# Farmers Coping Strategies Under Agricultural Stress: Diversification as A Risk-Management Tool in Haryana

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***Abstract*—Farmers in semi-arid agricultural regions increasingly confront multiple stressors, including climate variability, groundwater depletion, rising production costs, and unstable markets. Crop diversification is widely promoted as a risk-management tool, yet empirical evidence on how farmers actually perceive and use diversification for coping remains limited. This study examines diversification as a resilience strategy among farmers in Haryana's stress-prone districts, with a focus on risk perception, vulnerability, and behavioural responses. Using a mixed-methods design—comprising 420 household surveys, six focus group discussions (FGDs), resilience and vulnerability indexing, historical climate data correlation, logistic regression modelling, and structural equation modelling (SEM)—the study provides rigorous micro-level insights. Findings reveal that farmers with high climate-risk perception and greater exposure to groundwater scarcity were significantly more likely to diversify. Diversification reduced vulnerability by stabilizing seasonal incomes, improving input-use flexibility, and buffering farmers against climatic shocks. Marginal and small farmers diversified more intensively than medium farmers, primarily due to heightened exposure to risk. However, institutional constraints—such as weak procurement for non-paddy crops, volatility in vegetable markets, and limited crop insurance—restricted the full resilience benefits of diversification. The study offers a policy framework linking diversification to farmer resilience, emphasizing risk-responsive extension, market reforms, and region-specific diversification pathways.**

***Index Terms*—crop diversification, risk perception, resilience, coping strategies, climate variability, groundwater stress, Haryana, vulnerability index**

## I. INTRODUCTION

Agricultural systems across South Asia are increasingly exposed to a complex interplay of climatic, hydrological, and economic stressors that threaten production stability and the livelihoods of millions of farming households. Haryana provides a particularly illustrative case of this transition. Once celebrated as a core driver of the Green Revolution, the state achieved substantial gains in foodgrain production through intensive cultivation of wheat and paddy. However, this success has simultaneously generated long-term ecological pressures, and the region now confronts severe groundwater depletion, erratic monsoon behaviour, rising temperatures, and fluctuating market conditions that collectively undermine farm-level resilience (Chand, 2021; Kumar & Singh, 2020). For many farmers—particularly those in semi-arid and water-stressed districts—agriculture has shifted from a high-productivity enterprise to one marked by heightened risk, reduced predictability, and escalating vulnerability.

Against this backdrop, crop diversification has gained prominence as a key strategy advocated by researchers, policymakers, and environmental institutions to strengthen resilience under uncertainty. Diversification is believed to mitigate risk by distributing it across multiple crops that differ in their climatic responses, water requirements, and market cycles (Birthal et al., 2021). By moving away from water-intensive cereal monoculture toward more balanced and context-sensitive crop portfolios, farmers can reduce exposure to climatic shocks, stabilize income flows, and enhance adaptive capacity. Moreover, diversified cropping systems contribute to improved soil structure, reduced dependence on chemical inputs, and greater ecological sustainability—benefits increasingly emphasized in contemporary debates on sustainable agri-food systems (Pretty, 2018).

Despite such recognized advantages, the behavioural, perceptual, and institutional dynamics that shape diversification remain insufficiently understood. Farmers' decisions under stress are rarely guided by economic rationality alone; they are embedded in a broader social and experiential context involving risk perception, trust in institutions, access to extension services, household resource constraints, and the legacy of past shocks (Mehta & D'Souza, 2020). These factors influence not only whether farmers diversify, but also the extent, direction, and timing of diversification. In Haryana, where traditional procurement systems, groundwater extraction patterns, and established cropping norms play a decisive role, understanding how farmers perceive and respond to risk becomes essential.

This study seeks to address this gap by examining diversification as a coping and risk-management strategy among farmers in Haryana. Specifically, it investigates how climate- and market-related risks shape cropping decisions, how diversification contributes to vulnerability reduction, and which categories of farmers—marginal, small, or medium—are more likely to diversify under conditions of stress. By integrating household survey data, focus group insights, and quantitative risk-modelling approaches, the study contributes to a deeper understanding of diversification behaviour within a risk-prone ecological and market environment.

## II. RESEARCH PROBLEM

Although diversification is widely endorsed as a mechanism for risk reduction, little empirical research documents how farmers themselves perceive and use diversification to cope with climate and market stress. Existing studies often conceptualize diversification as an agronomic or economic decision but rarely analyse it as a behavioural response to risk. This disconnect limits the ability of policymakers to design interventions aligned with farmers' real motivations and constraints.

In regions such as Haryana—where climate shocks, groundwater depletion, and volatile markets converge—the lack of empirical evidence on diversification as a coping strategy represents a serious knowledge gap. There is limited understanding of whether risk-averse farmers diversify more or less, how climate and market uncertainties shape decisions, or which crops provide the strongest buffering effect. This study responds directly to these gaps by focusing on farmer behaviour under stress.

### OBJECTIVES

The study pursues three interlinked objectives:

- To analyze farmers' risk perception related to climate variability, groundwater decline, and market uncertainty.
- To examine how crop diversification functions as a coping and resilience-building strategy.
- To identify the types of farmers—marginal, small, medium—most likely to diversify under conditions of stress.

### RESEARCH QUESTIONS

The analysis is guided by the following questions:

- How do climate and market risks influence farmers' cropping decisions in stress-prone regions?
- Do risk-averse farmers diversify more or less than risk-neutral or risk-taking farmers?
- Which diversified crops (pulses, oilseeds, vegetables, fodder, millets) provide the strongest risk-buffering effect?

## III. REVIEW OF LITERATURE

The literature relevant to this study spans three intersecting domains—agricultural risk, diversification behaviour, and resilience thinking. Together, these strands provide the conceptual and empirical foundation for understanding how farmers respond to stress and how diversification functions as a coping mechanism within risk-prone environments.

### RISK AND AGRICULTURAL DECISION-MAKING

Agricultural risk arises from the interaction of climatic variability, hydrological uncertainty, pest outbreaks, volatile prices, shifting market preferences, and frequent policy adjustments that redefine incentives and input availability (Hardaker et al., 2015). Within such environments, farmers seldom make decisions solely on the basis of profit maximization. Instead, their choices are mediated by risk perception, a subjective cognitive process shaped by earlier

experiences of crop failure, access to climate and market information, institutional trust, and socio-economic position (Meuwissen et al., 2019). Empirical work increasingly shows that farmers who perceive higher levels of climatic or market risk tend to prefer strategies that stabilize income—even when these strategies involve lower expected returns. Consequently, risk aversion emerges as a major determinant of cropping decisions, influencing whether households remain in monoculture systems or transition toward more varied crop portfolios. Understanding these behavioural drivers is essential, as they determine how farmers interpret stress signals and which adaptation pathways they eventually choose.

### DIVERSIFICATION AS A RISK-MANAGEMENT STRATEGY

Crop diversification has long been conceptualized as a classic risk-spreading mechanism. By cultivating crops with different water requirements, growth cycles, market behaviours, and susceptibility to climatic extremes, farmers can reduce the probability that a single shock will undermine their entire production system (Jhajharia & Salam, 2021). In the Indian context, pulses and oilseeds complement traditional cereals by demanding less irrigation while improving soil fertility through nitrogen-fixing properties. Horticultural crops, although capable of generating higher returns, expose farmers to market volatility and perishability risks (Narayanan, 2020). The literature acknowledges these agronomic and economic advantages, yet relatively few studies explicitly examine diversification as a behavioural response to stress, particularly how farmers choose to diversify when confronted with declining groundwater, unpredictable rainfall, or unstable prices. Existing work typically treats diversification as an agronomic choice rather than an adaptive coping mechanism shaped by psychological factors and livelihood vulnerabilities. This gap limits our understanding of the conditions under which diversification becomes a preferred strategy.

### RESILIENCE AND VULNERABILITY IN AGRICULTURE

Resilience frameworks shift attention from short-term responses to the long-term capacity of farmers to withstand, absorb, and recover from shocks. Resilience is conceptualized not merely as resistance to stress but as the ability to reorganize and maintain core functions in the face of disturbance (Folke, 2016). Within this perspective, diversification strengthens resilience by broadening livelihood options, reducing dependence on a single crop, and creating buffer mechanisms that stabilize income and food availability. Studies by FAO (2020) highlight that diversified systems often exhibit greater flexibility and quicker recovery after climatic or market shocks. Complementing this, vulnerability research emphasizes the uneven distribution of risk exposure: marginal and small farmers face higher levels of stress due to limited land, constrained access to credit and irrigation, and reduced bargaining power. These structural constraints interact with risk perception to produce differentiated adaptation strategies. Understanding resilience and vulnerability together therefore provides a more holistic explanation of why some farmers diversify aggressively while others remain locked into monoculture despite its risks.

## IV. RESEARCH GAP

Although the benefits of diversification are widely cited in policy and scholarly discussions, substantial gaps remain in understanding how diversification relates to risk perception and coping behaviour, particularly in ecologically stressed regions such as Haryana. Most existing studies examine diversification patterns using district-level or macro datasets, which mask household-level behavioural dynamics. Moreover, limited research integrates quantitative modelling of risk with qualitative insights into farmers' lived experiences. Consequently, the link between perceived stress, diversification decisions, and actual resilience outcomes remains weakly established. This study seeks to address these gaps by combining household surveys, focus group discussions, climate–risk correlation, and statistical modelling to produce a more grounded understanding of diversification as a risk-management strategy.

## V. METHODOLOGY

This study employs a mixed-methods approach, combining quantitative data, qualitative insights, and climatic records to provide a multidimensional understanding.

STUDY AREA

The research focuses on stress-prone districts of Haryana characterized by semi-arid climate, declining groundwater tables, and cereals-dominated cropping. These districts represent Haryana's typical agro-ecological vulnerabilities and offer fertile ground for studying risk-driven diversification behaviour.

RESEARCH DESIGN

A cross-sectional design distinguishes between farmers who:

- continue cereal-based monoculture, and
- adopt diversified cropping systems (pulses, oilseeds, vegetables, fodder, and millets).

## VI. DATA COLLECTION

PRIMARY DATA

- Household surveys administered to 420 farm households.
- Focus Group Discussions (FGDs) conducted in six villages to explore risk narratives.
- Risk perception scale covering climate variability, groundwater stress, and market volatility.

SECONDARY DATA

- Historical rainfall and temperature records.
- Market price data for major crops.
- Government agricultural reports and groundwater statistics.

ANALYTICAL FRAMEWORK

1. Climate correlation analysis linking rainfall variability with cropping patterns.
2. Vulnerability and resilience indices constructed using socio-economic, ecological, and infrastructural indicators.
3. Binary logistic regression to identify determinants of diversification.
4. Structural Equation Modelling (SEM) to analyze pathways between risk perception and diversification decisions.

## VII. RESULTS AND DISCUSSION

FARMERS' RISK PERCEPTION

The findings reveal that farmers across the study area perceive a marked increase in climatic and hydrological stress, particularly delayed monsoons, rising temperatures, and erratic rainfall patterns. Groundwater depletion emerged as one of the most pressing concerns, especially for households dependent on shallow tube wells. Alongside climatic stress, farmers expressed strong apprehension about market-related risks, such as sudden price crashes in vegetables and the absence of assured procurement mechanisms for oilseeds and pulses. These intertwined risks substantially influenced cropping decisions: households reporting higher levels of perceived climatic uncertainty were significantly more inclined to diversify their crop mix, indicating that risk perception plays a central role in shaping adaptive behaviour.

DIVERSIFICATION AS A COPING STRATEGY

The analysis shows that diversification functioned as an effective coping strategy by reducing households' vulnerability scores and offering greater flexibility in resource use. Diversified farms demonstrated more stable income flows across seasons due to the complementary nature of different crops. Drought-resilient crops such as mustard, guar, and fodder provided security during years of low rainfall, while vegetables contributed additional cash income across shorter cycles. This combination enabled farmers to distribute risk across crops with different climatic sensitivities and market behaviours, thereby enhancing their resilience to both environmental and economic stress.

FARMER CATEGORY DIFFERENCES

Differences in diversification behaviour were evident across farmer categories. Marginal and small farmers showed the highest diversification intensity, driven largely by their heightened exposure to climate stress and limited capacity to absorb losses. With fewer financial buffers and restricted access to groundwater, these farmers relied more heavily on diversification as a survival strategy. In contrast, medium farmers tended to remain committed to cereal-based monocultures, supported by greater access to tube wells, credit facilities, and machinery. These structural advantages reduced their perceived need to diversify despite growing environmental risks.

REGRESSION AND SEM FINDINGS

Quantitative analysis further reinforced these patterns. Logistic regression results indicated that climate-risk perception, declining groundwater levels, and exposure to market volatility were significant predictors of diversification behaviour. Structural Equation Modelling (SEM) provided deeper insight by demonstrating that vulnerability acted as a key mediating variable: farmers with higher risk perception were more likely to diversify because they simultaneously experienced greater levels of vulnerability. This mediated relationship underscores the importance of both psychological and structural factors in determining how households respond to agricultural stress.

BARRIERS LIMITING RESILIENCE THROUGH DIVERSIFICATION

Despite the clear benefits associated with diversification, several structural and institutional barriers continued to limit its potential to enhance resilience. Farmers consistently highlighted weak market infrastructure for non-paddy crops, which discouraged them from expanding into oilseeds, pulses, and vegetables despite their ecological suitability. Price volatility remained a persistent worry, especially for perishable crops that lacked storage or processing facilities. Limited access to crop insurance further heightened perceived risk, as farmers felt inadequately protected against climatic shocks. In addition, extension services for diversified crops were found to be insufficient, leaving farmers without the technical guidance needed to manage new varieties effectively. Poor availability of quality seeds also constrained diversification efforts. Together, these barriers undermine the ability of farmers to fully utilize diversification as a long-term resilience strategy, aligning with earlier assessments of Haryana's market and institutional constraints (Rathore, 2021).

## VIII. CONCLUSION AND POLICY IMPLICATIONS

The study establishes that crop diversification serves as a critical coping mechanism and resilience-building strategy for farmers confronted with climatic uncertainty, groundwater decline, and market volatility. Farmers' risk perception emerged as a central behavioural factor shaping their decision to diversify, with marginal and small farmers showing the strongest adaptive response due to their heightened vulnerability and limited buffers against agricultural shocks. Although diversification improved income stability, resource-use flexibility, and drought resilience, its full potential remains constrained by structural barriers such as inadequate markets, weak procurement systems, limited insurance coverage, and insufficient technical support.

To enhance the resilience benefits of diversification, policy interventions must focus on strengthening procurement and market linkages for oilseeds, pulses, and millets, while expanding climate-responsive extension services that provide localised agronomic guidance. Improved crop insurance mechanisms, tailored to diversified systems, would further reduce farmers' exposure to risk. Equally important is the need for region-specific diversification planning that aligns crop choices with ecological suitability and emerging climate trends. By framing diversification within a broader risk-management and behavioural context, this study offers policymakers an evidence-based foundation for promoting more sustainable and adaptive agricultural transitions in Haryana and comparable agro-ecological regions.

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