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Organic farming and the challenges of migration in the mountains of Uttarakhand

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Abstract: Agricultural practices in rural Uttarakhand are undergoing significant changes due to widespread migration from mountainous regions. Farmers remaining in these areas face increased workloads, greater family responsibilities, and challenges to their livelihoods. Despite being known for organic produce, the state's agricultural sector now relies heavily on a small number of farmers. Based on the survey of 255 farmers in six villages of Pauri district, the present research explores the issues hindering sustainable organic farming. Using multiple regression analysis, the results show that improved access to resources, infrastructure, and mental health support, alongside rural development policies, could mitigate the negative effects of migration. Additionally, strengthening community-based farming initiatives may empower farmers to maintain organic production, benefiting the economy and preserving the environment. The study offers actionable recommendations for policymakers and community leaders to design interventions that enhance farmers' livelihoods and promote sustainable organic farming in the region.

Keywords: Mountain region • farmers • organic farming • migration • financial stress

Introduction

As Wendell Berry famously stated, "Eating is an agricultural act." This quote highlights the deep connection between agriculture and human well-being, a relationship particularly evident in regions like the mountainous areas of Uttarakhand, where organic farming is not just a practice but a way of life. In these regions, the food produced is inherently organic and therapeutic, as the farmers have traditionally refrained from using chemical-based fertilizers (Dwivedi et al., 2024). Uttarakhand, with its rich agricultural heritage and favorable environmental conditions, presents a unique opportunity to explore the dynamics of organic food production. However, the region's potential as an organic hub is being challenged by socio-economic issues, particularly the widespread migration of farmers (MLF) from the mountains.

Organic farming has garnered global attention as consumers increasingly seek healthier, environmentally sustainable alternatives to conventional food production. According to Lernoud and Willer (2019), organic agriculture has grown rapidly worldwide, with India emerging as a key player due to its traditional practices and favourable policies. The organic farming has potential to boost rural economies, preserve biodiversity, and tackle environmental issues (Dwivedi et al. (2024). Addtionally, it emphasizes in promoting sustainable farming in India (Roy et al., 2024).

Despite these benefits, Uttarakhand's organic farming sector faces significant challenges, primarily due to the migration of farmers from the region (Biella et al., 2022). Additionally, two other critical factors impact farmers: lack of resources (LR) and the home-work interface (HWI). Farmers struggle with limited access to modern farming tools, financial support, and irrigation systems, which hinders their ability to maintain and scale organic farming (Haneef et al., 2019). Additionally, the HWI plays a significant role, as many farmers are left to manage both agricultural work and household responsibilities, especially with the evacuation of younger family members. This dual burden, leads to heightened mental and physical stress (Tomar et al., 2024).

This research thus intends to address this gap by focusing on six villages in the Pauri district of Uttarakhand. Specifically, it examines how the LR, migration, and the interface between home and work contribute to financial stress (FS) among these farmers and, in turn, how this stress negatively impacts the organic food production cycle (OFPC) in the region.

- To resolve these concerns, the research is framed through the subsequent research questions:
- Is there a relationship between the MLF, LR, and the HWI in relation to FS experienced by farmers in Uttarakhand's mountainous regions?
- Does this FS negatively impact the OFPC in the region?

By investigating these questions, the research seeks to provide actionable insights that can inform rural development policies and agricultural support programs.

Literature Review

Scope of Organic Farming in Mountains

The mountainous regions of Uttarakhand offer a unique ecological advantage for organic farming due to their biodiversity, favorable climate, and traditional practices. Farmers here largely avoid synthetic fertilizers and insecticides, producing naturally organic and therapeutic food (Maikhuri et al., 2015). Organic farming not only benefits the environment but also provides significant economic opportunities for local communities. It promotes healthier soil, biodiversity, and reduced environmental degradation, making it a sustainable solution for regions vulnerable to climate change (Panwar et al., 2022).

Research has highlighted Uttarakhand's potential as an organic hub, driven by growing demand for organic produce. Bisht (2021) emphasized organic farming's role in sustainable rural development by offering alternative livelihoods and conserving fragile ecosystems. However, socio-economic challenges such as migration and resource scarcity remain underexplored.

This study addresses these gaps by investigating the impact of migration, resource limitations, and the HWI on farmers' financial and mental stress, offering insights to enhance the sustainability of organic farming in the region.

Migration of Local Farmers from Mountains

Migration has significantly impacted the agricultural landscape of Uttarakhand's hilly areas, creating "ghost villages" where entire communities are abandoned. According to the 2011 Census, out of 16,793 villages, 1,053 are uninhabited, and 405 have fewer than 10 residents (euttaranchal.com, 2024; Kumar and Prasad Sati, 2023). This has left an aging farming population struggling to manage both agricultural and household responsibilities, disrupting traditional farming systems and causing severe labor shortages. Investigating migration's impact on mountain farming is crucial due to its potential for creating sustainable local employment through organic agriculture (Joshi, 2018). Furthermore, examining the effects of migration on farmers' financial and mental stress is key to formulating policies that promote local employment and enhance agricultural practices.

While prior studies have explored migration's causes and effects in Uttarakhand, few have addressed its specific impact on organic farming. This research aims to bridge that gap and propose the following hypothesis:

H1: MLF from the mountains of Uttarakhand significantly impacts the FS among mountain farmers.

Lack of Resources

According to Mensah et al. (2019) "Resources are the foundation upon which life sustains."

This statement is especially true for people living in mountainous regions, where the terrain and climate present significant challenges for everyday survival and agricultural production. In the context of farming, access to essential resources such as modern farming equipment, irrigation systems, financial support, and technical knowledge is critical for sustaining agricultural livelihoods in remote areas (Chaudhuri et al., 2021). However, in Uttarakhand's Mountain regions, resource scarcity is a persistent issue that hampers the growth and sustainability of organic farming.

Mountain farmers require a variety of resources to sustain a decent livelihood, including access to transportation networks, agricultural inputs, market infrastructure, and financial services (Subrahmanyeswari and Chander, 2022). Earlier investigations have consistently stressed the absence of adequate infrastructure and assistance services as major obstacles to agricultural development in Uttarakhand (Chaudhuri et al., 2021). Based on above discussion, the present study postulates that:

H2: LR in the mountain region of Uttarakhand significantly impacts the FS among mountain farmers.

Home and Work Interface of Local Farmers

The HWI refers to the balance or conflict between domestic responsibilities and professional duties. For farmers in rural areas of Uttarakhand, managing household chores alongside farming tasks presents unique challenges. This is particularly evident among women farmers, who form a significant part of the agricultural workforce, as many men migrate to urban areas for employment (Naudiyal et al., 2019).

Incorporating HWI into this study is essential because it addresses the intersection of socio-economic and gendered responsibilities, which significantly impact the financial and mental well-being of farmers (Bhandari and Reddy, 2015). Studies show that this dual burden leads to increased mental stress, reduced productivity, and physical exhaustion (Pandey et al., 2020).

This research highlights how HWI contributes to FS in mountain farming. The added burden from domestic duties reduces agricultural output, worsening financial strain. Understanding HWI's role is vital for designing policies to support farmers, particularly women, by offering solutions like childcare access and labor-sharing initiatives, thereby improving productivity and financial stability. Given this understanding, the subsequent hypothesis is presented:

H3: The HWI of local farmers significantly impacts the FS among mountain farmers.

Influence of Financial Stress on Organic Food Production Cycle

FS is a critical factor that influences the ability of farmers to sustain agricultural practices, especially in organic farming, which often requires significant upfront investment, time, and effort. Several researchers have investigated the connection between FS and the OFPC (Meng et al., 2017; Mutyasira et al. (2018). Soni et al. (2022) also noted that organic farming's long-term profitability is hindered by FS, which impacts investment in certifications, organic inputs, and labor. In Uttarakhand's mountain regions, where farmers already face migration, resource scarcity, and the HWI, FS exacerbates the challenges of maintaining organic farming.

This study aims to examine how FS negatively impacts the OFPC, offering insights for policymakers and marketers to develop support strategies, such as financial assistance programs and stable demand systems for organic products. Accordingly it is hypothesized that:

H4: FS among mountain farmers of Uttarakhand has a negative impact on the organic food production cycle.

Figure 1 presents the proposed theoretical framework:

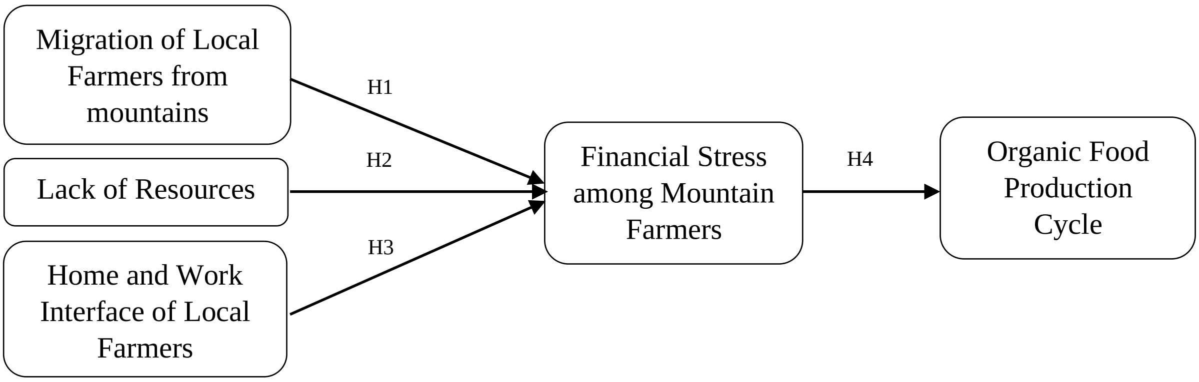

Figure 1. Conceptual Framework

Methodology

A self-administered survey employing a five-point Likert scale was used to measure the constructs. Six questions each for MLF, LR, and HWI were adapoted from Darouei and Pluut (2021), Ismail et al. (2023), and Kalantari et al. (2024). Ten questions for FS was adapted from Wilson et al. (2023). The dependent variable, organic food production cycle, was assessed through a series of questions designed to evaluate yield, quality, and sustainability of farming practices.

Purposive sampling was utilized to select mountain farmers who have relevant experiences and insights into the challenges related to migration, resource limitations, and balancing domestic responsibilities with farming duties. The six villages in the Pauri district were chosen based on their agricultural relevance and the diversity of challenges faced by farmers. The questionnaire was disseminated to 430 farmers across these villages, resulting in 255 completed responses. Data analysis was conducted using SPSS-26, employing multiple regression to explore the associations between the variables.

Results

Descriptive Statistics

The majority of respondents in the present study comprise of women farmers (187 no.). aged between 35 and 40 years. Regarding educational qualification, more than 50 percent of women farmers had no formal education, while only 70 percent of men had attained primary education. Furthermore, in asset holdings and social awareness, women farmers significantly outnumber their male counterparts with less than 25 percent owning land or other properties in their names. Table 1 elaborates the demographic distribution.

Table 1. Sample statistics by Gender

Variable	Category	Male (Frequency)	Male (%)	Female (Frequency)	Female (%)
Gender		68	26.7	187	73.3
Education	Primary	40	24.2	51	27.3
	Secondary	50	30.3	18	9.6
	Graduate	42	25.8	32	17.1
	Total	**132**	**80.3**	**101**	**19.7**
Age	18 - 25	30	15.8	53	28.3
	26 - 35	27	15.4	46	24.6
	35 - 45	11	7.5	88	43.8
	Total	**68**	**26.7**	**187**	**73.3**
Asset Holding	Male	199	78.4	-	-
	Female	-	-	56	21.6
Total		**199**	**78.4**	**56**	**21.6**

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Establishing Assumptions for Exploratory Factor Analysis (EFA)

Exploratory Factor Analysis (EFA) was carried out to investigate the inter-correlations among the constructs and identify the underlying factors influencing each variable's characteristics. EFA is a statistical technique used to uncover the latent structure of a set of variables by identifying clusters of related items, known as factors that explain the observed patterns of correlations within the data. This analysis involved assessing communalities, which indicate the proportion of each variable's variance that can be explained by the extracted factors, to understand the shared variance between observed variables and these factors. Utilizing Varimax rotation, a method designed to simplify the factor structure by maximizing the variance of squared loadings for each factor, and Principal Component Analysis (PCA), a dimensionality reduction technique that transforms the data into a smaller set of uncorrelated components, the data was condensed into statistically independent components. These components had factor loading values exceeding 0.7 in the Rotated Component Matrix (RCM), which signifies the strength of the relationship between each variable and its corresponding factor.

This process facilitated the identification of four components, including MLF, LR, HWI, and their relationships to FS, providing valuable insights into the underlying dimensions within the dataset (Table 2). The results contribute to a deeper understanding of the factors driving FS and their broader implications for sustainable organic farming in Uttarakhand.

Table 2. Assumptions for EFA

Conditions of EFA	**Criteria**	**Reference**
Sample size of 255	n > 200	(Glenn D. Israel, 2003)
Bartlett's sphericity test	p < 0.001	(Odoi et al., 2022)
KMO coefficient of 0.892 attests to the adequacy of the sample	> 0.70	(Shrestha, 2021)
Satisfactory communalities values	> 0.50	(Ximénez et al., 2022)
Total variance explained is 80.689%	> 50%	(dos Santos and Cirillo, 2023)
The variance for the first factor is 15.719%	< 50%	(dos Santos and Cirillo, 2023)

Reliability Testing and Hypothesis Evaluation Results

Before evaluating the hypotheses concerning MLF, LR, and HWI in relation to FS, the reliability of the survey instrument was confirmed through testing, resulting in a Cronbach's alpha of 0.913, reflecting high internal consistency. Table 3 presents the findings from the proposed model, demonstrating that perceived value, service quality (SQ), and destination image (DI) together explain 69.5% of the variations in tourist satisfaction levels (TS) ($R^2 = 0.695$), with a significance level of $p < .001$. Moreover, the Durbin-Watson metric, recorded at 1.872, suggests indicating that the residuals show no substantial autocorrelation.

Table 3. Model Summary

Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**Change Statistics**	**Durbin-Watson**
					R Square Change	F Change
1	.815a	.665	.680	3.412	.715	198.237

a. Predictors: (Constant), MLF, LR, HWI; **b. Dependent Variable:** FS

The regression equation formulated based on the coefficients listed in Table 4 is: FS = -0.612 + 0.441 × MLF + 0.259 × LR + 0.121 × HWI. This equation indicates that MLF (β =

0.452, p < .001), LR (β = 0.249, p < .001), and HWI (β = 0.154, p = .002) all have significant positive effects on FS. The variance inflation factor (VIF) values suggest that multicollinearity is not an issue, as all values are below 5. Therefore, MLF, LR, and HWI are important predictors of FS, together accounting for a substantial portion of the variance.

Table 4: Coefficients

Model	Unstandardised Coefficients	Standardised Coefficients	t	Sig.	Collinearity Statistics
	B	Std. Error	Beta		Tolerance
1	(Constant)	-0.612	0.823	-0.722	0.446
	MLF	0.441	0.056	0.452	7.802
	LR	0.259	0.061	0.249	3.704
	HWI	0.121	0.062	0.154	3.114
a. Dependent Variable: FS					

The model summary in Table 5 emphasizes a robust association between FS and the independent factors: MLF, LR, and HWI. The R-value of 0.868 reflects a considerable correlation, demonstrating a significant linear association among the variables. An R^2 value of 0.742 indicates that the independent variables account for 74.2% of the variance in FS. The adjusted R^2 value of 0.734 adds to the model's overall explanatory strength, taking into account the sample size and predictors. The standard error of the estimate, which is 3.0248, reflects the average distance between the observed data points and the regression line. Furthermore, the Durbin-Watson value of 1.241 suggests that the residuals do not exhibit significant autocorrelation, confirming that the assumptions of the model are adequately satisfied.

Table 5. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.754	.569	.564	4.127	1.487

Predictors: (Constant), FS; **Dependent Variable:** OFPC

Further information on the coefficients of the regression model is provided in Table 6. The value of the unstandardized coefficient (B) for FS is -5.623, which implies that for each unit increase in FS, the OFPC decreases by 5.623 units. The Beta value of -0.823 indicates the standardized coefficient. demonstrates a strong negative correlation between FS and OFPC. Additionally, the t-value of -8.548 and the p-value of 0.000 indicate that this association is statistically significant at the 0.05 level. The collinearity statistics, with a tolerance of 1.000 and VIF of 1.000, show no multicollinearity challenges, confirming the reliability of the model.

An R-value of 0.754 is presented in the model summary, an R^2 value of 0.569, and an adjusted R^2 value of 0.564, suggesting that FS represents 56.9% of the variance in OFPC. The estimate has a standard error of 4.127, and the Durbin-Watson statistic is measured at 1.487, which implies that there is no significant autocorrelation among the residuals.

Overall, the findings reveal a significant negative impact of FS on the OFPC. This highlights the necessity of addressing FS to encourage positive outcomes such as increased recommendations of the destination and higher rates of repeat visitation.

Table 6. Coefficients

Model	Unstandardised Coefficients	Standardised Coefficients	t	Sig.	Collinearity Statistics
	B	Std. Error	Beta		Tolerance
1	(Constant)	36.275	1.768	18.847	.000
	FS	-5.623	.548	-0.823	-8.548

a. Dependent Variable: OFPC

The substantial R^2 value indicates suggesting that the model contributes significantly to the variance in OFPC, establishing it as a robust predictive model for understanding the association between FS and OFPC. These results offer important insights for decision-makers seeking to improve farmers' organic produce scale and standards, ultimately enhancing the sustainability and viability of organic farming in the mountain region of Uttarakhand.

Observations and Discussion

The hypotheses were tested using a significance threshold set at $\alpha = 0.05$, as detailed in Table 4. The analysis demonstrates that H1, which posited a substantial impact of MLF on FS, was accepted ($\beta = 0.452$, $p < 0.001$, $t = 7.802$). This indicates that higher MLF corresponds to increased FS, likely due to a reduced workforce and heightened responsibilities for those who remain. Research by Joshi (2018) and Sati (2021) confirms how migration-induced labor shortages exacerbate financial strain. To address this issue, policymakers should implement support programs that provide financial and technical assistance alongside employment-enhancing initiatives such as training programs, market access, and diversification resources. Strengthening rural employment opportunities can empower farmers, reduce FS, and promote sustainable agricultural practices.

Similarly, H2, which proposed a significant influence of LR on FS, was accepted ($\beta = 0.249$, $p < 0.001$, $t = 3.704$). Substantial LR corresponds to greater FS, as Chaudhuri et al. (2021) highlight that inadequate resources directly hinder productivity and increase financial pressure. Improving access to modern farming equipment, irrigation facilities, and financial support is essential. Policymakers should consider introducing resource-sharing platforms, subsidies for organic inputs, and accessible credit systems to alleviate the burden on farmers and enhance their productivity. H3, which hypothesized a significant influence of HWI on FS, was also accepted ($\beta = 0.154$, $p < 0.05$, $t = 3.114$). The dual burden of domestic and agricultural responsibilities, particularly for women, significantly increases FS. Studies like Pandey et al. (2020) emphasize the need for targeted interventions such as childcare support and community labor-sharing initiatives to help farmers balance their roles effectively. Addressing HWI challenges is critical to reducing stress and enabling farmers, especially women, to focus more on sustainable farming activities.

Furthermore, H4, positing that FS negatively influences the OFPC, was accepted ($\beta = -5.623$, $p < 0.001$, $t = -8.548$). Meng et al. (2017) corroborate that financial strain adversely affects productivity and sustainable farming practices. To mitigate this impact, stakeholders must implement financial assistance programs and organize workshops focused on sustainability and efficient farming practices. Encouraging collective farming models and organic cooperatives could also provide a buffer against financial pressures while fostering community engagement. The statistical analysis conducted for this study adhered to rigorous standards. For example, the KMO coefficient (Kaiser-Meyer-Olkin), which measures sampling adequacy, was 0.892, exceeding the threshold of 0.70 (Shrestha, 2021), indicating that the sample was well-suited for factor analysis. Bartlett's sphericity test, with p < 0.001 (Odoi et al., 2022), confirmed that the correlations between variables were strong enough to justify factor analysis. Additionally, the total variance explained was 80.689%, reflecting the robustness of the model (dos Santos and Cirillo, 2023).

Conclusion

This study has illuminated the significant relationships between FS, MLF, LR, and HWI in the context of organic food production among mountain farmers in Uttarakhand. The findings underscore the critical need for targeted interventions to alleviate FS and enhance the sustainability of organic farming methods. Policymakers should prioritize implementing support programs that furnish farmers with financial and technical assistance, alongside initiatives that improve employment opportunities. By facilitating access to training programs, market resources, and diversification strategies, stakeholders can empower farmers to enhance their income potential and reduce FS. Furthermore, addressing HWI issues through support systems for childcare and household responsibilities is essential for improving farmers' productivity and well-being. These measures are vital for fostering a resilient agricultural sector that supports local farmers and contributes to the broader economic stability of the region.

From a practical standpoint, this study offers specific recommendations for policymakers, including the provision of financial aid, capacity-building initiatives, and support for work-life balance. Facilitating easier access to farming inputs, including modern equipment, and creating opportunities for rural employment will not only improve farmers' livelihoods but also contribute to the long-term sustainability of organic farming practices in the region. Moreover, community-based agricultural initiatives, including cooperative farming models, can enhance resource pooling and offer collective bargaining power for small farmers, further strengthening their ability to withstand financial pressures and improve production. From an academic perspective, this research adds valuable insights to the literature on the socio-economic challenges faced by farmers in mountainous regions, particularly in relation to organic agriculture. It emphasizes the unique dynamics that influence FS in these areas, promoting a deeper understanding of mountain farming. The study highlights the importance of examining the interplay between FS and various factors affecting farmers' productivity. This opens avenues for future research to explore the lasting influences of FS on organic food production and the effectiveness of various support interventions. Additionally, it calls for interdisciplinary approaches that combine agricultural economics, social sciences, and environmental studies to address the complexities of sustainable farming in vulnerable regions.

A potential avenue for future research could involve integrating qualitative assessments, such as focused interviews or farmer testimonials. This qualitative approach could provide richer insights into the personal and social impacts of financial stress, home-work balance, and resource scarcity. Case studies could help illuminate the lived experiences of farmers and offer deeper contextual understanding that complements quantitative findings. Overall, the insights gained from this research emphasize the need for comprehensive strategies that mitigate FS and empower farmers to achieve sustainable organic production, ultimately benefiting the community and the environment.

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