Adapting Together: Climate Change and Gendered Adjustments of Intra-household Labor Allocation in Rural China

Fei XIE, Lin YANG, Wanru XIONG

The Hong Kong University of Science and Technology (Guangzhou)

Abstract

Climate change poses unpredictable challenges to rural livelihoods, particularly in regions where farming is the primary source of income. This study examines how rural households in China adapt to extreme weather events through intra-household labor allocation, with particular attention to gendered adjustments. Based on panel data from the China National Rural Fixed Point Survey and matched meteorological records from 2009 to 2017, we apply fixed-effects logit models to estimate the association between extreme weather and (i) households' reliance on farming income and (ii) individuals' involvement in farm work. Results show that, at the household level, more extreme heat days in the previous year reduces households' reliance on farming, while extreme cold and rainfall increase households' farming engagement. Within households, women exhibit a stronger shift away from farm work in response to prior extreme rainfall and drought than men. Specifically, extreme rainfall tends to keep men in farming, whereas extreme drought significantly encourages women to move into non-farm work. These findings highlight the critical role of intra-household, gendered labor reallocation as a key adaptive strategy for rural households in China to mitigate climate shocks.

Key words: Extreme weather, Climate adaptation, Intra-household labor allocation, Gendered labor allocation, Rural China

Extended Abstract

Background

Climate change, defined as long-term shifts in temperatures and weather patterns, has emerged as one of the most urgent and complex challenges of the 21st century. A key driver is global warming, primarily resulting from human activities (United Nations, 2025). According to the Intergovernmental Panel on Climate Change (IPCC, 2023), the global average surface temperature has risen markedly over the past century, with the pace of warming accelerating in recent decades. Climate models project an additional rise of approximately 1.4°C to 4.4°C by the end of the 21st century. Further warming is projected to intensify multiple concurrent hazards, including more frequent and severe extreme weather events such as heatwaves, heavy rainfall, and droughts. These increasingly evident impacts are producing widespread and detrimental consequences on both ecosystems and human societies.

Among the many sectors affected by climate change, agriculture is particularly vulnerable due to its strong dependence on weather conditions. Within agriculture, crop farming is the most sensitive to weather fluctuations, as crop growth cycles respond directly to changes in temperature and precipitation. In contrast, livestock, forestry, and fisheries are affected through more indirect pathways, such as reduced feed availability and broader ecosystem disturbances (Malhi et al., 2021). Beyond agricultural production, climate change also affects other vital dimensions of rural life, including infrastructure, housing, and employment conditions, which together influence the livelihoods of rural farming households (Cannon & Müller-Mahn, 2010).

As climate-related risks intensify, rural workers in the farming sector have responded by adopting various adaptation strategies to mitigate adverse impacts on their welfare. These strategies generally fall into two broad categories: adjustments in farming production and shifts in livelihood activities. In terms of farming, common strategies include diversifying crops to reduce risk, adopting resilient crop varieties that are more tolerant to heat, cold, floods, and

droughts, and modifying planting schedules in response to changes in growing seasons (Auffhammer & Carleton, 2018; H. Li et al., 2024; Mulwa & Kabubo-Mariara, 2022). Additionally, many producers implement sustainable land management practices, such as soil organic management, water conservation, and rainwater harvesting, to build climate-resilient farming systems (Altieri et al., 2015). On the livelihood side, workers may transfer from farming to non-farm work, often through rural-to-urban migration. Such shifts may be long-term or temporary, as in the case of seasonal labor. Individual shifts often relate to intra-household labor divisions, with some members remaining engaged in farming while others seek employment in urban construction or service sectors (Cohn et al., 2017; C. Li & Pan, 2021; Wei et al., 2024). Moreover, farming insurance is recognized as an effective tool for managing climate risks by providing a financial buffer against crop losses and supporting the recovery of farming operations (Nnadi et al., 2013; Wuepper et al., 2017).

Existing research on these adaptation strategies often treats households as singular decision-making units, overlooking the complexities of intra-household dynamics in climate adaptation. In reality, adaptation emerges not as a unified household response but through continuous bargaining over labor division and role reallocation within a household. These bargaining processes are often dynamic, situational, and context-specific, influenced by intra-household differences such as age, status, livelihood roles, and gender, as they all influence the responsibilities and capacity to manage climate risks (Rao et al., 2021). In particular, intra-household adaptive adjustments often take gendered forms, with men and women within the same household assuming different roles in response to climate-induced production pressures and livelihood uncertainties. In this sense, gendered reallocations of intra-household labor are not merely outcomes of climate stress, but adaptive strategies through which households navigate and mitigate climate risks.

Method

We use two datasets: rural socioeconomic data from the China National Rural Fixed Point Survey (CNRFPS) and daily meteorological records from the China Meteorological Administration (CMA). The CNRFPS is a nationally representative longitudinal survey launched in 1986 by the Ministry of Agriculture and Rural Affairs of China (MARA) and conducted annually, except for 1992 and 1994. It employs a three-tier village–household–individual sampling design, covering all 31 provincial-level regions in mainland China. The data provide comprehensive multilevel metrics ranging from village collective economies to individual work records, which enable robust analysis of rural socioeconomic dynamics. The CMA operates a network of 2,474 standardized weather stations and collects continuous daily meteorological data since 1951, including temperature (0.1°C precision), precipitation, and pan evaporation (both at 0.1 mm precision), allowing for robust detection of long-term climate trends across all regions in mainland China.

We construct our analytical sample based on three key criteria to ensure alignment with our research objectives. First, we restrict our sample to individuals of working ages between 16 and 60 years old. Under China's employment policies, those outside the working age face systematic employment restrictions in the formal labor market. Many older migrant workers (over age 60) return to rural areas and reengage in agricultural work, meaning their labor activities may reflect passive responses to institutional constraints. The labor allocation patterns of working-age individuals may more effectively capture rural households' adaptive adjustments when coping with climate-related challenges. Second, we include only households with both men and women working members to analyze the gendered adjustments of intra-household labor allocation. Third, we focus on rural households in the farming sector, defined as those economically dependent on farming in at least one year, ensuring that our analysis captures households directly exposed to climate-related farming risks.

We further restrict the analytical sample to households with at least six years of

observations during the study period, which accounted for 56.4% of the full sample. This restriction serves two purposes. First, it ensures that the panel data contain sufficient longitudinal observations for analyzing changes in household behaviors over time. Second, because the MARA conducted large-scale sampling from 2009 to 2015 followed by a subsample-based design in 2016 and 2017, this threshold balances sample size and panel consistency. We also perform robustness checks using two alternative samples: the full sample and a less restrictive sample including households with at least four years of observations (82.2% of the full sample).

The final analytical sample spans 2009 to 2017, covering 254 villages, 5,331 households, and 11,293 individuals across 28 provincial-level regions in mainland China, excluding Beijing, Hainan, and Tibet. Beijing is excluded due to its low reliance on crop farming, while Hainan and Tibet are excluded because they lack eligible households with continuous observations covering at least six years.

The outcome variables capture two key dimensions of rural household labor activities. At the household level, farming dependence is measured by a binary indicator based on self-reported primary income sources (1 = farming-dependent; 0 = non-farming-dependent). At the individual level, working status is classified into four ordered categories: (1) full-time farming, (2) seasonal farming, (3) local non-farm employment, and (4) migrant employment outside the township, reflecting decreasing farming involvement and increasing engagement in non-farm work.

The core independent variables are village-level extreme weather indicators including extreme heat, cold, rainfall, and drought, which constructed from the nearest weather stations using geographic coordinates and geodesic distance. Each variable measures the annual number of days the event occurs and is lagged by one year to account for delayed behavioral responses, as weather shocks often influence economic activities with temporal persistence

(Emediegwu et al., 2022; Hsiang, 2016).

Extreme weather events are identified following the methodology of Ren et al. (2010) and national meteorological standards. Using 1971–2000 as the baseline period, we calculate percentile-based thresholds for each calendar day: the 90th percentile of temperature for extreme heat, 10th percentile for extreme cold, and 95th percentile of non-zero precipitation for extreme rainfall. Extreme drought days are determined using the Standardized Precipitation Index (SPI) based on China's national standard GB/T 20481-2017, with days having SPI $\leqslant -1.5$ classified as severe drought. Annual frequencies of each event are then aggregated to construct the village-level indicators.

Results

We examine how farming households adjust labor allocation and gender roles in response to climate change in rural China, focusing on four extreme weather events including extreme heat, cold, rainfall, and drought, which represent some of the most direct and visible forms of climate stress.

We find that prior-year exposure to extreme heat reduces households' reliance on farming, indicating a shift away from agricultural dependence under prolonged high-temperature stress. In contrast, extreme cold and rainfall are associated with greater farming dependence, suggesting that households may intensify farming activities to stabilize production or recover losses. Moreover, extreme rainfall and drought are linked to gender-differentiated intra-household labor responses. Specifically, men are more likely to remain in farming under extreme rainfall, whereas women show stronger shifts toward non-farm work under extreme drought. These patterns suggest evolving gender roles within climate-affected rural households and highlight intra-household labor allocation as an important adaptive strategy in the context of climate stress.

Our analysis provides new insights into how rural households in China adapt to climate change not only through livelihood diversification but also through internal gendered adjustments in labor division.

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