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Socioeconomic Impact of Irrigation Scarcity on the Deprived Community at the Bottom of the Pyramid

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The impact of irrigation scarcity is not limited to farming alone. It affects different aspects of life, such as education, health, and migration. When farmers cannot grow enough food, their families face food insecurity and malnutrition. Poor nutrition can lead to health problems, making it harder for people to work and earn a living. Children from farming families are often forced to leave school and help with farming or find other jobs to support their households. In extreme cases, families migrate to urban areas in search of work, which results in overcrowded cities and more competition for low-paying jobs.

Research Questions: How does irrigation scarcity affect the income and economic stability of BoP communities? How do small farmers and laborers face the key livelihood challenges due to

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irrigation shortages? How does water scarcity contribute to seasonal or permanent migration among marginalized populations?
Aim: 1. To study the impact of irrigation shortage on agricultural yield and income of communities at BoP. 2. To study the impact of irrigation scarcity on employment opportunities in rural areas. 3. To study the migration patterns caused by water scarcity and its impact on families. 4. To study the strategies adopted by the people at the bottom of the pyramid to deal with water scarcity.
Methodology Used: A descriptive research design is used to understand and explain the effects of irrigation scarcity on farmers at the bottom of the pyramid. A well-structured questionnaire was distributed to farmers, labourers, and migrant families to collect their responses. The questionnaire includes both close-ended and open-ended questions. A purposive sampling method was used to collect the sample, focusing on communities at the Bottom of the pyramid.
Expected Outcome: 1. Clear evidence of how irrigation scarcity affects livelihoods, food security, and migration patterns. 2. Identification of coping strategies used by BoP communities to sustain themselves. 3. Policy recommendations for improving irrigation infrastructure, employment opportunities, and rural resilience.

Keywords: Irrigation scarcity; farming; employment; migrate; socioeconomic conditions; food security; deprived community.

1. INTRODUCTION

Water scarcity is a critical challenge affecting agricultural productivity and rural livelihoods, particularly in regions dependent on rainfed agriculture. The deprived communities at the *Bottom of the Pyramid (BoP)*—those with the lowest income levels—are deeply affected by irrigation facilities, as they rely heavily on farming and daily wage labor. Without constant access to water for irrigation, these communities are facing economic and social instability, food insecurity, and that increases the migration towards metros (Asim et al., 2012; Israilova et al., 2023). This research aims to identify, how irrigation for farming impacts the socioeconomic conditions of BoP communities and to identify potential strategies for sustainable livelihood of these communities in rural areas.

The rural peoples, particularly those at the bottom of the pyramid (BoP), face a critical challenge: a lack of water for irrigation in India. When there is not enough water to support farming, that directly affects crop production of the farmers, and it impacts the income, and food security of the population (Shah et al., 2020). The problem of income and food is even more severe because deprived communities live in extreme poverty because they struggle with limited resources and opportunities (Molden et al., 2017).

The problem is even more severe for the deprived community at the bottom of the pyramid (BoP), who have fewer resources and opportunities. The term 'bottom of the pyramid' refers to the poorest section of society that struggles to meet their basic needs (Prahalad, 2005).

In a state like Maharashtra agriculture is the backbone of rural economies. For the communities at the BoP and living in rural parts of the state, farming is not just a job but a way of life. In rural parts, without a reliable source of water for irrigation, farmers cannot grow enough crops to feed their families or earn a stable income (Narayan & Pritchett, 2019). This creates a cycle of poverty, where families fight to meet their basic needs, such as food, shelter, healthcare, and education (Shah, 2009). In regions like the rural Ahilyanagar district of Maharashtra, many people depend on rain-fed agriculture, hence irrigation is a major concern to them. When rainfall is not adequate, crops fail, and farmers do not get sufficient income, which pushes them deeper into poverty (Gleick, 2014).

2. LITERATURE REVIEW

The impact of irrigation scarcity goes beyond just economic challenges. It affects the health and education of deprived communities. For instance, when families cannot grow enough food due to irrigation issues, that leads to hunger and malnutrition, which creates serious health problems, especially for children (United Nations, 2018). When farmers cannot earn enough money through non-irrigated farms, they force their children to be with them in farming or find work. This is the problem with farmer's children, they may not get opportunities for a better future, which may create a cycle of poverty that can last for generations (Jha et al., 2021).

One, of the most important consequences of irrigation scarcity is migration. When farming becomes unmanageable due to water shortages, and impact on their family income, many people leave their villages and move to cities in search of work. That disrupts their families and communities at the bottom of the pyramid, which puts pressure on urban areas, where resources are already limited (World Bank, 2020). Migration hampers the resources and, hence leads to poor living conditions in cities, with limited access to clean water, sanitation, healthcare, and education. This further worsens the challenges to deprived communities migrating to urban (World Bank, 2020).

Water is essential for life and plays a key role in economic and social development. Agriculture, which is the primary source of income for millions of people worldwide, depends on sufficient water supply for irrigation. However, in many parts of the world, irrigation scarcity has become a major issue, particularly affecting poor communities that rely on farming for their livelihood (Shah et al., 2020).

Irrigation scarcity happens due to multiple reasons, including climate change, declining groundwater levels, inefficient water management, and government policies that fail to address the needs of marginalized farmers (Molden et al., 2017). When farmers do not have enough water for their crops, their agricultural production declines. This leads to lower incomes, higher food prices, and more poverty, especially among those who are already struggling to make a living (Narayan & Pritchett, 2019).

The impact of irrigation scarcity is not limited to farming alone. It affects different aspects of life, such as education, health, and migration. When farmers cannot grow enough food, their families face food insecurity and malnutrition. Poor nutrition can lead to health problems, making it harder for people to work and earn a living (Gleick, 2014). Children from farming families are often forced to leave school and help with farming or find other jobs to support their households. In extreme cases, families migrate to urban areas in search of work, which results in overcrowded cities and more competition for low-paying jobs (Jha et al., 2021).

The problem is even more severe for the deprived community at the bottom of the pyramid (BoP), who have fewer resources and opportunities. The term 'bottom of the pyramid' refers to the poorest section of society that struggles to meet their basic needs (Prahalad, 2005). For these communities, irrigation scarcity means not only economic hardship but also social instability. Women and children, who often bear the burden of collecting water for household use, face additional challenges when water sources dry up (Biswas & Tortajada, 2019).

Addressing irrigation scarcity requires a multi-faceted approach, including better water management, government support, and the adoption of new technologies for efficient water use. Policies should focus on equitable water distribution and support for small-scale farmers who depend on irrigation for their survival (Shah et al., 2020). Sustainable solutions such as rainwater harvesting, efficient irrigation systems, and community-based water management can help alleviate the crisis and improve the livelihoods of affected communities (Molden et al., 2017).

This study aims to explore the socioeconomic impact of irrigation scarcity on deprived communities, particularly those at the bottom of the pyramid. By understanding the challenges they face, policymakers and stakeholders can develop strategies to improve water accessibility and promote economic stability. The findings of this research will provide insights into the link between water scarcity, poverty, and sustainable development, contributing to long-term solutions for vulnerable populations (Narayan & Pritchett, 2019).

3. PROBLEM STATEMENT

The non-availability of irrigation facilities creates poverty and economic differences in farmers, which leads to limited agricultural output, reduced employment opportunities, and migration toward metro cities. Small and marginal farmers and landless laborers are the most affected groups, which are struggling with low incomes and limited livelihood opportunities to them.

Understanding the socioeconomic importance of irrigation is essential for developing policies that can mitigate these challenges and support comprehensive rural development.

4. RESEARCH OBJECTIVES

1. To study the impact of irrigation shortage on agricultural yield and income of communities at BoP.

2. To study the impact of irrigation scarcity on employment opportunities in rural areas.
3. To study the migration patterns caused by water scarcity and its impact on families.
4. To study the strategies adopted by the people at the bottom of the pyramid to deal with water scarcity.

5. RESEARCH QUESTIONS

1. How does irrigation scarcity affect the income and economic stability of BoP communities?
2. How do small farmers and laborers face the key livelihood challenges due to irrigation shortages?
3. How does water scarcity contribute to seasonal or permanent migration among marginalized populations?
4. What coping mechanisms do affected communities adopt to sustain their livelihoods?

6. SCOPE OF THE STUDY

The study focuses on smallholder farmers, landless labourers, and other economically vulnerable groups in rural areas affected by irrigation scarcity. It analyses direct and indirect socioeconomic consequences, including income, employment, migration, and social well-being.

6.1 Significance of the Research

This research provides insights into the real-life struggles of BoP communities in water-scarce regions, helping policymakers, NGOs, and development agencies to:

- Design sustainable irrigation and water conservation programs.
- Promote alternative livelihood options and skill development.
- Improve rural infrastructure and policy frameworks to support marginalized farmers.

7. RESEARCH METHODOLOGY

This research aims to study the impact of irrigation scarcity on the agriculture, income, employment, migration, and coping strategies of people at the Bottom of the Pyramid (BoP) in rural areas. The research uses a structured approach to collect and analyse data, ensuring reliable and meaningful findings.

7.1 Research Design

A descriptive research design was used to understand and explain the effects of irrigation scarcity on farmers at the bottom of the pyramid. It collects information from farmers, laborers, and migrant workers to get a clear understanding of the situation.

7.2 Data Collection Methods

Both primary data and secondary data were used in this research.

7.2.1 Primary data collection (Direct information from people)

Survey Method: A well-structured questionnaire was distributed to farmers, laborers, and migrant families to collect their responses.

The questionnaire includes both close-ended and open-ended questions.

Interviews and Focus Group Discussions: Selected farmers, laborers, and families who were affected by migration were interviewed for detailed insights.

7.2.2 Secondary data collection (Existing information)

- Government reports on irrigation, agriculture, and migration.
- Census and statistical data on rural employment and livelihoods.
- Research papers and articles related to water scarcity and rural development**.**

7.3 Sampling Method

A purposive sampling method was used to collect the sample, focusing on communities at the Bottom of the pyramid. The people were selected based on the following conditions:

- Small and marginal farmers who have less than 5 acres of land.
- Landless laborers who depend on farming jobs.
- Migrants who left their villages due to irrigation problems.

The research covers 164 respondents from multiple villages where irrigation scarcity is a known issue.

8. RESULTS

8.1 Demographic Dividend

The majority (41%) of respondents were in the above-50-years age group, followed by 41-50 years (33%).

- Gender: 70% of respondents were male, while 30% were female.
- Education Level: 28% of respondents have a secondary education, while 25% have a primary education. Only 7% have a graduate degree.
- Occupation: 52% of respondents were farmers, 20% were agricultural laborers, and 18% relied on daily wage work.
- Land Ownership**:** 42% of respondents own 1-5 acres of land, while 20% are landless.

It is observed that the farmers who had their land were not educated that much, which may bring a change in their agricultural land through technological advancement. But the other side of the coin is that women were participating in agricultural activity and producing their food for families, though they were less educated.

8.2 Impact of Irrigation on Agriculture

Source of water for Irrigation:

As a rain-fed area in Maharashtra, canal water supply facilities are available in very selected areas (15%). Very selected revers in areas were flowing towards the east, which brings water for a very short duration like the rainy season only, so that the people who were on the bank of such revers may depend on this water for irrigation (25%). The farmers who were away from rivers depended only on wells or borewells (43%), and that was the only way by which they may irrigate their fertile land up to very few months from the rainy season.

8.3 Effect of Irrigation Shortage on Crop

The farmers who depend on canal irrigation (13%) were not affected as much as others. However, the effect of irrigation shortage was observed in the farmers who depend on wells/borewells or rainfall. This means that most of the farmers (61+ 42=103) (63%) were affected due to irrigation shortage, which impacts their crop yield.

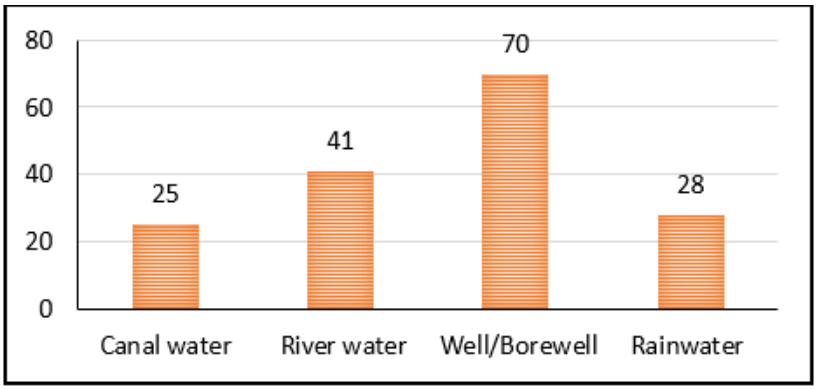

Fig. 1. Source of water for Irrigation

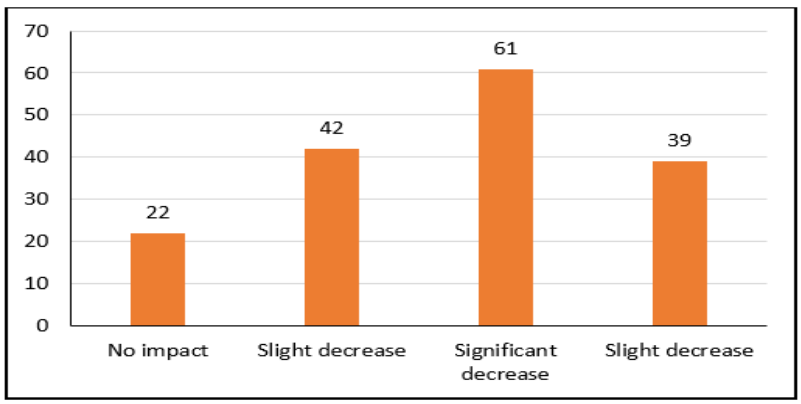

Fig. 2. Effect of Irrigation Shortage on Crop

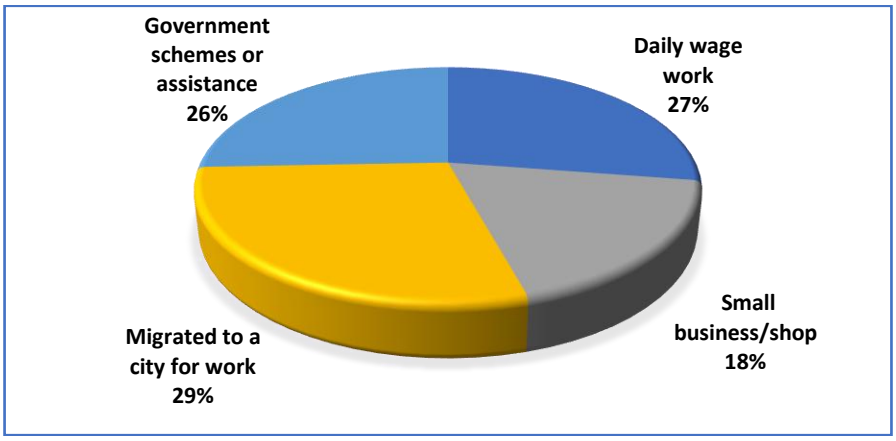

Fig. 3. Alternative source of income

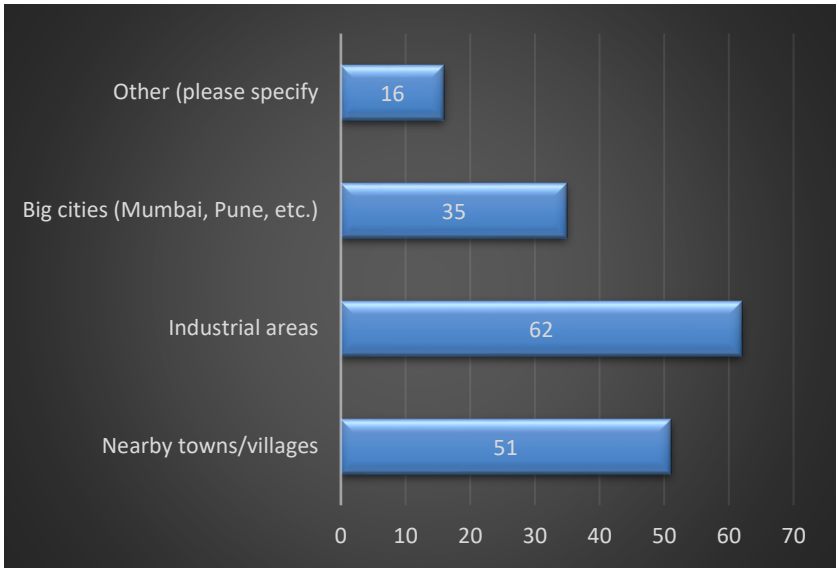

Fig. 4. Migration due to water scarcity

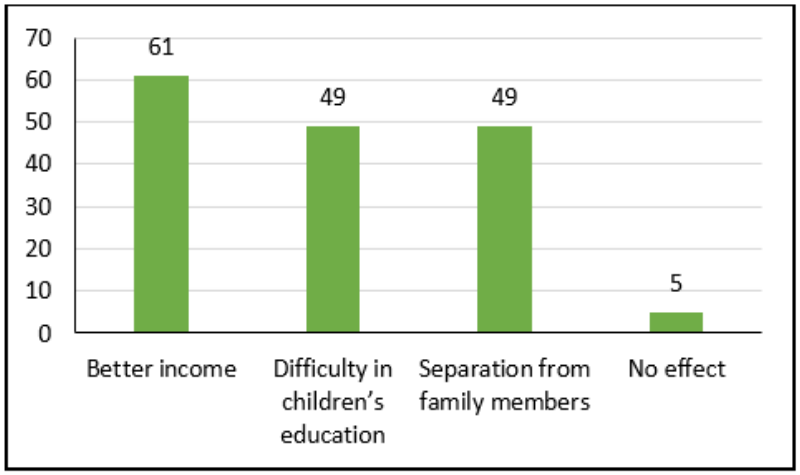

Fig. 5. Migration's Effect on Family

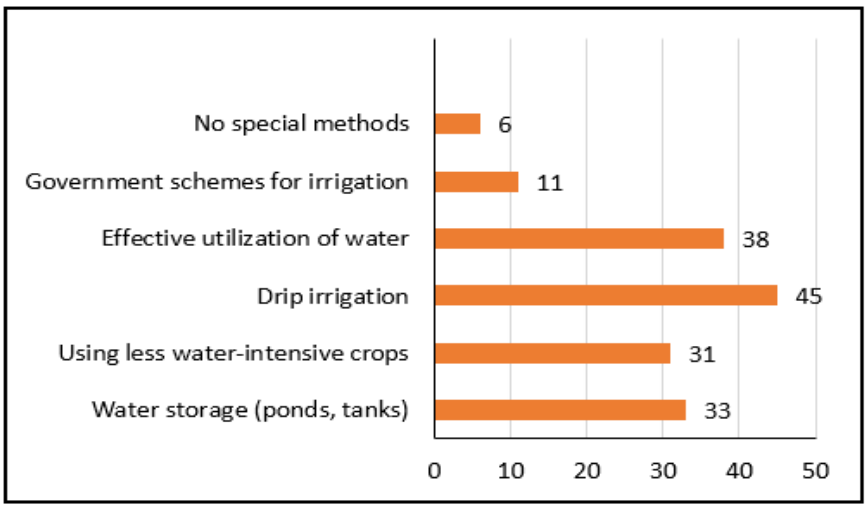

Fig. 6. Methods to manage water for farming

8.4 Alternative Source of Income

Most farmers (55%) were either working as daily wage laborers or migrating to cities, showing how irrigation scarcity affects farming activity and rural employment. Entrepreneurship (small businesses) was growing but a less common option (18%). Government support was available but did not fully help to overcome the irrigation crisis.

The income from farming was reduced due to water shortage. Because of less water, crops do not grow properly and do not get a proper yield. This means that earning less money from farming made it difficult to cover the expenses.

8.5 Migration Due to Water Scarcity

69% (113 out of 164) migrate towards industrial areas or nearby villages for employment closer to rural areas. Whereas only 21% people migrated towards the urban areas, which was lower, possibly due to lack of skills, affordability, or difficulty in adjusting to city life.

8.6 Migration's Effect on Family

The largest group (37%) of respondents said that migration had resulted in better financial condition of family. 30% of respondents faced challenges in their children's education due to migration. Another 30% reported emotional and social distress caused by separation from their families. A very small group (3%) reported that migration did not significantly impact their family life.

8.7 Methods to Manage Water for Farming

Drip irrigation played a vital role in drought-affected areas. This method is adopted by 27% of respondents, whereas 23% of farmers focus on better management of available water resources. Only 20% of stored water is in traditional structures like ponds and wells. But some farmers (19%) have shifted to drought-resistant or low-water crops. Only 7% have received government assistance for water management.

9. FINDINGS

1. Farmers depend on wells or borewells for the irrigation of their fertile land for a few months from the rainy season, as the groundwater level goes down very fast.
2. Irrigation shortage adversely impacts the crop yield of the farmers.
3. Irrigation scarcity hampers the income level of the farmer, as they are not able to grow their crop and convert it into cash, which is required for daily expenses.
4. Some people migrate to large urban cities, likely for better employment opportunities, education, or self-employment.
5. A small group moves to Ahilyanagar, Sambhajinagar, or nearby tehsil headquarters, which may be seasonal migration, for engaging in informal jobs.
6. Though migration provides better income (37%) to the families, it comes with emotional (separation - 30%) and educational (disruptions - 30%) challenges.
7. Due to frequent relocations of the people, it leads to a lack of proper schooling in

migration areas or financial constraints hampering education.

8. Drip irrigation and water-efficient techniques are preferred by 50% of farmers, which shows the shift of farmers toward modern, sustainable farming practices. Very negligible (7%) farmers, at the bottom of the pyramid, rely on government schemes. A small percentage (4%) do nothing, showing that some farmers still lack access to water management solutions.

10. SUGGESTIONS

1. Training programs must be organized for farmers at the bottom of the pyramid to teach new technology and modern farming methods.
   To enhance women's participation in agriculture, provide better resources, training, and financial support. Government Schemes Awareness Program (GSAP) must be organized for farmers at the bottom of the pyramid.
2. Efforts must be made to promote rainwater harvesting and building more small ponds to store water for farming. A Water-Saving Encouragement Program should be organized at the grassroots level for farmers. Provide government support for building more water storage structures to help farmers during dry seasons. Provide support for digging and maintaining wells and borewells in water-scarce areas
3. The government and policymakers should focus on local employment generation and water management policies to reduce distress migration.
4. Policy measures such as local employment opportunities, better rural education, and financial support could help reduce forced migration.
5. The farmers are trying efficient water usage techniques to maximize crop yield while minimizing wastage. Farmers make the irrigation schedule, reduce runoff, and use advanced farming practices to improve water use.

11. CONCLUSION

Though a moderate level of rainfall has been there in the last few years, irrigation water scarcity has a major impact on farmers at the bottom of the pyramid, especially those who depend on rainwater, wells, and borewells, as groundwater levels drop quickly. This is due to inefficient usage of water for farming (Flood Irrigation Method), which leads to lower crop yields and financial struggles, forcing some families to migrate for better job opportunities to the cities or towards industrial zones. While migration of people improves the income of some families, it also causes emotional stress and hampers children's education.

Many farmers are adopting modern water-saving techniques like drip irrigation, but those at the bottom of the pyramid still lack awareness and access to government schemes. To address these challenges, efforts must focus on rainwater harvesting, local job creation, and training programs for farmers. By improving water management and providing financial support, both agricultural sustainability and rural livelihoods can be strengthened.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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