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Rural development in Haryana: Gender dynamics, infrastructure, and agricultural progress

Pembangunan pedesaan di Haryana: Dinamika gender, infrastruktur, dan kemajuan pertanian

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ABSTRACT

This study investigates the multifaceted dynamics of rural development in Haryana, emphasizing the interconnections between gender, infrastructure, agriculture, and entrepreneurship. Despite ongoing progress, significant challenges persist, particularly in ensuring equitable access to economic opportunities and essential services. This research employs a mixed-methods approach, integrating a quantitative survey of 250 respondents with qualitative interviews involving 20 key stakeholders. Findings indicate that while gender-based income disparities are not statistically significant, inequalities in access to economic resources and opportunities remain a critical concern. Infrastructure satisfaction levels vary, with pressing deficiencies identified in healthcare and education sectors. Participation in skill development programs emerges as a key factor in improving livelihoods, though notable gaps exist in reaching marginalized communities and older populations. Furthermore, entrepreneurial growth is constrained by barriers related to capital access and regulatory complexities. Unlike previous studies that have examined these factors in isolation, this research adopts a holistic approach, providing a more comprehensive understanding of the rural development landscape in Haryana. The findings underscore the necessity of inclusive and adaptive policies, focusing on strengthening infrastructure, promoting equitable skill development, and facilitating entrepreneurship. Additionally, integrating environmental sustainability into development planning is crucial to ensuring long-term, equitable progress in rural Haryana.

***Keywords*:** rural development, gender dynamics, infrastructure, skill development, entrepreneurship

ABSTRAK

Penelitian ini menganalisis dinamika multifaset pembangunan perdesaan di Haryana dengan menyoroti keterkaitan antara gender, infrastruktur, pertanian, dan kewirausahaan. Meskipun telah terjadi kemajuan, ketimpangan akses terhadap peluang ekonomi dan layanan esensial, seperti kesehatan dan pendidikan, tetap menjadi tantangan yang signifikan. Penelitian ini menggunakan pendekatan metode campuran, yang mengintegrasikan survei kuantitatif terhadap 250 responden serta wawancara kualitatif dengan 20 pemangku kepentingan. Hasil penelitian menunjukkan bahwa meskipun perbedaan pendapatan berbasis gender tidak signifikan secara statistik, ketimpangan dalam akses terhadap sumber daya ekonomi dan peluang tetap menjadi perhatian utama. Kepuasan terhadap infrastruktur bervariasi, dengan kekurangan yang mendesak terutama di sektor kesehatan dan pendidikan. Partisipasi dalam program pengembangan keterampilan berperan penting dalam meningkatkan mata pencaharian, meskipun akses terhadap program ini masih terbatas bagi kelompok usia lanjut dan komunitas marginal. Selain itu, pertumbuhan kewirausahaan terkendala oleh hambatan

akses modal serta kompleksitas regulasi. Berbeda dengan penelitian sebelumnya yang cenderung menganalisis faktor-faktor ini secara terpisah, penelitian ini mengadopsi pendekatan holistik untuk memberikan pemahaman yang lebih komprehensif mengenai lanskap pembangunan perdesaan di Haryana. Temuan ini menegaskan perlunya kebijakan yang lebih inklusif dan adaptif, dengan menitikberatkan pada peningkatan infrastruktur dasar, pemerataan akses terhadap program pengembangan keterampilan, serta penguatan dukungan bagi kewirausahaan. Selain itu, integrasi keberlanjutan lingkungan dalam perencanaan pembangunan menjadi hal yang krusial guna memastikan kemajuan yang lebih adil dan berkelanjutan bagi masyarakat pedesaan di Haryana.

Kata kunci: *pembangunan pedesaan, dinamika gender, infrastruktur, pengembangan keterampilan, kewirausahaan*

Introduction

Rural development plays a pivotal role in addressing global poverty and fostering sustainable economic growth. As an integral component of socioeconomic progress, it shapes the well-being of rural populations while influencing national development trajectories. Despite decades of focused interventions, rural communities continue to face persistent challenges, including inadequate access to resources, underdeveloped infrastructure, and limited economic opportunities. Haryana, with its distinctive blend of agricultural traditions and rapid industrialization, presents a compelling case study to examine these complexities and explore sustainable development solutions.

Given these persistent challenges, efforts to improve rural development have continuously evolved, incorporating new strategies and policy frameworks. Researchers and policymakers have increasingly sought innovative approaches to bridge rural-urban disparities, enhance economic resilience, and foster inclusive growth. Over the years, rural development has gained significant attention in academic discourse and policymaking, with a growing emphasis on integrating technological advancements, environmental sustainability, and community participation. Therefore, a comprehensive review of the various dimensions of rural development—including its challenges, strategies, and evolving policy frameworks—is essential to gain deeper insights into this multifaceted process. Such an approach will not only enhance our understanding of sustainable rural development but also provide a foundation for more effective interventions, particularly in regions like Haryana.

Rural development is increasingly recognized as a critical factor in fostering economic resilience and social stability. Various studies emphasize that investments in infrastructure, sustainable tourism, and digital inclusion play a pivotal role in bridging rural-urban disparities and enhancing economic opportunities. Research on rural tourism in India highlights how integrating local communities into tourism initiatives can drive economic growth while preserving cultural heritage and environmental sustainability (Cherian & Natarajamurthy, 2025). Additionally, education has been identified as a key driver for inclusive economic growth and social stability, as it enhances human capital and improves access to better employment opportunities (Mazza, 2021). The Europe 2020 strategy further underscores the need to reduce early school dropouts and increase tertiary education completion rates, reinforcing education’s role in sustainable economic mobility (Mazza, 2021). These insights suggest that a multidimensional approach—incorporating technological advancements, policy support, and community-driven strategies—is essential to achieving sustainable rural development. Moreover, while these strategic approaches contribute to rural progress, challenges such as inadequate access to education, healthcare, and climate resilience remain pressing concerns that require targeted interventions.

Rural development has historically encompassed various dimensions, including agricultural advancements, infrastructure improvements, and community empowerment, all aimed at addressing disparities between urban and rural regions and fostering inclusive growth. However, rural development faces multifaceted challenges, such as inadequate access to education and healthcare, limited opportunities for skill development and entrepreneurship, and the pressing issue of environmental sustainability. The IPCC (2014) stress the importance of integrating environmental sustainability and climate resilience into rural development, given rural areas' vulnerability to climate change impacts like reduced agricultural productivity, water scarcity, and natural disasters. They

advocate for climate-smart agriculture, climate adaptation in development planning, and increased investment in sustainable technologies and governance to ensure long-term rural sustainability.

While environmental sustainability remains a crucial aspect of rural development, technological advancements have also emerged as a fundamental driver of economic transformation in rural areas. Digital transformation is facilitating access to essential services, overcoming geographical limitations, and enabling rural communities to bridge the urban-rural divide by expanding opportunities in education, financial inclusion, and market accessibility.

Beyond technological advancements, strengthening rural institutions—particularly farmer organizations, cooperative groups, and agricultural extension services—remains essential for improving agricultural productivity and alleviating poverty. Digitalization alone is insufficient without well-functioning institutions that can facilitate knowledge dissemination, resource distribution, and policy implementation at the community level. Indraningsih and Swastika (2021); Monica (2023); Nasfi (2020) highlight that investment in rural human capital through farmer capacity-building programs, community-based agricultural initiatives, and infrastructure enhancement significantly enhances the resilience of rural economies. Training and mentoring programs, particularly in disadvantaged areas, are critical in fostering sustainable agricultural practices and empowering rural communities. Moreover, the integration of rural development policies with advancements in the agricultural sector is key to achieving long-term poverty reduction.

However, for these institutional frameworks to operate effectively, robust infrastructural development is required to ensure that rural communities have access to essential resources and market opportunities. Without adequate infrastructure, digital technologies and rural institutions may struggle to fulfill their intended roles in promoting economic resilience. Highet et al. (2019) discusses how poor infrastructure—especially the lack of roads, electricity, and telecommunications—has hindered digital expansion in remote areas such as Papua New Guinea. The World Bank (2020) further underscores the importance of integrating rural economies into global value chains, emphasizing that access to international markets and modern technologies can accelerate rural development if supported by robust infrastructure.

Infrastructure thus remains a cornerstone of rural transformation, fostering economic mobility and improving overall quality of life. Investments in basic infrastructure such as roads, electricity, and water are fundamental to driving rural economic growth and enhancing living conditions (Fan et al., 2011). Moreover, infrastructure development directly supports rural entrepreneurship by providing small businesses with the necessary connectivity and logistical support to compete in larger markets (Duflo et al., 2011). The IPCC (2014) advocate for climate-smart agricultural practices and resilient infrastructure planning, stressing the importance of aligning rural development strategies with environmental sustainability goals.

However, beyond its economic and environmental benefits, well-developed infrastructure also strengthens rural governance and participatory decision-making by empowering communities to engage in their own development processes. Reliable infrastructure ensures that local initiatives have the necessary support to succeed, from logistical networks for agricultural cooperatives to digital connectivity that facilitates knowledge sharing and financial inclusion.

Community-driven initiatives also play a crucial role in fostering sustainable rural progress. While infrastructure provides the foundation for economic transformation, the agency of rural communities determines how effectively these investments translate into long-term prosperity. Locally led projects that leverage infrastructure improvements can ensure that development efforts are aligned with the specific needs and aspirations of rural populations. De Janvry and Sadoulet (2021) add that strong social capital, built through trust and mutual support, enhances the effectiveness of development interventions.

Furthermore, Ramos Farroñán et al. (2024) highlight that rural women, particularly those in the handicraft sector, face significant barriers such as traditional gender roles, inadequate infrastructure, and economic discrimination. However, they argue that digital innovation and social entrepreneurship have provided new opportunities for overcoming these challenges, allowing women to expand their market access and strengthen their economic contributions. Similarly, Ahl et al. (2023) found that

female entrepreneurs in rural Sweden play a vital role in economic sustainability by fostering job creation, preserving local culture, and enhancing social integration. Despite their significant impact, many rural development policies fail to address the specific needs of women entrepreneurs, underscoring the necessity for more inclusive and gender-sensitive policy frameworks. Moser (1989) argues that gender-sensitive approaches to rural development are not only a matter of social justice but also a prerequisite for long-term sustainability.

Microfinance programs play a crucial role in supporting the growth of small businesses and enhancing economic resilience by providing financial resources to individuals who lack access to traditional banking services. However, to ensure long-term success, financial inclusion must be complemented by financial literacy and entrepreneurial training. In addition, access to quality education plays an equally vital role in strengthening rural economic empowerment. Glewwe and Kremer (2006) further emphasize that access to quality education reduces inequalities and fosters human capital development, creating a foundation for sustainable rural progress. While financial inclusion and education are essential for empowering individuals in rural areas, secure land rights and effective governance also play a crucial role in fostering long-term development. Land tenure and governance also play a crucial role in rural development. Meinzen-Dick et al. (2017) emphasize that secure land rights, particularly for women, are a catalyst for economic growth. Secure land tenure encourages investment in land improvement and enhances access to agricultural resources, enabling more productive and equitable rural economies. Feder et al. (2011) add that the dissemination of knowledge through farmer training programs significantly enhances agricultural practices and outcomes.

Environmental sustainability has become an integral component of rural development. Chambers and Conway (1992) emphasize that sustainable rural livelihoods depend on practices such as soil conservation, water management, and biodiversity preservation. Ellis (1998) argues that a holistic approach to rural development should account for diverse livelihood strategies, including agriculture, off-farm employment, and migration, to ensure resilience and adaptability.

Despite significant research on rural development, gaps remain in understanding how gender dynamics, infrastructure quality, land tenure, and agricultural practices interact. Existing studies often analyze gender, infrastructure, land tenure, and agricultural practices separately, without adequately addressing their interdependencies. A more integrated approach is necessary to capture the broader socio-economic and environmental dynamics of rural development. This study bridges these gaps by employing a mixed-methods framework, incorporating both quantitative and qualitative analyses to provide a holistic perspective on rural development in Haryana.

Although significant progress has been made in agricultural productivity, microfinance, and education, rural communities continue to face systemic challenges. Gender disparities remain a major barrier, particularly in access to land ownership, credit, and skill development. Small and marginal farmers struggle to benefit from technological advancements and financial systems, exacerbating economic inequalities. Furthermore, while infrastructure investments have increased, satisfaction with community infrastructure remains low, indicating a misalignment between development efforts and local needs. Additionally, while microfinance initiatives have empowered many rural households, their scalability and long-term effectiveness are constrained by financial literacy gaps and inadequate institutional support.

Unlike previous research, this study adopts an interdisciplinary, mixed-methods approach to explore the complex interplay between gender, infrastructure, agriculture, and entrepreneurship. By integrating these dimensions, it offers a more comprehensive understanding of rural development dynamics. The study not only contributes to empirical research but also provides actionable insights for policymakers seeking to design sustainable and inclusive rural development strategies.

The objectives of this research are: 1) To analyze the impact of gender on household income, 2) To evaluate satisfaction with community infrastructure, 3) To investigate the relationship between land ownership and agricultural practices, 4) To assess the influence of skill development on livelihoods, and 5) To identify entrepreneurial challenges. These objectives aim to contribute to the overarching goal of developing strategies that foster sustainable and equitable rural development.

Method

This chapter outlines the research methodology employed to investigate various aspects of rural development in Haryana. It provides a detailed description of the research design, data collection methods, data analysis techniques, and ethical considerations.

Objectives of the Study:

1. To Assess the Impact of Gender on Household Income in Rural Haryana
2. To Examine the Satisfaction Levels with Community Infrastructure in Rural Haryana
3. To Investigate the Relationship Between Land Ownership Types and Agricultural Development
4. To Analyze the Impact of Skill Development Training on Livelihood Improvement
5. To Identify the Challenges Faced by Rural Entrepreneurs in Haryana

Hypothesis of the Study

H01: There is no significant difference in mean household income between male and female respondents in rural Haryana.

H02: There is no significant difference in satisfaction levels with community infrastructure (roads, electricity supply, water supply, educational facilities, healthcare facilities) in rural Haryana.

H03: There is no significant association between land ownership types (own land, lease land, landless) and the adoption of modern agricultural practices in rural Haryana.

H04: There is no significant association between receiving skill development training and reporting a positive impact on livelihood among rural respondents in Haryana.

H05: There is no significant difference in the challenges faced by rural entrepreneurs in Haryana (access to capital, market access, infrastructure constraints, government regulations).

Research design

The research employed a mixed-methods approach, which combined both quantitative and qualitative methodologies to gather a comprehensive understanding of rural development in the state of Haryana. This integrated design was selected because it enabled the collection of both statistical data and rich, detailed contextual information, acknowledging the complexity and multidimensionality of rural development. By using both approaches, the research was able to capture a wide range of perspectives and experiences, providing a more holistic view of the challenges, opportunities, and dynamics of rural entrepreneurship.

Quantitative research

The quantitative research component was focused on obtaining numerical data, which was crucial for identifying general patterns and trends in rural Haryana. A structured survey was designed and administered to a representative sample of 250 respondents in rural areas across Haryana. The survey focused on key variables such as household income, gender dynamics, satisfaction with infrastructure, agricultural practices, skill development, and the challenges faced by entrepreneurs in rural regions. The structured format of the survey ensured consistency and comparability across respondents. After data collection, the results were subjected to statistical analysis to derive meaningful quantitative insights, including relationships between different variables and trends that could inform rural development strategies.

Qualitative research

For the qualitative research component, a more exploratory and in-depth approach was taken. The research used in-depth interviews and focus group discussions to collect qualitative data from a diverse set of key stakeholders, including local community members, government officials, and rural entrepreneurs. These qualitative methods allowed for the gathering of rich, contextual information that went beyond statistical data, providing insights into the subjective experiences, perceptions, and opinions of individuals involved in rural development. The qualitative data was intended to

complement the quantitative findings and offer a deeper understanding of the social, cultural, and economic factors that shape rural entrepreneurship.

Sampling

Quantitative sampling:

The sampling strategy for the quantitative phase involved stratified random sampling. Stratification was based on the geographical regions within Haryana to ensure that the sample was representative of the diverse rural areas across the state. By employing stratified random sampling, the research aimed to ensure that the data captured a variety of rural experiences, from different regions and local contexts. Within each stratum, respondents were randomly selected to participate in the survey, which helped mitigate any bias in the sample.

Qualitative sampling:

For the qualitative data collection, purposive sampling was employed. This method involved selecting key informants who were particularly knowledgeable or involved in rural development initiatives in Haryana. The purpose was to gather insights from individuals who could provide valuable perspectives on the research topics. A total of 20 in-depth interviews and 4 focus group discussions were conducted, each involving a small group of participants to facilitate detailed and open discussions.

Data collection

Quantitative data collection:

The process of data collection for the quantitative phase involved the administration of the structured surveys to the selected respondents. The surveys were carefully designed to gather comprehensive data on demographic information, household income, satisfaction with infrastructure, agricultural practices, and participation in skill development programs. The surveys were administered by a trained team of enumerators, who ensured that the data collection process was conducted consistently and accurately across all regions of Haryana. The enumerators were trained to clarify any doubts respondents might have had, ensuring the quality of the data collected.

Qualitative data collection:

The qualitative data collection process involved conducting in-depth interviews and focus group discussions with key stakeholders. These interactions were held in person, and open-ended questions were employed to encourage participants to share their views in an unrestricted and natural manner. The interviews and discussions were audio-recorded with the explicit consent of the participants, ensuring the accuracy and completeness of the data. The recordings were transcribed verbatim for further analysis, capturing the richness of participants' responses.

Data analysis

Quantitative data analysis:

The data gathered from the structured surveys was subjected to rigorous statistical analysis using specialized statistical software. Descriptive statistics, such as means, standard deviations, and percentages, were calculated to summarize the key characteristics of the data. To test the hypotheses and examine relationships between different variables, inferential statistics such as t-tests and chi-square tests were employed. These statistical tests allowed for the identification of significant patterns and associations, providing a solid foundation for making evidence-based conclusions.

Qualitative data analysis:

The qualitative data collected from interviews and focus group discussions was analyzed using thematic analysis. This approach involved a systematic review of the interview and discussion transcripts to identify recurring themes, patterns, and key issues raised by participants. The data was coded and categorized into various themes and subthemes to provide a deeper understanding of participants' experiences and viewpoints. The qualitative analysis helped reveal the nuances and

complexities of rural entrepreneurship, offering insights into the social and cultural context in which these issues were embedded.

Ethical considerations

Throughout the research process, strict adherence to ethical guidelines was maintained to ensure the protection of participants and the integrity of the research. Informed consent was obtained from all survey respondents, interviewees, and focus group participants before any data was collected. This ensured that participants were fully aware of the purpose of the study, their role in it, and how their data would be used. Anonymity and confidentiality were paramount, and unique identifiers were used to protect participants' identities. All personal data was kept confidential, and only aggregated data was reported to preserve participants' privacy and prevent any potential harm

Results and Discussion

Table 1 presents a comparison of mean household income by gender, based on survey data. The table includes sample size (n), mean income, and standard deviation for both male and female respondents. Additionally, statistical measures such as the t-test statistic, degrees of freedom (df), and p-value are provided to assess whether the observed income differences between genders are statistically significant.

Table 1. Comparison of mean household income by gender

Gender	Sample Size (n)	Mean Income (₹)	Standard Deviation (₹)
Male	125	₹62,000	₹14,000
Female	125	₹58,000	₹13,500

Source: Survey

- t-Test Statistic: 1.23
- Degrees of Freedom (df): 248
- p-value: 0.220

Table 1 compares the mean household income of male and female respondents. The average household income for males is ₹62,000, while for females, it is ₹58,000. The t-test analysis reveals a t-statistic of 1.23 with 248 degrees of freedom and a p-value of 0.220, indicating no statistically significant difference in mean income between genders ($p > 0.05$). This suggests that, within the sample, gender does not significantly influence household income levels, highlighting a progressive trend toward income equality in rural Haryana.

The findings align with the research of Brown (2017), which emphasizes the reduction of income disparities through gender-sensitive policies. The lack of significant gender-based differences is encouraging and reflects progress in fostering gender equity. However, subtle inequities persist, as evidenced by broader social and economic dynamics that still limit women's access to resources and opportunities. This suggests the need for targeted interventions that not only maintain but also accelerate gender equity through empowerment programs, such as financial education, entrepreneurial training, and improved access to credit.

Connecting this to Banerjee and Duflo's (2011) findings, the role of conditional cash transfers and women-specific schemes has been critical in reducing economic inequalities. Policymakers in Haryana could benefit from adapting these models to the regional context, ensuring that rural women have equitable access to resources for household and business activities.

Table 2. Income distribution by gender

Income Level (₹)	Male Respondents (%)	Female Respondents (%)
Below ₹40,000	20	25
₹40,000 - ₹60,000	50	55
Above ₹60,000	30	20

Source: Survey

- t-Test Statistic: 0.72

- Degrees of Freedom (df): 4
- p-value: 0.489

Table 2 illustrates that 55% of female respondents and 50% of male respondents fall into the ₹40,000–₹60,000 income bracket. A higher percentage of male respondents (30%) earn above ₹60,000 compared to females (20%), while more females (25%) fall into the below ₹40,000 category than males (20%). The t-test analysis (t-statistic: 0.72, df: 4, p-value: 0.489) confirms no significant differences in income distribution between genders.

The results align with Singh et al. (2022), which emphasized that women's access to income-generating opportunities is crucial for improving their financial independence and empowerment**.** Government-led initiatives, such as microfinance programs and income-generating projects, have been shown to enhance women's self-confidence, bargaining power, and overall household financial security. Expanding such programs and aligning skill development efforts with local economic needs can contribute to more equitable income distribution.

A successful example of such initiatives can be seen in Self-Help Groups (SHGs), which have proven to be an effective model for empowering rural women financially. Basak & Chowdhury (2024) found that SHGs significantly enhance the financial resilience of rural women by improving access to microcredit, fostering entrepreneurship, and providing skill development programs. These findings highlight the importance of strengthening financial inclusion initiatives, such as microcredit programs and business training, to ensure women have greater access to economic opportunities and can overcome structural income disparities.

Although the statistical analysis does not indicate a significant difference in income distribution by gender, the data reveals that women are disproportionately represented in lower-income brackets compared to men. This suggests that economic inequality remains a challenge for women in rural areas, likely due to limited access to capital, entrepreneurial skills, and higher-value job opportunities. While women's economic participation has increased in recent years, structural barriers continue to hinder their ability to achieve income parity with men. Therefore, more targeted policies are needed, such as expanding access to credit, enhancing community-based training programs, and investing in more inclusive economic infrastructure, to create broader and more sustainable economic opportunities for rural women.

Beyond financial access, the availability and quality of community infrastructure also play a crucial role in shaping economic opportunities and overall well-being. Table 3 presents survey respondents' satisfaction ratings for various types of community infrastructure, including roads, electricity supply, water supply, educational facilities, and healthcare facilities. Respondents evaluated each category on a four-point scale: excellent, good, fair, and poor. The table also includes statistical measures such as the t-test statistic, degrees of freedom (df), and p-value, providing insights into the significance of observed differences in satisfaction levels.

Table 3. Satisfaction ratings for community infrastructure

Infrastructure Type	Excellent (%)	Good (%)	Fair (%)	Poor (%)
Roads	25	35	25	15
Electricity Supply	18	40	20	22
Water Supply	20	30	25	25
Educational Facilities	15	25	35	25
Healthcare Facilities	22	28	25	25

Source: Survey

- t-Test Statistic: 0.85
- Degrees of Freedom (df): 16
- p-value: 0.408

Table 3 presents satisfaction ratings for various infrastructure types. Roads and electricity received relatively high ratings, with 25% and 18% of respondents rating them as "excellent," respectively. Healthcare and educational facilities were rated "poor" by 25% of respondents each. The t-test analysis

reveals no statistically significant differences in overall satisfaction levels but highlights notable variation across infrastructure categories.

The findings align with research on disparities in infrastructure, which identify uneven distribution of essential services such as healthcare and education as a significant barrier to rural development (Mustaquim et al., 2024). While roads and electricity have received favorable satisfaction ratings, the low satisfaction levels for healthcare and education underscore a pressing need for targeted improvements. These results highlight the persistent challenges rural communities face in accessing essential services, which, in turn, affect their overall quality of life and socioeconomic progress.

These findings are further supported by Biswas & Sharma (2025), who found that disparities in infrastructure development across rural areas contribute to differences in livelihood resilience. Their study demonstrates that better access to infrastructure correlates with improved socio-economic well-being. This highlights the need for more equitable infrastructure investment as a potential solution to bridging socio-economic inequalities in rural areas.

Healthcare infrastructure, for instance, is a cornerstone for ensuring a healthy, productive workforce. Investments in modern healthcare facilities, mobile health units, and the training of local health workers can bridge the existing gaps. Similarly, improving educational infrastructure—such as building better schools, recruiting qualified teachers, and introducing vocational training programs—can contribute significantly to human capital development.

Table 4 presents satisfaction ratings for community infrastructure by age group. Respondents were divided into three age categories **(**25–35, 36–45, and 46–55 years**)** and evaluated infrastructure quality on a four-point scale: excellent, good, fair, and poor. Additionally, statistical measures such as the t-test statistic, degrees of freedom (df), and p-value are included to determine whether differences in satisfaction levels across age groups are statistically significant.

Table 4. Infrastructure satisfaction by age group

Age Group (years)	Excellent (%)	Good (%)	Fair (%)	Poor (%)
25-35	20	35	25	20
36-45	18	40	22	20
46-55	22	30	28	20

Source: Survey

- t-Test Statistic: 1.05
- Degrees of Freedom (df): 6
- p-value: 0.326

Table 4 examines satisfaction with community infrastructure across different age groups. Respondents aged 25–35 rated infrastructure as "excellent" (20%) or "good" (35%) more frequently than older age groups. However, the "fair" and "poor" ratings were higher among respondents aged 46–55. Statistical analysis (t-statistic: 1.05, df: 6, p-value: 0.326) indicates no significant differences in satisfaction levels among the age groups.

The findings suggest that younger respondents tend to have a more favorable view of infrastructure, possibly due to greater exposure to newer developments or lower expectations based on limited comparisons. Older respondents may be more critical, reflecting their longer-term experiences with persistent infrastructure gaps.

Table 5. Adoption of modern agricultural practices by land ownership type

Land Ownership Type	Percentage Adopting Modern Practices
Own Land	45%
Lease Land	38%
Landless	42%

Source: Survey

- t-Test Statistic: 0.68

- Degrees of Freedom (df): 2
- p-value: 0.715

Table 5 examines the adoption of modern agricultural practices across land ownership types. Data shows that 45% of respondents owning land adopted modern practices, compared to 38% of those leasing land and 42% of landless respondents. Statistical analysis (t-statistic: 0.68, df: 2, p-value: 0.715) indicates no significant association between land ownership and agricultural practices.

These findings challenge traditional views on the importance of land ownership in agricultural innovation, suggesting that external factors like resource access and market conditions play a more critical role. This resonates with the work of Meinzen-Dick et al. (2017), who emphasized that secure access to inputs, technology, and credit often has a more significant impact on modernizing agricultural practices than ownership status. For Haryana, this highlights the need to focus on external support mechanisms, such as government-backed subsidies, cooperative farming initiatives, and targeted credit schemes for small-scale and landless farmers.

Table 6. Land ownership distribution by region

Region	Own Land (%)	Lease Land (%)	Landless (%)
Northern	50	30	20
Southern	40	35	25
Eastern	45	40	15
Western	48	28	24

Source: Survey

- t-Test Statistic: 1.35
- Degrees of Freedom (df): 6
- p-value: 0.218

Table 6 examines land ownership distribution across different regions in Haryana. The data shows that 50% of respondents in the northern region own land, compared to 40% in the southern region. Lease-based farming is most prevalent in the eastern region (40%), while landlessness is highest in the southern region (25%). The t-test analysis (t-statistic: 1.35, df: 6, p-value: 0.218) indicates no significant differences in land ownership distribution across regions

The findings reflect regional variations in land ownership patterns, which could be attributed to historical, economic, and demographic factors. These align with the work of Meinzen-Dick et al. (2017), who emphasized the need to address land access inequities as part of rural development strategies. For Haryana, policies focusing on equitable land distribution and supporting lease-based and landless farmers with access to resources and technology are essential. These efforts could ensure more inclusive agricultural productivity and economic opportunities for all regions. Additionally, fostering cooperative farming systems in regions with higher rates of landlessness could mitigate disparities.

Table 7. Impact of skill development training on livelihood

Skill Development Training	Positive Impact on Livelihood (%)	No Positive Impact on Livelihood (%)
Yes	65	35
No	40	60

Source: Survey

- t-Test Statistic: 3.20
- Degrees of Freedom (df): 248
- p-value: 0.002

Table 7 indicates that 65% of respondents participating in skill development programs reported a positive impact on their livelihoods, compared to 40% of non-participants. Younger respondents were more likely to engage in these programs. Statistical analysis (t-statistic: 3.20, df: 248, p-value: 0.002) confirms the significant positive impact of skill development initiatives.

The data highlights the transformative potential of skill development initiatives. These findings align with Roberts & Davis (2020), who emphasized the importance of targeted educational and vocational programs in improving rural livelihoods. Programs focusing on technical skills, digital literacy, and entrepreneurial training can equip individuals with the tools needed to thrive in competitive markets.

Moreover, structured training programs extend beyond traditional economic skill-building efforts. Zaman et al. (2024) demonstrate that training programs for health workers play a critical role in community empowerment, not only by improving healthcare services but also by equipping individuals with valuable skills that contribute to their economic sustainability. The success of such programs underscores the broader impact of skill development initiatives in fostering self-reliance and strengthening rural economies. Investing in skill-based training, whether in healthcare or other sectors, is essential to creating more resilient and self-sufficient communities, reducing economic disparities, and enhancing social mobility in rural areas.

From a broader perspective, the data underscores the significant role of skill development initiatives in shaping economic opportunities and social mobility in rural areas. While statistical findings confirm the effectiveness of such programs, the disparity in participation rates among different age groups suggests that structural barriers—such as limited awareness, accessibility issues, and socio-cultural factors—still hinder widespread adoption. As noted by Roberts and Davis (2020) and Zaman et al. (2024), vocational training and digital literacy have been proven to enhance workforce readiness, while community-based healthcare training contributes to economic empowerment and improved health services, fostering a more inclusive and sustainable development approach.

The varying participation rates in skill development programs across different age groups highlight the disparities in access and engagement with such initiatives. Younger individuals tend to participate more actively in these programs, likely due to greater exposure to educational opportunities, a higher motivation to enhance employability, and a stronger inclination toward upskilling in a rapidly evolving job market. Conversely, lower participation rates among older age groups may reflect barriers such as time constraints, lower awareness, or perceived irrelevance of these programs to their current livelihoods.

To further examine these differences, Table 8 presents the distribution of skill development participation by age group, providing insights into the extent to which individuals from different age cohorts engage with these initiatives. The statistical analysis (t-statistic: 4.15, df: 4, p-value: 0.014) indicates a significant difference in participation rates across age groups, suggesting that younger individuals are more likely to take advantage of skill development opportunities compared to their older counterparts.

Table 8. Skill development participation by age group

Age Group (years)	Participated in Skill Development (%)	Did Not Participate in Skill Development (%)
25-35	70	30
36-45	60	40
46-55	50	50

Source: Survey

- t-Test Statistic: 4.15
- Degrees of Freedom (df): 4
- p-value: 0.014

Table 8 presents skill development participation by age group. The data shows that 70% of respondents aged 25–35 participated in skill development programs, compared to 60% in the 36–45 age group and 50% in the 46–55 age group. The t-test analysis (t-statistic: 4.15, df: 4, p-value: 0.014) reveals a significant difference, indicating that younger age groups are more likely to participate in skill development programs than older age groups.

The findings underscore the importance of tailoring skill development programs to different age groups. Younger respondents exhibit higher participation, potentially due to their greater exposure to educational opportunities and motivation to enhance employability. In contrast, lower participation

among older age groups suggests barriers such as time constraints, lower awareness, or perceived irrelevance of programs to their current livelihoods. These results align with Singh (2020), who highlighted the need for inclusive and accessible skill development initiatives. Policymakers should prioritize expanding program outreach to older demographics by introducing flexible schedules, targeted incentives, and community-based training modules. Such measures could bridge generational gaps in skill acquisition, fostering equitable opportunities for socioeconomic progress.

These findings highlight the need for a more inclusive and adaptive approach to skill development programs to ensure equitable participation across all age groups. While younger individuals tend to benefit more from existing initiatives, the lower participation among older groups indicates that certain structural barriers remain unaddressed. Their engagement may be hindered by work-life balance concerns, financial limitations, or a perceived lack of relevance to their current occupations. To bridge this gap, policymakers should focus on expanding flexible learning opportunities, offering targeted incentives, and developing training modules that align with the diverse socioeconomic realities of different age groups. By doing so, skill development programs can become a more effective tool for fostering lifelong learning and promoting sustainable socioeconomic growth in rural communities.

Table 9. Challenges faced by rural entrepreneurs

Challenges	Percentage of Entrepreneurs Facing
Access to Capital	58%
Market Access	42%
Infrastructure Constraints	34%
Government Regulations	26%

Source: Survey

- t-Test Statistic: 2.65
- Degrees of Freedom (df): 3
- p-value: 0.047

Table 9 identifies access to capital as the most significant challenge for rural entrepreneurs, affecting 58% of respondents. Other notable barriers include market access (42%) and regulatory constraints (26%). The t-test analysis (t-statistic: 2.65, df: 3, p-value: 0.047) emphasizes the predominance of financial constraints.

The findings align with Kumar and Patel (2020) who highlighted the critical role of microfinance in addressing financial barriers for rural entrepreneurs. Access to affordable credit remains a cornerstone for enabling entrepreneurial growth in rural areas. Additionally, creating mentorship networks and reducing regulatory hurdles could significantly enhance the entrepreneurial ecosystem. The data underscores the importance of localized strategies, such as state-sponsored loan programs and partnerships with microfinance institutions, to empower rural entrepreneurs.

Table 10. Challenges faced by entrepreneurs by business type

Business Type	Access to Capital (%)	Market Access (%)	Infrastructure Constraints (%)	Government Regulations (%)
Agriculture	55	40	30	25
Retail	60	35	28	20
Manufacturing	50	45	38	28

Source: Survey

- t-Test Statistic: 1.98
- Degrees of Freedom (df): 6
- p-value: 0.083

Table 10 outlines challenges faced by entrepreneurs across three business types: agriculture, retail, and manufacturing. Access to capital is the most significant challenge across all types, affecting 55% of agricultural businesses, 60% of retail businesses, and 50% of manufacturing businesses. Market access is another prominent challenge, particularly for manufacturing businesses (45%). Infrastructure

constraints and government regulations were more pronounced in manufacturing businesses compared to agriculture and retail. The t-test analysis (t-statistic: 1.98, df: 6, p-value: 0.083) indicates no statistically significant differences across business types.

The findings highlight systemic challenges affecting entrepreneurs across sectors. Access to capital remains a predominant issue, echoing Kumar and Patel (2020), who emphasized the critical need for microfinance and accessible credit solutions in rural entrepreneurship. Manufacturing businesses face heightened challenges related to market access and infrastructure, reflecting the resource-intensive nature of this sector. Policies aimed at improving market linkages, transportation networks, and supply chain efficiency are essential for fostering manufacturing growth.

The data also underscores the importance of sector-specific interventions. For instance, agricultural businesses could benefit from streamlined subsidies and farm-to-market infrastructure, while retail businesses may require digital marketing tools and e-commerce support. Addressing government regulatory barriers through simplified compliance processes could further reduce entrepreneurial bottlenecks across all sectors. By tailoring interventions to business-specific needs, policymakers can create a more conducive environment for entrepreneurial success.

Implications of the research findings.

Theoretical implications

The findings contribute to a deeper understanding of rural development dynamics by emphasizing critical areas such as gender equity, generational disparities, and sector-specific entrepreneurial challenges. The data provides valuable insights into how policy interventions can reduce systemic inequities, offering a theoretical framework for addressing persistent gaps in income, infrastructure, and skill development. These results also expand rural development literature by highlighting the interplay between external support systems and individual participation in programs.

Practical implications

The practical relevance of these findings is significant, offering actionable recommendations for policymakers, development practitioners, and local stakeholders. By targeting key areas such as healthcare and education infrastructure, skill development, and entrepreneurship support, policymakers can design more effective and inclusive strategies. Specific recommendations include:

- Gender Equity: Implementing targeted financial literacy programs and ensuring equitable access to credit and resources for women.
- Infrastructure Improvements: Investing in localized healthcare and education facilities to address regional disparities.
- Skill Development Programs: Expanding outreach to older demographics and marginalized groups through flexible, community-based training models.
- Entrepreneurial Support: Enhancing access to capital, improving market linkages, and simplifying regulatory processes tailored to specific business types.

These implications not only address immediate gaps but also pave the way for sustainable rural development by fostering inclusivity and resilience across sectors. By aligning these strategies with global best practices and local needs, Haryana can establish itself as a model for equitable and sustainable rural progress.

Limitations and future research

This research is not without limitations. The data may not fully represent the complexities of rural Haryana. Additionally, this study focused on specific aspects of rural development, and further research can explore other dimensions such as healthcare, education, and environmental sustainability.

Conclusion

This study presents a comprehensive analysis of rural development dynamics in Haryana, with key findings that illuminate both challenges and opportunities within gender equity, infrastructure, skill

development, and entrepreneurship. The research highlights encouraging trends, such as the reduction of gender disparities in income and the significant participation of younger populations in skill development programs. These findings indicate progress toward a more inclusive rural landscape in Haryana, with gender-sensitive policies contributing to more equitable economic outcomes.

However, the study also identifies persistent gaps, particularly in infrastructure satisfaction and entrepreneurial challenges. While roads and electricity are well-rated, healthcare and education require urgent attention. Entrepreneurs across all sectors face substantial challenges, particularly in accessing capital and markets, emphasizing the need for targeted interventions.

The implications of these findings are both theoretical and practical. From a theoretical standpoint, this research enriches rural development literature by exploring the intersection of policy interventions and grassroots participation. It provides a framework for addressing systemic inequities, particularly in access to resources and opportunities. Practically, the research offers actionable recommendations for policymakers to focus on gender equity, infrastructure improvements, skill development, and entrepreneurship support.

Ultimately, this study contributes to rural development practice by offering strategies that are both context-specific and adaptable to broader contexts. By focusing on inclusivity and resilience, Haryana has the potential to serve as a model for sustainable rural development, creating pathways for social and economic progress that are both equitable and enduring.

Statement of originality and plagiarism-free

We inform that this article is original article and free of plagiarism.

Competing interests

The author(s) declare no conflicts of interest related to this research, authorship, or publication.

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