085	0.009	-0.203	-0.137	-0.049	-0.648***	-0.105	-0.372**
	(0.227)	(0.182)	(0.149)	(0.183)	(0.134)	(0.174)	(0.207)	(0.165)
Ghoshi	-0.460*	-0.552***	-0.430*	0.548***	0.452**	-0.276	-0.377	-0.800***
	(0.274)	(0.187)	(0.242)	(0.167)	(0.188)	(0.312)	(0.276)	(0.235)
Hulasganj	-0.350	-1.196***	-0.911***	0.490**	0.650***	0.257	0.396	-0.744***
	(0.391)	(0.209)	(0.274)	(0.208)	(0.226)	(0.255)	(0.243)	(0.161)
Jehanabad	-0.893***	-1.032***	-0.870***	0.133	0.254	-0.403*	-0.326**	-0.711***
	(0.267)	(0.224)	(0.206)	(0.189)	(0.159)	(0.213)	(0.162)	(0.150)
Ratni Faridpur	-0.837***	-1.030***	-0.990***	0.265	0.022	-0.454**	-0.257	-0.745***

	(0.267)	(0.177)	(0.187)	(0.192)	(0.159)	(0.230)	(0.167)	(0.162)
Makhdumpur	-0.768***	-0.339	-0.121	0.607***	0.499***	-0.263	-0.548***	-0.803***
	(0.259)	(0.260)	(0.252)	(0.172)	(0.156)	(0.238)	(0.190)	(0.206)
Modanganj	-0.180	-0.864***	-0.459**	0.446**	0.372*	-0.046	-0.248	-0.662***
	(0.293)	(0.165)	(0.206)	(0.185)	(0.202)	(0.201)	(0.178)	(0.159)
Constant	-0.679*	0.485	-0.086	-1.705***	-0.948***	0.233	0.232	-0.211
	(0.395)	(0.363)	(0.334)	(0.361)	(0.348)	(0.347)	(0.336)	(0.313)
Observations	2977	2977	2977	2977	2977	2977	2977	2977

Notes: Multivariate probit regression computed with a replication value at 60 as input to *mvprobit* program;
Robust standard errors (in parentheses) are clustered at the village level, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 5.10. Continued

	Rho1	Rho2	Rho3	Rho4	Rho5	Rho6	Rho7
Rho2	0.129***						
Rho3	0.422***	0.340***					
Rho4	-0.199***	-0.027	-0.231***				
Rho5	-0.159***	-0.054	-0.297***	0.587***			
Rho6	0.305***	0.109**	0.367***	0.053	0.057		
Rho7	0.266***	0.149***	0.204***	-0.183***	-0.164***	-0.018	
Rho8	0.196***	0.039	0.089*	-0.016	-0.138**	-0.304***	0.592***

Likelihood ratio test of rho21 = rho31 = rho41 = rho51 = rho61 = rho71 = rho81 = rho32 = rho42 = rho52 = rho62 = rho72 = rho82 = rho43 = rho53 = rho63 = rho73 = rho83 = rho54 = rho64 = rho74 = rho84 = rho65 = rho75 = rho85 = rho76 = rho86 = rho87 = 0: chi2(28) = 1587.63 Prob. > chi2 = 0.0000; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Figure 2. Households' perceived climate change

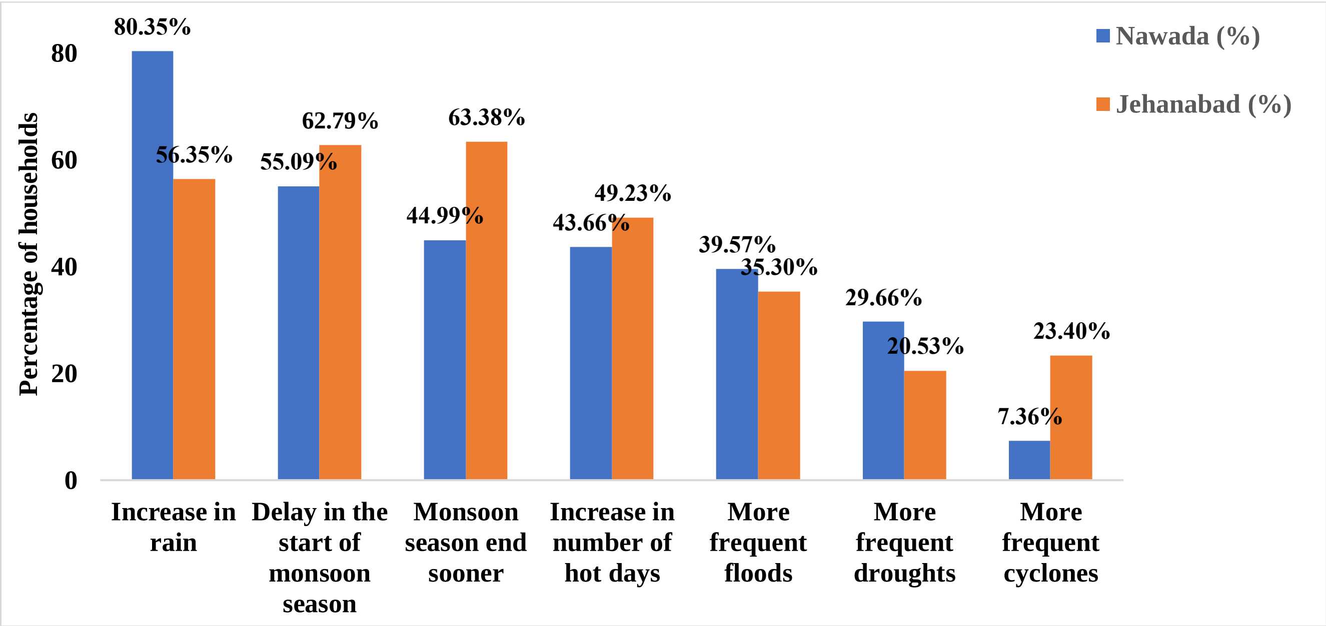
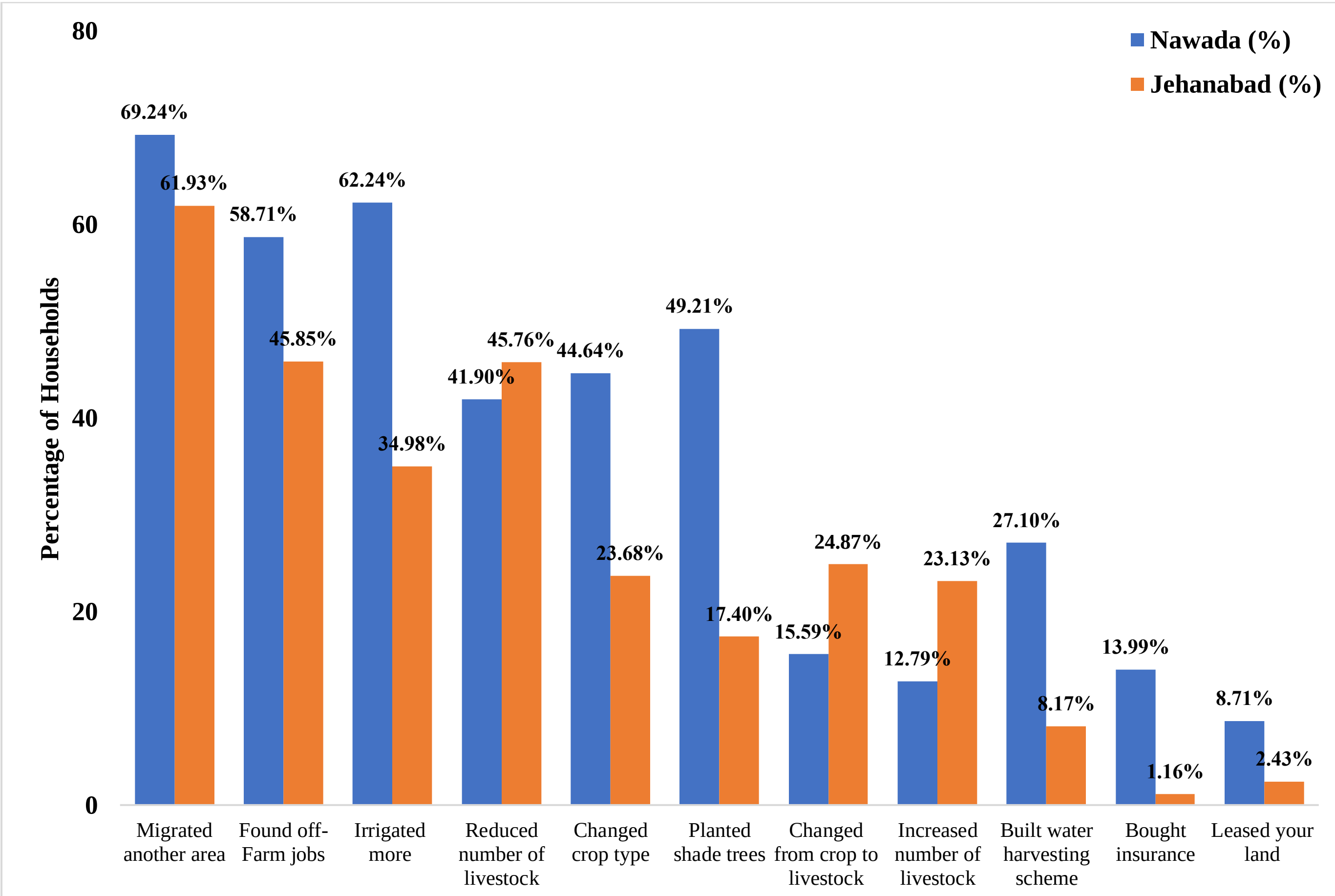


Figure 3. Households reported adaptation strategies



Essay 2

Perceived Climate Change and Adaptation of Rural Livelihoods: Results from a Flood-Prone Region of India

Abstract

Using a survey data on 3,300 representative households from a flood-prone region of India, we examine the impacts of households' perceived climate change on their livelihoods adaptation choice. The livelihoods adaptation choices are jointly modeled as the multivariate probit regression estimated by the simulated likelihoods estimation procedure. The main results are as follows. The households who perceived delay in the monsoon season were more likely to plant shade trees, irrigate, reduced the number of livestock, seasonally migrate to other areas and find off-farm jobs. Among the other factors of livelihoods adaptation choice, male-headed households were more likely to find off-farm jobs. The ownership of agricultural land matters in the determination of adaptation choice. The households who own agricultural land are more likely to change crop, irrigated and change from crop to livestock. The landholding size has positive impact on number of livestock. These results are suggestive of kind of livelihoods adaptation strategies that can be pursued in flood-prone agro-climate regions.

Keywords: climate change perceptions; climate adaptation; flood-prone regions; Bihar, India

1. Introduction

Rural livelihoods are directly linked to local agro-climatic conditions. With climate change, agro-climatic conditions are changing, which pose new risks to rural livelihoods. Therefore, climate-resilience of the rural livelihoods are tied to effective climate risks management strategies (IPCC, 2007, 2012). Climate services, which provide relevant climate related information and knowledge to communities and decision makers, are seen as an important part of improving the management of climate-related risks. Climate services seeks to improve decision making by providing historical information (Hansen et al. 2011; Meza, Hansen, and Osgood 2008), and long-term climate projections. The idea is that climate services would improve household decisions by informing them of climate change. But, this will be true only if households adapt their livelihood decisions to perceived climate change, which can be either self-realized or informed by climate services and other interventions. Climate adaptation, however, is poorly understood (Abiddoye, Kurukulasuriya and Mendesohn, 2017; Nhemachena and Hassan 2008), particularly, climate adaptation in response to perceived changes in climate. In this study, we systematically investigate the impacts of households' perceived climate change on adaptation of livelihoods. India, where roughly half the country's population is engaged in agriculture, the impact of climate change on agriculture is likely to be negative (e.g. negative impact on yield, depress consumption among the poor) over short-to medium-term (Guiteras 2007).

In this paper, we study the impacts of households' perceived climate change on their livelihoods adaptation choice. The data is representative of rural households from the flood-prone part of Bihar, India. Specifically, we utilize 3,300 household survey data from two flood-prone districts of Darbhanga and East Champaran. Bihar has the least capacity compared to other Indian states to cope with climate shocks. Furthermore, there are distinct challenges to climate adaptation in rural Bihar such as social, cultural, institutional, and geographical characteristics have made some communities particularly vulnerable to climate risks. At the household level, poverty, illiteracy among adults and poor school enrollment for children, limited access to credit from institutionalized sources (e.g. Banks, Cooperatives, etc.), moneylenders lending money at usurious rates, and inadequate and untimely access to climate information have limped the ability to confront the climate shocks. The survey identifies household climate-induced stresses and formulate questions such as over the last 5 years have they noticed climate change such as increase in rain, more frequent droughts, floods, cyclones, increase in the number of hot days, recent erratic pattern of monsoon season that is delayed at the start of monsoon season and monsoon season ending sooner. If households perceived one of the above changes, they were asked a follow up set of questions relating to how they adapted to that specific change. For example, the adaptive measures were changed crop variety, built water harvesting scheme, planted shade trees, changed from crop to livestock, found off farm jobs, or migrated to another area, etc. This paper aims to contribute to formulating targeted government policies to enable effective adaptation among rural agricultural households.

The next section discusses the selection of an area of study, and section 3 describes the data used in the study. Section 4 presents the empirical framework and selection of variables to include in the analysis and hypothesis to be tested. Section 5 presents results, and discussion and conclusion of the study are given in the final section.

2. Context and Data

The study area is the two districts namely Darbhanga and East Champaran which is located in the Flood Prone Area of Bihar state as shown in Figure 1. Darbhanga and East Champaran are having a geographical area of 2279 Sq. Km and 3968 Sq. Km respectively. The average annual rainfall[1] in Darbhanga is 1142 mm and that of East Champaran district is 1241 mm. The maximum rainfall in the both districts comes from a Southwest monsoon season of June till September. The mean maximum temperature in the both the districts of Darbhanga and East Champaran roughly varies from 33 to 46 degrees Celsius and minimum temperature varies from 5 to 16 degrees Celsius. Both the districts come under the Agro-Climatic Zone I[2], Northern West, due to near flatness of landscape, vast area get flooded during rains. The average literacy rate[3] of Darbhanga in 2011 was 44.32% of which males and females were about 57.18% and

[1] Official website of Darbhanga and East Champaran
[2] Government of Bihar; Available at: http://krishi.bih.nic.in/introduction.htm
[3] Census of India, 2011

30.35% respectively, while in East Champaran the average literacy rate as per census 2011 was 58.26% of which males and females were about 68% and 47% respectively.

As per Census of India, 2011, Darbhanga and East Champaran with a population of 3,937,385 and 5,099,371 in Bihar, accounts for 3.78 and 4.90 percent of the state's population. As of 2011, East Champaran is the second most populous district of Bihar. In Darbhanga, the workforce participation rate is about 31%, whereas in the district of East Champaran is about 34%. Table 1 and 2 reports the workforce participation rates for districts Darbhanga and East Champaran respectively. In both districts of Darbhanga and East Champaran more than 90% of the workforce are engaged in the rural areas. Individuals who are part of the workforce could be working for at least 6 months a year, or 3–6 months a year or 0-3 months a year. Any individual who works for at least a year is considered to be a main worker while those working for less than 6 months a year are considered marginal workers. Both districts have about 15% of the workforce as main workers working as cultivators. In both districts about same 16% of main workers working as cultivators in rural areas. In Darbhanga, about 26% of the main workers working as agricultural labor, whereas in the district of East Champaran the figure is about 37%. A higher percent of main workers working as agricultural labor in rural areas of East Champaran than Darbhanga. In both districts, less than 5% of marginal workers working as cultivators. In Darbhanga, about 28% of marginal workers working as agricultural labor while in East Champaran the figure is about 25%. In both districts, the rural areas engage larger percentage of marginal workers as agricultural labor than Urban areas. Cumulatively, in the district of Darbhanga about 72% of the labor force are engaged in the agriculture for their livelihood. The figure is 81% in the district of East Champaran. Many have no land of their own and manage to support the livelihoods by working on other people's rice paddies. When the paddies are under several feet of water, there is no work.[4] Based on the flood reportage, these areas lie south of the India-Nepal border, and water coursing through Himalayan rivers had nowhere to go. Nepal opened a huge dam up river, sending a torrent downstream.

2.1. Sample Design and Data

We use data on 3,300 households survey from two flood-prone districts of Darbhanga East Champaran in Bihar. We use data on perceptions of climate change and adaptations made in response to them. In this paper, two flood prone districts of Darbhanga and East Champaran are chosen to analyze the impact of perceived climate change on livelihood adaptations. An individual rural household is considered as a primary sampling unit. A multi-stage stratified systemic sampling techniques were used to select samples from the target population. This technique includes 6 blocks per district, 11 villages per block, and 25 randomly selected households per village that is, it is translated into sample size of 25*11*6*2 = 3,300.

A total of 3300 households were interviewed from both flood prone districts namely Darbhanga and East Champaran, of which 96% were male-headed with 49 years as the average age. The overall average household size of the sampled population was 6, which is larger than the average size of 5 persons per household in the Bihar state[5]. Only about 17% of the household head had an education level higher than high school. About 38% of households own farmland and about 30% of households have access to irrigation. Cows were the most popular animal as livestock with 29% of households owning them followed by buffaloes and goats having roughly the same percent that is 20%. The average land holding size was 7.22 *kathas* that is

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[4] Flood Reportage;
Available at https://www.nytimes.com/2017/09/07/world/asia/bihar-india-monsoon-floods.html

[5] Census of India, 2011

approximately 0.09 hectares and thus can easily be identified as marginal farmers[6]. More than half of the sampled households had strong confidence in the government. About one-tenth of households were the members of a local credit group, and less than 5% of households were members of a local farmers' union. About 43% of respondents believed that in recent five years there is an increase in rain and about equal percent of households perceived delay in the monsoon season, shortening of monsoon, and increased number of hot days with figure 73%, 72%, and 70% respectively. About 46% of households perceived more frequent droughts, 21% more frequent floods, and 28% more frequent cyclones. The neighbors and or relatives (41%) and Television and or radio (19%) were the main sources of climate related information. Less than 5% of households received climate information from agricultural extension agents. Other least popular sources of climate related information were Cooperatives and Producer's Associations (less than 1%). Cumulatively, about 66% of the households received information about the onset of monsoon season and about 39% of the households received information about the amount of rain before planting season. Detail figures are given in Table 4.

3. Empirical Strategy

In this paper, three questions are of interest. First, Is there a relationship between household perceptions about climate change and climate adaptation? Second, Are adaptation strategies related to the households demographic and other control variable? Third, Is the link between household perceptions about climate change and climate adaptation dependent on certain household demographic and other control variables?

[6] Households with marginal (< 1 ha), small (1 – 2 ha), large (> 4 ha) land holdings; Agricultural Census Commissioner, Government of India, 2010 – 2011.
Approximately, 2 bighas make an acre and 20 kathas make a bigha.

Given that we investigate several adaptation choices that might be correlated with one or more choices, the multivariate probit model is employed to analyze the link between perceptions about climate change and climate adaptation behavior of households. The correlation between the different multiple options is the main source of the correlation between error terms (Belderbos et al. 2004). This study uses multivariate probit econometric technique that could eliminate these correlations (Huguenin, Pelgrin, and Holly 2009; Nhemachena and Hassan 2008). The multivariate probit model simultaneously models the influence of the set of explanatory variables on each of the different options and allow error terms to be freely correlated (Golob and Regan 2002; Lin, Jensen, and Yen 2005). Furthermore, the multivariate probit model allows a flexible correlation structure for the unobservable variables (Huguenin, Pelgrin, and Holly 2009).

Following (Cappellari and Jenkins 2003), the multivariate probit econometric approach used for this study is as follows:

$y^*_{ivbm} = \beta'_m X_{ivbm} + \alpha_b + \epsilon_{ivbm}$, i = 1,…,25; v = 1,…,132; b = 1,…,12; m = 1,…,8

$y_{ivbm} = 1$ if $y^*_{ivbm} > 0$ and 0 otherwise,

ϵ_{ivbm}, m = 1,…,8 are error terms distributed as multivariate normal, each with a mean of zero, and variance-covariance matrix *V*, where *V* has a values of 1 on the leading diagonal and correlations $\rho_{jk} = \rho_{kj}$ as off-diagonal elements.

The y_{ivbm} represent outcomes for 8 different choices at the same point in time. The X_{ivbm} represent a matrix of explanatory variable, β_m represent a matrix of parameters, $\alpha_b$is the block fixed effects, and ϵ_{ivbm} is clustered at village-level.

Dependent variables

Table 3 reports the descriptive statistics of dependent variables. It comes from the survey questionnaire "*Has your household made these [Adaptation] in response to long-term shifts in climate change? [Check all that apply]*". The most adopted practices specific to climate change variable as per survey for this study were irrigated more, planted shade trees, reduced the number of livestock units, and found off-farm jobs whereas, the least adopted strategies were leasing land and purchasing insurance.

Explanatory variables and hypotheses

Table 4 reports the descriptive statistics of explanatory variables. The explanatory variables included in the model are based on the review of existing literature on adoption studies, climate change adaptation strategies, and availability of variables in the dataset. These variables can be grouped into a) Perceptions about climate variable, b) Access to information, c) Household characteristics, d) Asset ownership, and e) Social capital.

Perceptions about climate variable

It comes from a survey questionnaire "*Over the last 5 years have you noticed?*". The perceived climate change variables such as an increase in rainfall or the number of hot days, more frequent droughts or floods or cyclone, and erratic nature of rainfall pattern were used. Each climate change variable perceived would have resulted in undertaking one or more than one adaptation strategies. For example, if an increase in rainfall was perceived, the household would likely to have more adoption rates.

Access to Information

The respondents were asked if they received information about the forecasted date of onset of monsoon season, the following information sources were mentioned a) Agricultural extension services, b) Non-governmental organization, c) Cooperative, d) Producer's Association, e) Neighbor or relative, f) Television or radio, g) Mobile phone service, h) Paper media, i) Self-help group or *Jeevika*, j) and Others.

Both explanatory variables under access to information that is the Information about the onset of monsoon and Information about the amount of rain includes responses from above all sources. Better climate, and agricultural information helps farmers choose strategies that enable them to cope well with changes in climatic conditions (Baethgen, Meinke, and Gimenez 2003). The hypothesis is that access to information would have a positive relationship with the household adaptation choices.

Household characteristics

Important variables considered under household characteristic include male headed households, household head age, education level, and family size. Adoption studies point to a positive relationship between education levels and technology adoption (Czaja et al. 2006) but are indeterminate on the effect of age (Akudugu, Guo, and Dadzie 2012; D'souza, Cyphers, and Phipps 1993). In the context of female headed household, a study present woman as risk averse and hence more likely to adopt technologies which would lower their risk exposure (Arano, Parker, and Terry 2010). However, another study found that female headed households were more likely to take up climate change adaptation methods (Nhemachena and Hassan 2008). The hypotheses are that the household size and education level would be positively related to adaptation choices.

Asset ownership

The variables in this category include ownership to farm land, access to irrigation, land holding size, and livestock units such as a cow, buffalo, and goat owned by household. Long-term investments in land are positively correlated with the ownership of that land. Livestock is a form of saving and insurance for many rural households (Bosman, Moll, and Udo 1997; Doran, Low, and Kemp 1979). Households with a higher livestock unit can afford to take risks and rely on the livestock in times of climate shocks (Jones and Thornton 2009). The hypothesis is that the land and livestock ownership would have a positive relationship with adaptation strategies.

Social capital

The important variables in this category include strong confidence in government, member of the farmers' union, and member of the local credit group. Effective local adaptation requires responsive and flexible local institutions[7] that in turn play an important role in reducing the costs of adaptation (Agrawal, Kononen, and Perrin 2009). Members of a certain group (including neighbors) are able to share information among themselves, which accelerates the process of technology adoption and diffusion (Munasib and Jordan 2011; Mulwa et al. 2017). Credit access relaxes liquidity constraints thus increasing technology adoption (Simtowe and Zeller 2006). The

[7] Local institutions such as local government, farmers groups, community based organizations, local association and NGOs, etc.

hypothesis is that a household with social capital would have a positive relationship with adaptation strategies.

4. Results

The empirical analysis begins by identifying how many households in both districts perceived a specific change in climate. The results in Table 5 identify how many households perceived a change in each climate variable by district. The results suggest that about 43% perceived increase in rainfall, however, same percent of households that is 72% perceive delay in the start of monsoon season and shortening of the monsoon season. About 46% households perceived more frequent droughts and 43% households perceived more frequent floods. About 70% households perceived increased number of hot days. More frequent cyclones were perceived by 28% of households.

Households that perceived a long-term change in weather pattern, were then asked has the household made adaptation in response to long-term shifts in temperature and precipitation. The following were the adaptation measures presented to the households a) Changed crop variety, b) Built water harvesting scheme, c) Planted shade trees, d) Irrigated more, e) Changed from crop to livestock, f) Increased number of livestock, g) Reduced number of livestock, h) Migrated another area, i) Found off-Farm jobs, j) Leased your land, and k) Brought Insurance. We review the adaptive measures in response to each climatic variable in Tables 6 - 13.

Table 6 reports the results of adaptive measures in response to increased rainfall. Less that 5% of households migrated to another area, and 13% found off-Farm jobs. About 22% of households irrigated their farm more. About 13% households had planted shade trees, 5% changed crop type, and less than one-tenth, households had changed from crop to livestock, increased or decreased the number of livestock units. About equal percent of households had leased farm land and brought insurance that is 2%. The least frequent adaptive measure was building water harvesting scheme. Darbhanga seems to have higher rates of adaptive change compared to East Champaran.

Table 7 reports the results of adaptive measures in response to more frequent droughts. About equal percent of households had changed crop type, built water harvesting scheme, increased number of livestock units, migrated another area and found off-farm jobs. East Champaran had high adaptation rates almost in all measures except adaptive measures such as found off-farm jobs where Darbhanga had almost double percent that is 5% and 10% respectively.

Table 8 reports the results of adaptive measures in response to more frequent floods. All the adaptive measures were less than 10%, specifically, adaptive measures such as building water harvesting scheme, changing from crop to livestock, increasing or decreasing the number of livestock units, choosing to migrate another area, finding off-farm jobs, leasing land, and purchasing insurance were reported to be less than 5%.

The response to delay in the start of monsoon season were quite similar to the response to monsoon season ending sooner. Members of 11%% households migrated to another area in response to monsoon season starting late and ending soon. About 40% of households irrigated their farm land more and more than quarter percent had planted shade trees. The least frequent adaptive measures were leased farm land and brought insurance. East Champaran again seems to have a higher adaptive response compared to Darbhanga in adaptive measures such as changed crop type, built water harvesting scheme, planted shade trees, and changed from crop to livestock Almost double percent of households in East Champaran than Darbhanga that is 7% and 14% respectively had chosen for migration in response to perceived erratic start and end of monsoon season.

Table 11 reports the results of adaptive measures in response to increased hot days. Darbhanga and East Champaran had similar percent of responses such as quarter percent of households had planted shade trees, and 18% of households had reduced the number of livestock units. The adaptive measures such as finding off-farm jobs, leasing land, and purchasing insurance were quite similar in response to perceived delay in monsoon season, shortening of monsoon season, and increased number of hot days. East Champaran have a higher adaptation rate.

Table 12 reports the results of adaptive measures in response to more frequent cyclones. Darbhanga had higher adaption rates compared to East Champaran in measures such as planting shade trees, irrigating more, changing from crop to livestock, and finding off-farm jobs. Except adaptive measures such as irrigating more, and finding off-farm jobs all other measures had respond below 6%.

Table 13 reports the results of adaptive measures in response to climate change considering all climates variable discussed above. About 46% of households had irrigated more, 32% planted shade trees, and 25% reduced the number of livestock units. About 18% of households changed from crop to livestock, and about 14% increased the number of livestock units. The least frequently reported adaptive measures were leased land and bought insurance. East Champaran had higher adaptation rates.

Table 14 describes the simple correlation across the eleven adaptation measures and suggests for example, households who changed crop type almost always adopted other measures except planting shade tree, irrigating more, and increasing the number of livestock units. Households that built water harvesting scheme also irrigated more, changed from crop to livestock, increased or decreased the number of livestock units, leased land and brought insurance. Adaptation measures such as found off-farm jobs was less highly correlated with all others.

The final analysis is to investigate the determinants of several adaptive measures that households from districts Darbhanga and East Champaran have undertaken in response to their perceived change in climate variables such as temperature and precipitation. The multivariate probit regression examines all the perceptions together. The results of the multivariate analysis on adaptation choice are shown in Table 15. Variables related to perceptions about climate change, access to information, household characteristics, household assets, household social capital are significant determining adaptation measures in response to climate change.

A household that perceived an increase in the rainfall were less likely had chosen for seasonal migration, whereas were more likely had adopted measures such as changed crop type, planted shade trees, and increased irrigated. A household that perceived more frequent droughts were more likely had adopted measures such as changed crop type, planted shade trees, irrigated more, changed from crop to livestock, increased the number of livestock units, and reduced the number of livestock units. A household that perceived more frequent floods had adopted measures such as changed crop type, changed from crop to livestock, reduced the number of livestock units, and chosen for seasonal migration. Households that perceived delay in the monsoon season were more likely had adopted measures such as planted shade trees, increased irrigation, changed from crop to livestock, reduced the number of livestock units, chosen for seasonal migration, and found off-farm jobs. Households that perceived shortening of monsoon season were more likely had adopted measures such as changed crop type, reduced the number of livestock units, chosen for seasonal migration and found off-farm jobs. Households that perceived increase in the number of hot days were more likely had adopted measures such as irrigated more, changed from crop to livestock, reduced the number of livestock units, chosen for seasonal migration, and found off-farm jobs. Households that perceived more frequent cyclones were more likely had adopted measures such as irrigated more, and found off-farm jobs, whereas less likely had adopted measures such as changed crop type, and reduced the number of livestock units.

Access to information such as onset of monsoon and the amount of rain significantly determines adaptation across the several adaptive measures. Access to Information about the onset of monsoon season increases the likelihood that a household adopt by planting shade trees, and irrigating more. Moreover, with access to information about the amount of rain, a household more likely to change crop type, reduced the number of livestock units, and choose for seasonal migration.

Households with male head were more likely to find off-Farm jobs. Household with the older male head were less likely to irrigating more. Household head with a higher than high school education was more likely had planted shade trees, whereas less likely had changed from crop to livestock and increased the number of livestock units. *Household family size* has a positive and significant relationship with adaptive measures such as planted shade trees, irrigated more, changed from crop to livestock, reduced the number of livestock units, chosen for seasonal migration, and found off-farm jobs.

A household that own farmland were more likely had changed crop type, irrigated more, changed from crop to livestock, and reduced the number of livestock units. A household that has access to irrigation facility were less likely had reduced the number of livestock units, and chosen for seasonal migration. *Household agricultural land holding size* has a positive association with adaptive measures such as increased number of livestock units and negative association with reduced number of livestock units.

Household with strong confidence in government were less likely had reduced the number of livestock units. Households that were members of the local farmers' union were more likely had irrigated more, whereas less likely had found off-farm jobs. Households that were a member of a local credit group were more likely had reduced the number of livestock units.

4.1 Robustness

One limitation of this study is that all the perceived climate change variables are used in the multivariate probit regression simultaneously to analysis the association between perceived changes and adaptation strategies. The data points collected on the perceived climate change variables are based on the survey question that asked whether household have noticed climate change over recent 5 years?

The response to each perceived climate change variable might not be mutually exclusive, for example a household that responded having noticed an increased rainfall might have also responded to have noticed delays in the start of monsoon season. Theoretically, the responses to the perceived climate change variable are highly interrelated and interdependent.

Table 16 shows the correlation matrix of climate change perceptions. The perceived increase in the rain is highly correlated with other perceptions such as more frequent droughts, more frequent floods, increase in the number of hot days, and more frequent cyclones, however, not correlated to delay in the monsoon season and shortening of monsoon season.

Table 17 shows the robustness to perceptions about climate change. We estimate the reduced model with including only three perceived climate change variable that is increase in rain, delay in the monsoon season, and shortening of monsoon season and maintaining all other control variables same as full model and for all the adoption strategies. The comparison between full and reduced model suggests that for adaptation strategies such as irrigated more, changed from crop to livestock, and increased the number of livestock units, the results from the reduced model is sensitive.

Appendix Table 24 shows the univariate probit model clustered at village level results of the most frequent adapted strategy that is irrigation. Furthermore, Appendix Table 25 – 32 are the multivariate probit regression results with the perceived climate change.

5. Conclusions and policy implications

The perceived climate change significantly determines the rural household livelihood adaptation strategies. The empirical analysis suggests that each reported perceived climate change had different magnitude and sign for adaptation coefficients. A household that perceived an increase in the rainfall were less likely had chosen for seasonal migration, whereas were more likely had adopted measures such as changed crop type, planted shade trees, and increased irrigated. A household that perceived more frequent droughts were more likely had adopted measures such as changed crop type, planted shade trees, irrigated more, changed from crop to livestock, increased the number of livestock units, and reduced the number of livestock units. A household that perceived more frequent floods had adopted measures such as changed crop type, changed from crop to livestock, reduced the number of livestock units, and chosen for seasonal migration. Households that perceived delay in the monsoon season were more likely had adopted measures such as planted shade trees, increased irrigation, changed from crop to livestock, reduced the number of livestock units, chosen for seasonal migration, and found off-farm jobs. Households that perceived shortening of monsoon season were more likely had adopted measures such as changed crop type, reduced the number of livestock units, chosen for seasonal migration and found off-farm jobs. Households that perceived increase in the number of hot days were more likely had adopted measures such as irrigated more, changed from crop to livestock, reduced the number of livestock units, chosen for seasonal migration, and found off-farm jobs. Households that perceived more frequent cyclones were more likely had adopted measures such as irrigated more, and found off-farm jobs, whereas less likely had adopted measures such as changed crop type, and reduced the number of livestock units. Other important factors were access to information from sources such as neighbors and or relatives, and television and or radio. Household characteristics played an important role to determine what adaptation strategies the household adopted, for example a household with male head were more likely found off-farm jobs whereas, less likely irrigated more. A household that owns a farmland had positive relationships with adaptive measures such as changed crop type, irrigated more, changed from crop to livestock, and reduced the number of livestock units. The landholding size had a positive relationship with adaptive measures such as the increased number of livestock units, while negative association with reduced number of livestock units. A household with a strong confidence in government were less likely had adopted measures such as reduced the number of livestock units. Members of households that were in the local farmers' union were more likely irrigated more, whereas less likely found off-farm jobs. Members of households that were in a local credit group were more likely reduced the number of livestock units. The findings from the empirical investigation can be important to policy.

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Table 1. Workforce participation rates in Darbhanga, 2011

	Rural	Urban	Total
Total Population	3,554,057 (90.26%)	383,328 (9.74%)	3,937,385 (100.00%)
Total number of workers	1,117,368 (91.32%)	106,272 (8.68%)	1,223,640 (100.00%)
Total number of main workers working as Cultivators	175,225 (15.68%)	4,224 (3.97%)	179,450 (14.67%)
Total number of main workers working as Agricultural Laborers	294,894 (26.39%)	6,621 (6.23%)	301,515 (24.64%)
Total number of marginal workers working as Cultivators	55,954 (5.01%)	1,334 (1.26%)	57,288 (4.68%)
Total number of marginal workers working as Agricultural Laborers	333,716 (29.87%)	6,920 (6.51%)	340,636 (27.84%)

Source: Census of India, 2011

Table 2. Workforce participation rates in East Champaran, 2011

	Rural	Urban	Total
Total Population	4,698,028 (92.13%)	401,343 (7.87%)	5,099,371 (100.00%)
Total number of workers	1,624,563 (93.50%)	112,976 (6.50%)	1,737,539 (100.00%)
Total number of main workers working as Cultivators	267,076 (16.44%)	8,214 (7.27%)	275,290 (15.84%)
Total number of main workers working as Agricultural Laborers	594,467 (36.59%)	20,698 (18.32%)	615,165 (35.40%)
Total number of marginal workers working as Cultivators	72,249 (4.45%)	1,546 (1.37%)	73,795 (4.25%)
Total number of marginal workers working as Agricultural Laborers	430,520 (26.50%)	11,698 (10.35%)	442,218 (25.45%)

Source: Census of India, 2011

Table 3. Descriptive statistics of dependent variables.

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Changed crop type	3252	0.15	0.36	0	1
Built water harvesting scheme	3251	0.10	0.30	0	1
Planted shade trees	3250	0.32	0.47	0	1
Irrigated more	3249	0.46	0.50	0	1
Changed from crop to livestock	3249	0.18	0.39	0	1
Increased number of livestock	3249	0.14	0.35	0	1
Reduced number of livestock	3248	0.25	0.43	0	1
Migrated another area	3247	0.13	0.33	0	1
Found off-Farm jobs	3246	0.19	0.39	0	1
Leased your land	3246	0.05	0.22	0	1
Brought Insurance	3218	0.05	0.23	0	1

Table 4. Descriptive statistics of explanatory variables.

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Increase in rain	3289	0.43	0.50	0	1
More frequent droughts	3289	0.46	0.50	0	1
More frequent floods	3289	0.21	0.41	0	1
Delay in the start of monsoon season	3289	0.73	0.45	0	1
Monsoon season end sooner	3289	0.72	0.45	0	1
Increase in number of hot days	3288	0.70	0.46	0	1
More frequent cyclones	3281	0.28	0.45	0	1
Information about onset of monsoon	3300	0.66	0.47	0	1
Information about amount of rain	3300	0.39	0.49	0	1
Male head	3300	0.96	0.20	0	1
Head age	3300	48.76	13.06	18	95
Education level	3300	0.17	0.37	0	1
Family size	3300	5.88	2.43	1	20
Farm land	3300	0.38	0.49	0	1
Access to Irrigation	3300	0.30	0.46	0	1
Cow	3300	0.29	0.45	0	1
Buffalo	3300	0.21	0.41	0	1
Goat	3300	0.19	0.39	0	1
Farm land holding (*Kathas*)	3300	7.22	23.08	0	500
Strong confidence in government	3300	0.51	0.50	0	1
Member of farmers' union	3300	0.04	0.20	0	1
Member of local credit group	3300	0.10	0.30	0	1

Table 5. Percent of households perceiving climate change.

	Darbhanga	East Champaran	Entire sample
Increase in rain	72.35	14.39	43.45
More frequent droughts	26.08	65.06	45.52
More frequent floods	23.95	17.50	20.74
Delay in the start of monsoon season	78.53	66.46	72.51
Monsoon season end sooner	78.90	64.21	71.57
Increase in number of hot days	79.93	60.83	70.41
More frequent cyclones	42.13	13.63	27.92

Table 6. Impact of perceived *increase in the rain* on adaptation choices.

	Darbhanga	East Champaran	Entire sample
Changed crop type	2.73	7.35	5.01
Built water harvesting scheme	1.03	2.31	1.66
Planted shade trees	22.77	2.93	12.98
Irrigated more	38.88	3.81	21.58
Changed from crop to livestock	9.48	2.18	5.88
Increased number of livestock	11.79	2.12	7.02
Reduced number of livestock	13.86	3.68	8.84
Migrated another area	3.28	2.31	2.80
Found off-Farm jobs	23.92	1.06	12.63
Leased your land	3.59	0.37	2.00
Bought insurance	3.06	0.95	2.02

Table 7. Impact of perceived *more frequent droughts* on adaptation choices.

	Darbhanga	East Champaran	Entire sample
Changed crop type	1.15	16.07	8.52
Built water harvesting scheme	0.61	15.21	7.81
Planted shade trees	12.51	29.01	20.65
Irrigated more	15.19	39.30	27.09
Changed from crop to livestock	3.40	21.40	12.28
Increased number of livestock	3.40	10.92	7.11
Reduced number of livestock	4.44	22.83	13.52
Migrated another area	1.09	14.29	7.61
Found off-Farm jobs	10.16	5.30	7.76
Leased your land	1.70	3.43	2.56
Bought insurance	2.26	5.18	3.70

Table 8. Impact of perceived *more frequent floods* on adaptation choices.

	Darbhanga	East Champaran	Entire sample
Changed crop type	0.79	8.04	4.37
Built water harvesting scheme	0.24	4.74	2.46
Planted shade trees	6.38	5.55	5.97
Irrigated more	11.00	5.05	8.06
Changed from crop to livestock	3.28	4.55	3.91
Increased number of livestock	3.52	3.24	3.39
Reduced number of livestock	6.14	8.48	7.30
Migrated another area	2.92	4.49	3.70
Found off-Farm jobs	6.82	1.43	4.16
Leased your land	1.46	1.68	1.57
Bought insurance	0.98	3.35	2.14

Table 9. Impact of perceived *delay in the monsoon season* on adaptation choices.

	Darbhanga	East Champaran	Entire sample
Changed crop type	2.67	17.07	9.78
Built water harvesting scheme	1.03	15.02	7.94
Planted shade trees	23.80	29.26	26.49
Irrigated more	39.61	38.99	39.30
Changed from crop to livestock	10.75	20.40	15.51
Increased number of livestock	10.87	10.79	10.83
Reduced number of livestock	17.57	23.14	20.32
Migrated another area	7.36	14.29	10.78
Found off-Farm jobs	27.75	5.49	16.76
Leased your land	5.36	3.18	4.28
Bought insurance	3.73	5.69	4.69

Table 10. Impact of perceived *shortening of the monsoon season* on adaptation choices.

	Darbhanga	East Champaran	Entire sample
Changed crop type	2.73	16.39	9.47
Built water harvesting scheme	1.09	13.72	7.32
Planted shade trees	23.44	28.51	25.94
Irrigated more	39.49	39.11	39.30
Changed from crop to livestock	10.45	20.96	15.64
Increased number of livestock	11.36	10.54	10.96
Reduced number of livestock	17.57	21.83	19.67
Migrated another area	7.30	14.97	11.09
Found off-Farm jobs	27.69	5.43	16.70
Leased your land	5.48	3.06	4.28
Bought insurance	3.61	4.68	4.13

Table 11. Impact of perceived *increased hot days* on adaptation choices.

	Darbhanga	East Champaran	Entire sample
Changed crop type	2.49	13.34	7.84
Built water harvesting scheme	1.15	13.47	7.23
Planted shade trees	25.38	26.72	26.04
Irrigated more	41.01	38.08	39.56
Changed from crop to livestock	10.57	20.60	15.52
Increased number of livestock	11.66	9.55	10.62
Reduced number of livestock	17.99	18.98	18.48
Migrated another area	7.48	14.61	11.00
Found off-Farm jobs	28.36	5.18	16.92
Leased your land	5.72	2.43	4.10
Bought insurance	4.10	2.85	3.48

Table 12. Impact of perceived *more frequent cyclones* on adaptation choices.

	Darbhanga	East Champaran	Entire sample
Changed crop type	0.67	3.37	2.00
Built water harvesting scheme	0.61	4.50	2.53
Planted shade trees	15.95	2.88	9.50
Irrigated more	24.54	5.32	15.06
Changed from crop to livestock	7.00	3.75	5.40
Increased number of livestock	6.70	3.44	5.09
Reduced number of livestock	5.48	5.94	5.71
Migrated another area	1.71	4.63	3.15
Found off-Farm jobs	18.91	1.56	10.35
Leased your land	2.56	0.38	1.48
Bought insurance	2.02	0.63	1.34

Table 13. Impact of perceived climate change on adaptation choices.

	Darbhanga	East Champaran	Entire sample
Changed crop type	3.95	26.36	15.01
Built water harvesting scheme	1.34	18.39	9.75
Planted shade trees	29.27	34.62	31.91
Irrigated more	48.36	44.54	46.48
Changed from crop to livestock	12.15	24.20	18.10
Increased number of livestock	14.52	13.35	13.94
Reduced number of livestock	20.73	28.70	24.66
Migrated another area	7.97	17.90	12.87
Found off-Farm jobs	30.86	6.86	19.01
Leased your land	6.33	3.99	5.18
Bought insurance	4.40	6.51	5.44

Table 14. Simple correlation across adaptation choices.

	Changed crop type	Built water harvesting scheme	Planted shade trees	Irrigated more	Changed from crop to livestock	Increased number of livestock	Reduced number of livestock	Migrated another area	Found off-Farm jobs	Leased your land	Bought insurance
Changed crop type	1										
Built water harvesting scheme	0.294***	1									
Planted shade trees	0.014	0.013	1								
Irrigated more	0.004	0.130***	0.297***	1							
Changed from crop to livestock	0.131***	0.196***	0.094***	0.240***	1						
Increased number of livestock	0.040	0.071***	-0.016	0.081***	0.252***	1					
Reduced number of livestock	0.223***	0.308***	-0.041	0.005	0.108***	0.040	1				
Migrated another area	0.168***	0.252***	-0.080***	-0.001	0.178***	0.058*	0.275***	1			
Found off-Farm jobs	-0.057*	-0.025	-0.027	0.094***	0.064**	0.023	0.032	0.100***	1		
Leased your land	0.092***	0.068***	0.013	0.055*	0.024	0.015	0.063**	0.134***	0.174***	1	
Bought insurance	0.141***	0.134***	0.057*	-0.029	0.013	-0.005	0.155***	0.018	0.044	0.123***	1

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 15. Multivariate probit regression of household adaptation choice.

Variable	(1) Changed crop type	(2) Planted shade trees	(3) Irrigated more	(4) Changed from crop to livestock	(5) Increased number of livestock	(6) Reduced number of livestock	(7) Migrated another area	(8) Found off-farm jobs
Perceived climate variable								
Increase in rain	0.609***	0.404***	0.251**	-0.037	0.151	-0.035	-0.467***	-0.078
	(0.142)	(0.096)	(0.102)	(0.096)	(0.092)	(0.101)	(0.130)	(0.117)
More frequent droughts	0.288**	0.527***	0.383***	0.219**	0.227**	0.256***	-0.073	0.148*
	(0.123)	(0.078)	(0.099)	(0.097)	(0.094)	(0.098)	(0.097)	(0.090)
More frequent floods	0.262**	0.053	0.042	0.256**	0.052	0.229**	0.188*	0.029
	(0.115)	(0.092)	(0.115)	(0.100)	(0.095)	(0.093)	(0.105)	(0.112)
Delay in monsoon season	0.057	0.154*	0.180**	0.166	0.086	0.443***	0.239**	0.262***
	(0.126)	(0.079)	(0.086)	(0.103)	(0.092)	(0.079)	(0.105)	(0.095)
Monsoon season end sooner	0.243**	0.009	0.129	0.151	0.108	0.399***	0.426***	0.204**
	(0.118)	(0.091)	(0.080)	(0.094)	(0.103)	(0.093)	(0.103)	(0.092)
Increase in number of hots day	-0.171	0.036	0.187**	0.334***	0.080	0.221**	0.676***	0.410***
	(0.128)	(0.086)	(0.080)	(0.096)	(0.087)	(0.096)	(0.127)	(0.092)
More frequent cyclone	-0.556***	0.121	0.185**	0.122	0.094	-0.326***	-0.104	0.401***
	(0.115)	(0.078)	(0.082)	(0.085)	(0.075)	(0.093)	(0.092)	(0.086)
Access to Information								
Information about **onset** of monsoon	-0.027	0.591***	0.707***	0.044	-0.266***	-0.347***	-0.260**	0.176
	(0.181)	(0.096)	(0.114)	(0.130)	(0.095)	(0.103)	(0.132)	(0.140)
Information about **amount** of rain	0.449***	-0.215**	-0.342***	0.026	-0.012	0.406***	0.361***	0.009
	(0.163)	(0.093)	(0.093)	(0.109)	(0.095)	(0.095)	(0.128)	(0.129)

Household characteristics								
Male head	-0.084	0.061	-0.112	0.099	0.022	-0.178	0.011	0.300*
	(0.191)	(0.124)	(0.114)	(0.141)	(0.132)	(0.110)	(0.153)	(0.172)
Head age	0.002	0.005	-0.023*	-0.003	0.006	-0.003	-0.015	0.029*
	(0.019)	(0.012)	(0.013)	(0.015)	(0.015)	(0.015)	(0.017)	(0.016)
Age square	-0.00001	-0.000003	0.0002*	0.00002	-0.00005	0.00002	0.0002	-0.0003*
	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)
Education	0.043	0.320***	-0.093	-0.321***	-0.343***	0.098	0.066	-0.099
	(0.122)	(0.081)	(0.073)	(0.118)	(0.109)	(0.075)	(0.095)	(0.076)
Family size	-0.020	0.026**	0.018*	0.026*	-0.014	0.030**	0.040***	0.035**
	(0.014)	(0.012)	(0.010)	(0.014)	(0.012)	(0.013)	(0.012)	(0.014)
Asset Ownership								
Farm-land	0.565***	0.122	0.662***	0.380***	0.035	0.438***	0.041	-0.055
	(0.152)	(0.128)	(0.146)	(0.122)	(0.142)	(0.126)	(0.153)	(0.141)
Access to Irrigation	0.073	0.024	-0.172	-0.155	-0.044	-0.426***	-0.274**	-0.066
	(0.152)	(0.127)	(0.147)	(0.125)	(0.146)	(0.122)	(0.132)	(0.149)
Cow	0.124*	0.022	0.242***	0.240***	0.351***	0.245***	-0.0003	0.014
	(0.075)	(0.057)	(0.066)	(0.075)	(0.073)	(0.072)	(0.065)	(0.067)
Buffalo	0.194**	0.027	0.295***	0.307***	0.400***	0.140**	-0.176*	-0.158*
	(0.084)	(0.066)	(0.064)	(0.089)	(0.077)	(0.071)	(0.093)	(0.094)
Goat	0.098	0.013	-0.037	0.165*	0.374***	0.204**	0.041	0.088
	(0.082)	(0.071)	(0.072)	(0.088)	(0.090)	(0.079)	(0.092)	(0.093)
Agricultural land size (*Kathas*)	0.002	-0.0005	0.0002	-0.003	0.002*	-0.003**	-0.002	0.001
	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)

Social Capital								
Strong confidence in government	0.103	0.005	0.018	0.147	0.048	-0.174**	0.025	-0.115
	(0.119)	(0.072)	(0.083)	(0.098)	(0.073)	(0.072)	(0.086)	(0.079)
Member of farmers' union	0.255	0.103	0.287**	-0.328	-0.003	0.065	-0.258	-0.315**
	(0.173)	(0.160)	(0.146)	(0.206)	(0.162)	(0.136)	(0.172)	(0.160)
Member of a local credit group	0.008	0.156	-0.041	0.013	0.103	0.252**	0.038	0.203
	(0.174)	(0.110)	(0.103)	(0.116)	(0.102)	(0.117)	(0.135)	(0.130)
Block fixed effects								
Benipur	-0.286	0.334*	-0.707***	-0.759***	-0.583***	0.059	-0.073	-0.434
	(0.272)	(0.202)	(0.235)	(0.141)	(0.177)	(0.211)	(0.267)	(0.305)
Ghanshyampur	0.071	-0.061	-0.108	-0.394**	-0.179	0.098	0.333	-0.339
	(0.265)	(0.181)	(0.191)	(0.189)	(0.154)	(0.170)	(0.226)	(0.245)
Hanuman Nagar	0.174	0.353**	-0.641***	-0.453**	-0.437**	0.389**	0.584**	-0.628**
	(0.247)	(0.176)	(0.217)	(0.182)	(0.199)	(0.180)	(0.243)	(0.261)
Hayaghat	-0.558	-0.551***	-0.517**	-0.813***	-1.021***	-0.456***	0.075	0.143
	(0.340)	(0.142)	(0.260)	(0.153)	(0.183)	(0.152)	(0.246)	(0.233)
Gaurabauram	-0.622***	-0.412**	-0.430	-0.551***	-0.171	0.277	0.500*	-0.292
	(0.204)	(0.168)	(0.308)	(0.170)	(0.202)	(0.222)	(0.285)	(0.223)
Banjariya	1.386***	-0.414*	-0.743***	-0.349	-0.204	0.602***	1.225***	-1.179***
	(0.212)	(0.245)	(0.270)	(0.228)	(0.192)	(0.182)	(0.257)	(0.230)
Areraj	1.997***	0.413**	-0.847***	-0.188	-0.252	0.841***	0.947***	-0.665***
	(0.212)	(0.189)	(0.239)	(0.153)	(0.193)	(0.170)	(0.290)	(0.240)
Kalyanpur	2.059***	-0.076	-0.126	0.237	-0.214	0.850***	1.378***	-0.683**
	(0.296)	(0.232)	(0.268)	(0.199)	(0.200)	(0.211)	(0.269)	(0.273)

Bankatwa	0.257	0.996***	0.479*	0.193	-0.352	-0.626***	-0.468*	-1.583***
	(0.357)	(0.267)	(0.254)	(0.223)	(0.257)	(0.212)	(0.269)	(0.263)
Ghorasahan	-3.762***	0.987***	0.397	-0.084	-0.886***	-0.920***	-0.567**	-2.443***
	(0.269)	(0.250)	(0.281)	(0.256)	(0.252)	(0.204)	(0.288)	(0.406)
Harshidhi	1.321***	0.117	-1.311***	-0.686***	-0.859***	0.332	0.660**	-1.336***
	(0.245)	(0.190)	(0.256)	(0.178)	(0.261)	(0.242)	(0.304)	(0.290)
Constant	-2.867***	-2.199***	-0.570	-1.819***	-1.376***	-1.705***	-2.362***	-2.286***
	(0.553)	(0.377)	(0.368)	(0.450)	(0.423)	(0.436)	(0.490)	(0.500)
Observations	3238	3238	3238	3238	3238	3238	3238	3238

Notes: Robust standard errors (in parentheses) are clustered at village level, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 15. Continued

	Rho1	Rho2	Rho3	Rho4	Rho5	Rho6	Rho7
Rho2	0.248***						
Rho3	0.212***	0.306***					
Rho4	0.193***	0.080	0.261***				
Rho5	0.034	-0.035	0.055	0.416***			
Rho6	0.114**	-0.020	0.010	0.079	0.007		
Rho7	-0.039	-0.087	0.031	0.241***	0.131***	0.194***	
Rho8	0.083	-0.039	0.107**	0.202***	0.009	0.080	0.273***

Likelihood ratio test of rho21 = rho31 = rho41 = rho51 = rho61 = rho71 = rho81 = rho32 = rho42 = rho52 = rho62 = rho72 = rho82 = rho43 = rho53 = rho63 = rho73 = rho83 = rho54 = rho64 = rho74 = rho84 = rho65 = rho75 = rho85 = rho76 = rho86 = rho87 = 0: chi2(28) = 414.35 Prob. > chi2 = 0.0000.
*; **; *** Significant at 10%; 5% and 1% respectively.

Table 16. Simple correlation across climate change perceptions.

	Increase in rain	More frequent droughts	More frequent floods	Delay in monsoon season	Monsoon season ending sooner	Increase in the number of hot days	More frequent cyclone
Increase in rain	1						
More frequent droughts	-0.380***	1					
More frequent floods	0.099***	-0.100***	1				
Delay in monsoon season	0.005	0.273***	-0.021	1			
Monsoon season ending sooner	0.040	0.272***	-0.047	0.563***	1		
Increase in number of hot days	0.102***	0.267***	-0.060**	0.474***	0.546***	1	
More frequent cyclone	0.404***	-0.011	0.108***	0.140***	0.177***	0.209***	1

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 17. Robustness of perceived climate change.

Variable	(1) Changed crop type		(2) Planted shade trees		(3) Irrigated more		(4) Changed from crop to livestock	
	(1) Full	(2) Reduced	(1) Full	(2) Reduced	(1) Full	(2) Reduced	(1) Full	(2) Reduced
Perceived climate change								
Increase in rain	0.609^{***}	0.509^{***}	0.404^{***}	0.346^{***}	0.251^{**}	0.255^{**}	-0.037	-0.001
	(0.142)	(0.135)	(0.096)	(0.093)	(0.102)	(0.101)	(0.096)	(0.084)
Delay in monsoon season	0.057	0.119	0.154^{*}	0.218^{***}	0.180^{**}	0.260^{***}	0.166	0.241^{**}
	(0.126)	(0.132)	(0.079)	(0.080)	(0.086)	(0.082)	(0.103)	(0.099)
Monsoon season end sooner	0.243^{**}	0.219^{*}	0.009	0.102	0.129	0.263^{***}	0.151	0.308^{***}
	(0.118)	(0.120)	(0.091)	(0.092)	(0.080)	(0.080)	(0.094)	(0.098)
More frequent droughts	Yes	No	Yes	No	Yes	No	Yes	No
More frequent floods	Yes	No	Yes	No	Yes	No	Yes	No
Increase in number of hots day	Yes	No	Yes	No	Yes	No	Yes	No
More frequent cyclone	Yes	No	Yes	No	Yes	No	Yes	No

Table 17. Continued

Variable	(5) Increased number of livestock		(6) Reduced number of livestock		(7) Migrated another area		(8) Found off-farm jobs	
	(1) Full	(2) Reduced	(1) Full	(2) Reduced	(1) Full	(2) Reduced	(1) Full	(2) Reduced
Perceived climate change								
Increase in rain	0.151	0.145*	-0.035	-0.122	-0.467***	-0.425***	-0.078	0.050
	(0.092)	(0.087)	(0.101)	(0.095)	(0.130)	(0.124)	(0.117)	(0.110)
Delay in monsoon season	0.086	0.127	0.443***	0.505***	0.239**	0.318***	0.262***	0.376***
	(0.092)	(0.094)	(0.079)	(0.087)	(0.105)	(0.100)	(0.095)	(0.092)
Monsoon season end sooner	0.108	0.178*	0.399***	0.464***	0.426***	0.591***	0.204**	0.380***
	(0.103)	(0.099)	(0.093)	(0.090)	(0.103)	(0.095)	(0.092)	(0.088)
More frequent droughts	Yes	No	Yes	No	Yes	No	Yes	No
More frequent floods	Yes	No	Yes	No	Yes	No	Yes	No
Increase in number of hots day	Yes	No	Yes	No	Yes	No	Yes	No
More frequent cyclone	Yes	No	Yes	No	Yes	No	Yes	No
Access to Information controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household characteristics controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Asset Ownership controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Social Capital controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Block Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3238	3246	3238	3246	3238	3246	3238	3246

Notes: Robust standard errors (in parentheses) are clustered at village level, ****p* < 0.01, ***p* < 0.05, **p* < 0.1.

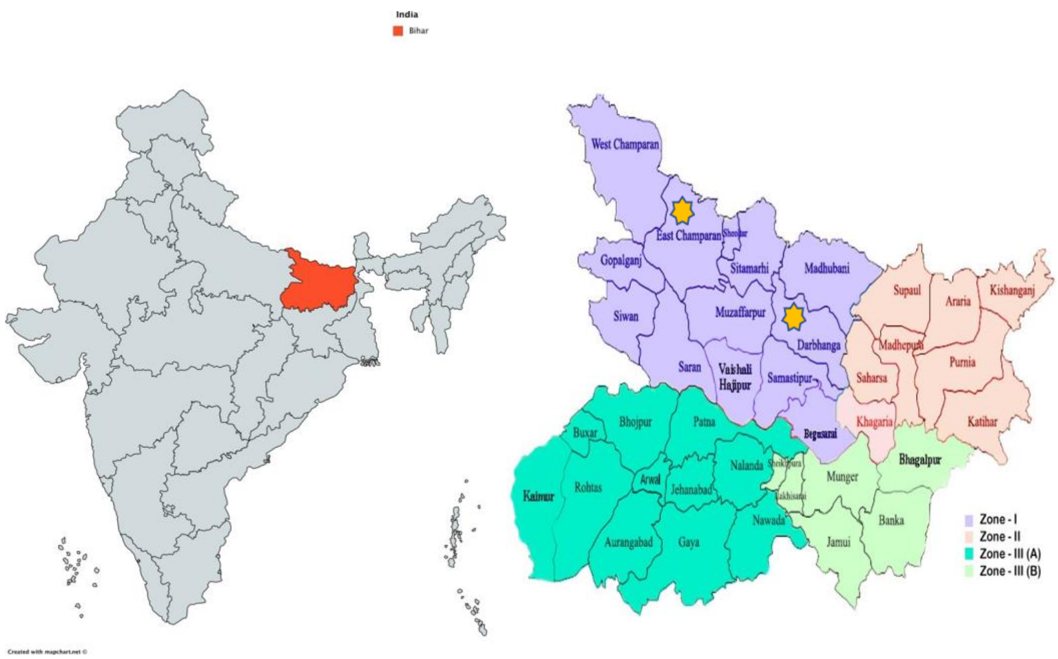

Figure 1: Study area Bihar, India

Flood-prone districts are Darbhanga and East Champaran.

Appendix A

Table 18. Variable Definitions.

Variable	Description
Dependent variables	
Changed crop variety	Dummy = 1 if household adapted by changing crop varieties as an adaptation strategy; = 0 otherwise
Built water harvesting scheme	Dummy = 1 if household adapted by building water harvesting scheme as an adaptation strategy; = 0 otherwise
Planted shade trees	Dummy = 1 if household adapted by planting shade trees as an adaptation strategy; = 0 otherwise
Irrigated more	Dummy = 1 if household adapted by irrigating farmland more as an adaptation strategy; = 0 otherwise
Changed from crop to livestock	Dummy = 1 if household adapted by changing from crop to livestock as an adaptation strategy; = 0 otherwise
Increased number of livestock	Dummy = 1 if household adapted by increasing the number of livestock as an adaptation strategy; = 0 otherwise
Reduced number of livestock	Dummy = 1 if household adapted by reducing the number of livestock as an adaptation strategy; = 0 otherwise
Migrated another area	Dummy = 1 if household adapted by migrating to another area as an adaptation strategy; = 0 otherwise
Found off-farm jobs	Dummy = 1 if household adapted by finding off-farm jobs as an adaptation strategy; = 0 otherwise
Leased your land	Dummy = 1 if household leased one's land as an adaptation strategy; = 0 otherwise
Brought Insurance	Dummy = 1 if household adapted by buying an insurance as an adaptation strategy; = 0 otherwise

Table 18. Continued

Variable	Description
Explanatory variables	
Perceived climate variable	
Increase in rain	Dummy = 1 if household noticed an increase in the rainfall during recent five years; = 0 otherwise
More frequent droughts	Dummy = 1 if household noticed an increased frequency of floods during recent five years; = 0 otherwise
Delay in monsoon season	Dummy = 1 if household noticed delays in the monsoon season during recent five years; = 0 otherwise
Monsoon season end sooner	Dummy = 1 if household noticed monsoon season ending sooner than expected during recent five years; = 0 otherwise
Increase in the number of hot days	Dummy = 1 if household noticed an increase in the number of hot days during recent five years; = 0 otherwise
More frequent cyclone	Dummy = 1 if household noticed an increased frequency of cyclones during recent five years; = 0 otherwise
Access to Information	
Information about onset of monsoon	Dummy = 1 if household received an information about the forecasted date of onset of monsoon season; = 0 otherwise
Information about amount of rain	Dummy = 1 if household received an information about the forecasted amount of rainfall before planting season; = 0 otherwise
Household characteristics	
Male head	Gender of household head, 1 = male, 0 otherwise
Head age	Age of household head in years
Education	Dummy = 1 if the household head education level is equal to or higher than high school; = 0 otherwise
Family size	Number of household size

Asset Ownership	
Farm-land	Dummy = 1 if household owns an agricultural plot; = 0 otherwise
Access to Irrigation	Dummy = 1 if household has access to irrigation; = 0 otherwise
Cow	Dummy = 1 if household owns a cow; = 0 otherwise
Buffalo	Dummy = 1 if household owns a buffalo = 0 otherwise
Goat	Dummy = 1 if household owns a goat = 0 otherwise
Agricultural land size	Agricultural land owned by the household in *Kathas*
Social capital	
Strong confidence in government	Dummy = 1 if household has a strong deal of confidence in the local government; = 0 otherwise
Member of farmers union	Dummy = 1 if household head is a member of farmers union; = 0 otherwise
Member of a local credit group	Dummy = 1 if household head is a member of a local credit group; = 0 otherwise
Block fixed effects	
Benipur	Dummy = 1 if a household from Dharbhanga lives in Benipur; = 0 otherwise
Ghan Shyampur	Dummy = 1 if a household from Dharbhanga lives in Ghan Shyampur; = 0 otherwise
Hanuman Nagar	Dummy = 1 if a household from Dharbhanga lives in Hanuman Nagar; = 0 otherwise
Hayaghat	Dummy = 1 if a household from Dharbhanga lives in Hayaghat; = 0 otherwise
Gaurabauram	Dummy = 1 if a household from Dharbhanga lives in Gaurabauram; = 0 otherwise
Banjariya	Dummy = 1 if a household from East Champaran lives in Banjariya; = 0 otherwise

Areraj	Dummy = 1 if a household from East Champaran lives in Areraj; = 0 otherwise
Kalyanpur	Dummy = 1 if a household from East Champaran lives in Kalyanpur; = 0 otherwise
Bankatwa	Dummy = 1 if a household from East Champaran lives in Bankatwa; = 0 otherwise
Ghorasahan	Dummy = 1 if a household from East Champaran lives in Ghorasahan; = 0 otherwise
Harshidhi	Dummy = 1 if a household from East Champaran lives in Harshidhi; = 0 otherwise

Appendix Tables

Table 19. Descriptive statistics of block fixed effects.

Variable	N	Mean	Std. Dev.	Min.	Max.
Benipur	3300	0.08	0.28	0	1
Ghanshyampur	3300	0.08	0.28	0	1
Hanuman Nagar	3300	0.08	0.28	0	1
Hayaghat	3300	0.08	0.28	0	1
Gaurabauram	3300	0.08	0.28	0	1
Banjariya	3300	0.08	0.28	0	1
Areraj	3300	0.08	0.28	0	1
Kalyanpur	3300	0.08	0.28	0	1
Bankatwa	3300	0.08	0.28	0	1
Ghorasahan	3300	0.08	0.28	0	1
Harshidhi	3300	0.08	0.28	0	1

Table 20. Study sites.

Darbhanga		East Champaran	
Block	No. of households	Block	No. of households
Alinagar	275	Banjariya	278
Benipur	275	Areraj	275
Ghanshyampur	275	Kalyanpur	272
Hanuman Nagar	275	Bankatwa	275
Hayaghat	275	Ghorasahan	275
Gaurabauram	275	Harshidhi	275
Total	1650	Total	1650

Table 21. Descriptive statistics of number of household adaptation choices.

	Obs.	Mean	Median	Std. Dev.	Min.	Max.
Dharbhanga	1650	1.79	2	1.38	0	8
East Champaran	1650	2.19	2	0.05	0	9
Entire sample	3300	1.99	2	0.03	0	9

Table 22. Missing observations for Dependent variables.

Variable	Darbhanga	East Champaran
Changed crop type	3	45
Built water harvesting scheme	3	46
Planted shade trees	3	47
Irrigated more	4	47
Changed from crop to livestock	4	47
Increased number of livestock	4	47
Reduced number of livestock	5	47
Migrated another area	6	47
Found off-Farm jobs	7	47
Leased your land	7	47
Bought insurance	14	68

Table 23. Missing observations for perceived climate variables.

Variable	Darbhanga	East Champaran
Increase in rain	1	10
More frequent droughts	1	10
More frequent floods	1	10
Delay in the start of monsoon season	1	10
Monsoon season end sooner	1	10
Increase in number of hot days	1	11
More frequent cyclones	5	14

Table 24. Robustness of perceived climate variable for adaptation strategy *Irrigated more*.

Variable	1	1b	1c	1d	1e	1f	1g	Jointly
Perceived climate variable								
Delay in monsoon season	0.337***	0.228***	0.185**	0.159*	0.174*	0.162*	0.163*	0.180**
	(0.089)	(0.084)	(0.085)	(0.089)	(0.090)	(0.090)	(0.090)	(0.086)
Monsoon season end sooner		0.260***	0.174**	0.138	0.147*	0.136	0.136	0.129
		(0.084)	(0.083)	(0.085)	(0.084)	(0.084)	(0.084)	(0.080)
Increase in number of hots day			0.298***	0.240***	0.208**	0.182*	0.184**	0.187**
			(0.084)	(0.080)	(0.081)	(0.083)	(0.083)	(0.080)
More frequent droughts				0.356***	0.405***	0.380***	0.382***	0.383***
				(0.094)	(0.100)	(0.102)	(0.102)	(0.099)
Increase in rain					0.310***	0.257**	0.255**	0.251**
					(0.103)	(0.104)	(0.106)	(0.102)
More frequent cyclone						0.177**	0.174**	0.185**
						(0.083)	(0.084)	(0.082)
More frequent floods							0.038	0.042
							(0.117)	(0.115)
Access to Information controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household characteristics controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Asset Ownership controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Social Capital controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Block Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3249	3249	3248	3248	3248	3241	3241	3238

Notes: Columns 1 – 1g computed as a univariate probit model clustered at village level and 1g is the full model, whereas, Jointly refers to multivariate probit full model and here results are presented only for the most frequent adaptation choice Irrigated more;
Robust standard errors (in parentheses) are clustered at village level, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 25. Multivariate probit regression of adaptation choice *Changed crop type*.

Variable	I	II	III	IV	V	VI	VII
Perceived climate variable							
Delay in monsoon season	0.170	0.100	0.122	0.107	0.109	0.083	0.063
	(0.141)	(0.133)	(0.134)	(0.134)	(0.134)	(0.134)	(0.128)
Monsoon season end sooner		0.170	0.234*	0.220*	0.270**	0.274**	0.259**
		(0.123)	(0.122)	(0.121)	(0.118)	(0.122)	(0.120)
Increase in number of hots day			-0.215*	-0.234**	-0.279**	-0.196	-0.181
			(0.112)	(0.116)	(0.120)	(0.127)	(0.128)
More frequent droughts				0.115	0.254**	0.297**	0.288**
				(0.114)	(0.117)	(0.124)	(0.125)
Increase in rain					0.559***	0.627***	0.599***
					(0.140)	(0.142)	(0.143)
More frequent cyclone						-0.537***	-0.552***
						(0.114)	(0.115)
More frequent floods							0.265**
							(0.117)
Access to Information controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household characteristics controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Asset Ownership controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Social Capital controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Block Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3246	3246	3245	3245	3245	3238	3238

Notes: Columns I – VII are multivariate probit model with VII as full model and here results are presented for only adaptation choice *Changed crop type*; Robust standard errors (in parentheses) are clustered at village level, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 26. Multivariate probit regression of adaptation choice *Planted shade trees.*

Variable	I	II	III	IV	V	VI	VII
Perceived climate variable							
Delay in monsoon season	0.254***	0.218***	0.194**	0.158**	0.165**	0.162**	0.161**
	(0.080)	(0.080)	(0.080)	(0.079)	(0.079)	(0.080)	(0.079)
Monsoon season end sooner		0.093	0.043	0.003	0.014	0.005	0.004
		(0.092)	(0.090)	(0.091)	(0.090)	(0.091)	(0.091)
Increase in number of hots day			0.183**	0.106	0.062	0.032	0.035
			(0.085)	(0.087)	(0.085)	(0.086)	(0.087)
More frequent droughts				0.473***	0.542***	0.526***	0.528***
				(0.076)	(0.078)	(0.078)	(0.078)
Increase in rain					0.434***	0.400***	0.395***
					(0.093)	(0.095)	(0.096)
More frequent cyclone						0.128	0.123
						(0.079)	(0.078)
More frequent floods							0.058
							(0.092)
Access to Information controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household characteristics controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Asset Ownership controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Social Capital controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Block Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3246	3246	3245	3245	3245	3238	3238

Notes: Columns I – VII are multivariate probit model with VII as full model and here results are presented for only adaptation choice *Planted shade trees;* Robust standard errors (in parentheses) are clustered at village level, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 27. Multivariate probit regression of adaptation choice *Irrigated more*.

Variable	I	II	III	IV	V	VI	VII
Perceived climate variable							
Delay in monsoon season	0.361***	0.261***	0.204**	0.176**	0.189**	0.189**	0.189**
	(0.088)	(0.083)	(0.082)	(0.084)	(0.085)	(0.087)	(0.087)
Monsoon season end sooner		0.244***	0.167**	0.132	0.143*	0.118	0.117
		(0.081)	(0.080)	(0.082)	(0.081)	(0.080)	(0.080)
Increase in number of hots day			0.303***	0.246***	0.213***	0.189**	0.190**
			(0.081)	(0.078)	(0.079)	(0.082)	(0.081)
More frequent droughts				0.359***	0.412***	0.386***	0.388***
				(0.092)	(0.097)	(0.099)	(0.099)
Increase in rain					0.319***	0.252**	0.249**
					(0.100)	(0.101)	(0.102)
More frequent cyclone						0.188**	0.185**
						(0.080)	(0.080)
More frequent floods							0.038
							(0.116)
Access to Information controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household characteristics controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Asset Ownership controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Social Capital controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Block Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3246	3246	3245	3245	3245	3238	3238

Notes: Columns I – VII are multivariate probit model with VII as full model and here results are presented for only adaptation choice *Irrigated more;* Robust standard errors (in parentheses) are clustered at village level, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 28. Multivariate probit regression of adaptation choice *Changed from crop to livestock.*

Variable	I	II	III	IV	V	VI	VII
Perceived climate variable							
Delay in monsoon season	0.366***	0.249**	0.194*	0.170*	0.171*	0.174*	0.178*
	(0.093)	(0.098)	(0.102)	(0.102)	(0.102)	(0.103)	(0.104)
Monsoon season end sooner		0.306***	0.209**	0.184**	0.185**	0.157*	0.146
		(0.097)	(0.098)	(0.093)	(0.093)	(0.094)	(0.093)
Increase in number of hots day			0.359***	0.323***	0.319***	0.307***	0.323***
			(0.091)	(0.091)	(0.092)	(0.095)	(0.096)
More frequent droughts				0.232**	0.235**	0.207**	0.219**
				(0.092)	(0.094)	(0.097)	(0.096)
Increase in rain					0.027	-0.023	-0.041
					(0.087)	(0.092)	(0.095)
More frequent cyclone						0.158*	0.134
						(0.086)	(0.087)
More frequent floods							0.245**
							(0.099)
Access to Information controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household characteristics controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Asset Ownership controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Social Capital controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Block Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3246	3246	3245	3245	3245	3238	3238

Notes: Columns I – VII are multivariate probit model with VII as full model and here results are presented for only adaptation choice *Changed from crop to livestock;* Robust standard errors (in parentheses) are clustered at village level, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 29. Multivariate probit regression of adaptation choice *Increased number of livestock*.

Variable	I	II	III	IV	V	VI	VII
Perceived climate variable							
Delay in monsoon season	0.188**	0.128	0.087	0.066	0.074	0.084	0.084
	(0.093)	(0.094)	(0.092)	(0.091)	(0.092)	(0.094)	(0.094)
Monsoon season end sooner		0.156	0.128	0.106	0.115	0.114	0.114
		(0.102)	(0.105)	(0.105)	(0.104)	(0.105)	(0.105)
Increase in number of hots day			0.144*	0.111	0.094	0.080	0.082
			(0.085)	(0.084)	(0.085)	(0.088)	(0.088)
More frequent droughts				0.220**	0.251***	0.215**	0.217**
				(0.091)	(0.092)	(0.095)	(0.095)
Increase in rain					0.180**	0.148	0.145
					(0.091)	(0.092)	(0.093)
More frequent cyclone						0.097	0.093
						(0.074)	(0.073)
More frequent floods							0.047
							(0.097)
Access to Information controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household characteristics controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Asset Ownership controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Social Capital controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Block Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3246	3246	3245	3245	3245	3238	3238

Notes: Columns I – VII are multivariate probit model with VII as full model and here results are presented for only adaptation choice *Increased number of livestock;* Robust standard errors (in parentheses) are clustered at village level, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 30. Multivariate probit regression of adaptation choice *Reduced number of livestock*.

Variable	I	II	III	IV	V	VI	VII
Perceived climate variable							
Delay in monsoon season	0.697^{***}	0.514^{***}	0.483^{***}	0.458^{***}	0.456^{***}	0.455^{***}	0.443^{***}
	(0.098)	(0.087)	(0.085)	(0.083)	(0.083)	(0.082)	(0.079)
Monsoon season end sooner		0.466^{***}	0.415^{***}	0.393^{***}	0.387^{***}	0.407^{***}	0.402^{***}
		(0.091)	(0.094)	(0.094)	(0.093)	(0.093)	(0.093)
Increase in number of hots day			0.198^{**}	0.161^{*}	0.172^{*}	0.215^{**}	0.221^{**}
			(0.095)	(0.094)	(0.095)	(0.097)	(0.096)
More frequent droughts				0.224^{**}	0.207^{**}	0.251^{**}	0.258^{***}
				(0.096)	(0.099)	(0.098)	(0.098)
Increase in rain					-0.101	-0.013	-0.033
					(0.100)	(0.103)	(0.101)
More frequent cyclone						-0.308^{***}	-0.327^{***}
						(0.092)	(0.093)
More frequent floods							0.229^{**}
							(0.094)
Access to Information controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household characteristics controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Asset Ownership controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Social Capital controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Block Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3246	3246	3245	3245	3245	3238	3238

Notes: Columns I – VII are multivariate probit model with VII as full model and here results are presented for only adaptation choice *Reduced number of livestock;* Robust standard errors (in parentheses) are clustered at village level, $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table 31. Multivariate probit regression of adaptation choice *Migrated another area.*

Variable	I	II	III	IV	V	VI	VII
Perceived climate variable							
Delay in monsoon season	0.601***	0.330***	0.250**	0.249**	0.239**	0.231**	0.226**
	(0.120)	(0.100)	(0.103)	(0.104)	(0.105)	(0.103)	(0.105)
Monsoon season end sooner		0.631***	0.482***	0.483***	0.451***	0.456***	0.444***
		(0.101)	(0.100)	(0.103)	(0.102)	(0.100)	(0.101)
Increase in number of hots day			0.631***	0.630***	0.661***	0.676***	0.680***
			(0.124)	(0.123)	(0.129)	(0.126)	(0.126)
More frequent droughts				0.008	-0.093	-0.092	-0.085
				(0.089)	(0.101)	(0.098)	(0.097)
Increase in rain					-0.473***	-0.449***	-0.470***
					(0.138)	(0.129)	(0.128)
More frequent cyclone						-0.094	-0.114
						(0.090)	(0.093)
More frequent floods							0.186*
							(0.105)
Access to Information controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household characteristics controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Asset Ownership controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Social Capital controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Block Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3246	3246	3245	3245	3245	3238	3238

Notes: Columns I – VII are multivariate probit model with VII as full model and here results are presented for only adaptation choice *Migrated another area;* Robust standard errors (in parentheses) are clustered at village level, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 32. Multivariate probit regression of adaptation choice *Found Off-farm Jobs*.

Variable	I	II	III	IV	V	VI	VII
Perceived climate variable							
Delay in monsoon season	0.523***	0.377***	0.282***	0.272***	0.276***	0.252***	0.252***
	(0.090)	(0.093)	(0.094)	(0.095)	(0.094)	(0.095)	(0.095)
Monsoon season end sooner		0.370***	0.258***	0.244***	0.244***	0.208**	0.208**
		(0.089)	(0.090)	(0.090)	(0.089)	(0.094)	(0.094)
Increase in number of hots day			0.498***	0.468***	0.464***	0.413***	0.413***
			(0.091)	(0.090)	(0.090)	(0.093)	(0.092)
More frequent droughts				0.206**	0.212**	0.148	0.148
				(0.089)	(0.091)	(0.091)	(0.091)
Increase in rain					0.042	-0.070	-0.072
					(0.117)	(0.116)	(0.116)
More frequent cyclone						0.394***	0.393***
						(0.086)	(0.087)
More frequent floods							0.021
							(0.113)
Access to Information controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household characteristics controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Asset Ownership controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Social Capital controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Block Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3246	3246	3245	3245	3245	3238	3238

Notes: Columns I – VII are multivariate probit model with VII as full model and here results are presented for only adaptation choice *Found Off-farm Jobs;* Robust standard errors (in parentheses) are clustered at village level, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Figure 2. Households perceived climate change

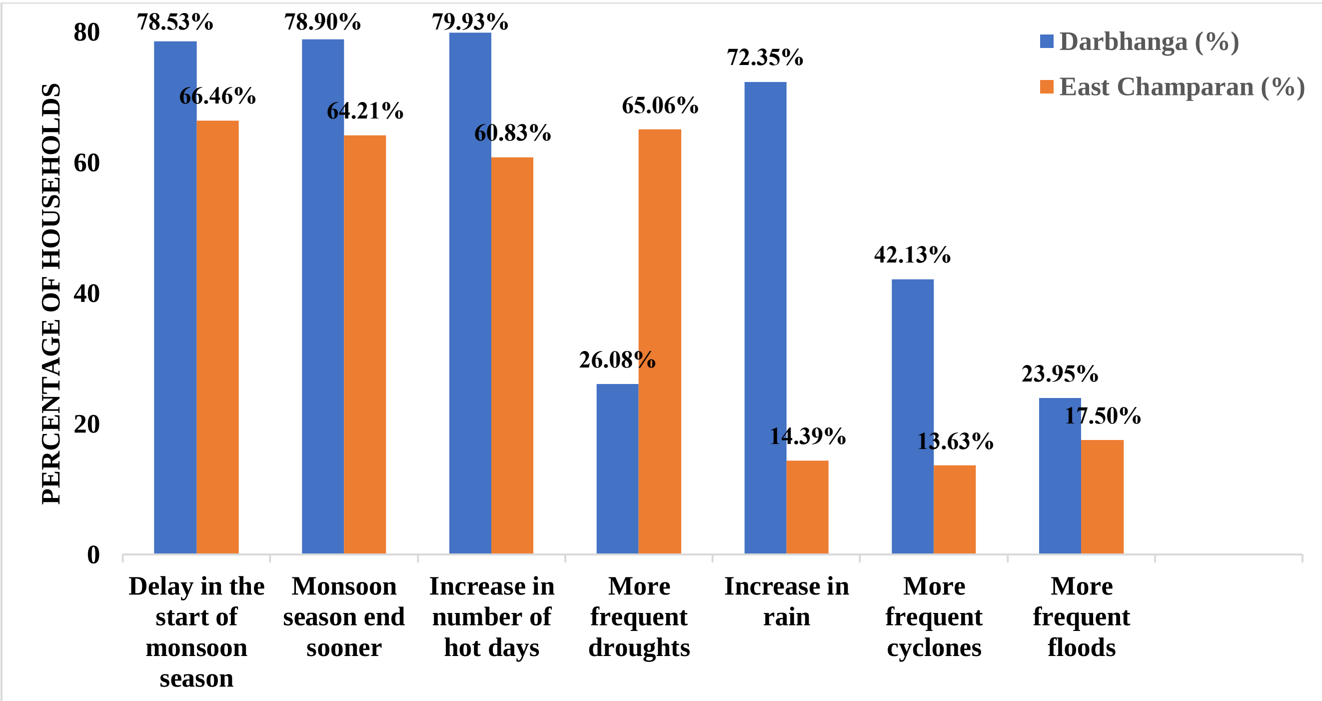

Figure 3. Households reported adaptation strategies