**Comparative assessment of potable water quality across different farm household groups**

**Abstract**

This study examines and compares potable water quality among tribal and non-tribal farm households in the Jorhat district of Assam. Despite similar socio-economic challenges, disparities exist in water access, usage practices, and microbiological safety. Based on data from 100 farm households across four villages and microbiological analysis of 36 water samples, the study reveals that tube wells are the primary water source for both groups, yet inadequate treatment and unsafe storage practices persist. Notably, only 40% of tribal farm households covered their water containers, compared to 78% of non-tribal ones. Microbiological tests found bacterial counts exceeding safe limits, especially in filtered and raw water, while boiled water showed better results. These findings highlight the urgent need for improved rural water infrastructure, targeted hygiene education, and integration of water safety into housing and public health policies in the farm households as they are the feeders of the population. Addressing these gaps is vital for reducing health risks and supporting the Sustainable Development Goals (SDG 6 and SDG 11).

**Key words**

Potable Water Quality, Water borne Diseases, Water Storage Hygiene, Microbial Contamination

Rural Public Health, Sustainable Development Goals (SDGs)

**Introduction**

Housing continues to be recognized not only as a basic human need but also as a fundamental human right that significantly influences health, social equity, and quality of life. Housing serves not only as a physical shelter but also as a foundation for human dignity, safety, and overall well-being. Adequate housing with proper ventilation, sanitation, and space significantly reduces the risk of communicable diseases, injuries, and mental stress among the farming community. Equally crucial is the provision of safe and potable drinking water, which directly affects their health. Contaminated water is a major source of waterborne illnesses such as diarrhea, cholera, and typhoid, especially in low-income farm households in rural areas. When both secure housing and clean drinking water are ensured, individuals—particularly women and children—experience better health outcomes, improved productivity, and enhanced quality of life. Therefore, housing interventions must be holistically planned for farming community to include access to clean water and sanitation, as these are essential for promoting sustainable health and supporting a robust agricultural production system.

According to the United Nations (2021), adequate housing is central to achieving Sustainable Development Goal 11, which emphasizes making cities and human settlements inclusive, safe, resilient, and sustainable. Inadequate housing—characterized by overcrowding, poor construction, or lack of water and sanitation—has been linked to a higher prevalence of respiratory diseases, mental stress, and increased vulnerability to disasters (Rolnik, 2020).

Post-pandemic studies emphasize that secure housing played a crucial role in protecting individuals from COVID-19 exposure and maintaining mental health. "During this period, individuals in the informal workforce faced increased housing insecurity, emphasizing the urgent need for inclusive and supportive housing policies (Boamah & Dobson, 2021). "Governments are now increasingly integrating housing into broader health and development agendas.

Assam is home to a rich mosaic of ethnic communities, including a significant tribal population. The Scheduled Tribes (STs) constitute about 12.4% of the state's total population (Census 2011). These communities are concentrated in rural and forested areas and are predominantly dependent on agriculture, forest produce, and traditional crafts for their livelihood. Many tribal households function as farm households, where subsistence farming forms the backbone of daily sustenance. Despite various welfare schemes, tribal populations still face challenges such as limited access to quality education, healthcare, and clean drinking water—factors that also impact their agricultural productivity and overall well-being. On the other hand, the non-tribal population—which includes various caste groups—forms the majority. This group is more urbanized and generally has better access to social services, economic opportunities, and political representation. However, rural non-tribal farming communities also grapple with poverty, underemployment, and resource-based conflicts in some regions, highlighting the shared vulnerabilities of farm households across ethnic lines.

Drinking water—also referred to as potable water—is essential for human survival and must be free from contaminants that pose health risks. Safe drinking water is not only crucial for hydration but also for cooking, food preparation, and hygiene. As of 2022, approximately 5.8 billion people worldwide had access to safely managed drinking water services, while about 2 billion people still relied on sources contaminated with feces and other pollutants (WHO & UNICEF, 2023). Unsafe drinking water remains a major source of waterborne illnesses such as cholera, dysentery, hepatitis A, and typhoid, particularly in low-income and rural areas.

Rapid urbanization, climate change, and inadequate infrastructure exacerbate the challenge of providing safe and equitable water access, especially in the Global South. Additionally, marginalized communities, including indigenous populations and people in informal settlements, are disproportionately affected by water insecurity (UN-Water, 2023). Contaminated water can carry pathogens including *Escherichia coli*, *Vibrio cholerae*, and *Salmonella typhi*, all linked to serious disease outbreaks. Efforts to improve water quality and accessibility have been linked to major reductions in child mortality and improvements in public health (World Bank, 2022).

Addressing the issue requires sustained investment in water infrastructure, community education, and policy interventions to ensure that water sources remain protected from agricultural runoff, industrial waste, and poor sanitation systems. The UN Sustainable Development Goal 6 aims to ensure availability and sustainable management of water and sanitation for all by 2030, but major gaps remain in achieving universal access to safe drinking water.

Occurrence of cholera in different parts of India and the outbreaks were ascribed to contaminated water. It is obvious that life expectancy is reduced by the use of contaminated water and community health is greatly affected. People in developing countries suffer most from waterborne diseases. High mortality from such diseases are being taken with great concern at various levels all over the world narrated by Bhattacharya *et al*. (2000)

High frequency of diarrheal episodes in children leads to environmental enteropathy which is the decreased ability of the intestine to absorb nutrients. This leads to malnutrition which has even more implications such as stunting and decreased intelligence (Korpe and Petri 2012).

Therefore, in light of these challenges, the present study was conducted to assess the quality of potable water used by tribal and non-tribal farm households in the Jorhat district of Assam. The study aims to understand variations in water sources, storage practices, and microbiological safety across these socio-cultural groups.

**Materials and Methods**

This study was conducted in the Jorhat district of Upper Assam during the year 2021–22. The sampling design involved a combination of purposive and simple random sampling techniques. Two Agricultural Development Officer (ADO) circles located in the Titabar and Jorhat development blocks were selected for the study. From each block, two villages were randomly chosen, making a total of four villages. A sample of 100 farm households—comprising both tribal and non-tribal families—was selected.

**Determination of Bacterial Load (Standard Plate Count Method)**

The total bacterial population in water samples was assessed using the standard plate count technique, as outlined by Mukherjee and Ghosh (2002). Nutrient agar was prepared using 28 g of commercially available medium dissolved in 1000 ml distilled water, sterilized at 121°C (15 lbs pressure) for 15 minutes. One millilitre of each thoroughly mixed water sample was inoculated into sterile Petri plates, followed by the addition of melted and cooled nutrient agar (45–50°C). Plates were gently rotated for uniform distribution and incubated at 20–22°C for 72 hours. Colonies were counted, and bacterial load was calculated as colony-forming units (CFU) per ml. Water samples with <100 CFU/ml were considered of acceptable quality.

Data collection involved a combination of interview and observation methods. Interviews were conducted to gather general demographic data, information on potable water sources, and water storage practices at the household level. Additionally, microbiological analysis test was done to determine the total bacterial population of 36 number of potable water sample by standard plate count technique.

**Results and Discussion:**

A perusal of Table 1 reveals that the majority (55%) of the tribal respondents belonged to the age group of 25-35years. On the other hand, the majority of the non-tribal respondents (50%) belonged to the age group of 35-45years and an equal percentage of the respondents i.e. (7.5%) belonged to the age group of 45 and above.

Concerning the educational qualification 17.5% of the tribal respondents were found to be illiterate, whereas amongst the non-tribal respondents none were found to be illiterate. The highest education level of both tribal and non-tribal respondents was completion of higher secondary level, which was 40% in tribal and 50% in non-tribal respondents. Very few percent were found to be graduates and none were post-graduates among the respondents of both groups (Table 1).

Regarding occupation, it was found that almost equal percentage of heads of the families of the respondent households of both tribal farm households and non tribal farm households were only farmer (58% and 54%). Very few were servicemen (2% and 10%) and businessmen involved mostly in petty business related to farm produce were 16% and 18% respectively. Data indicated that there was mixed occupation among the respondents and mostly were not involved in only one type of occupation.

Concerning the monthly family income of the respondent households, it was revealed that 77.5% of the tribal respondents and 65% of the non-tribal respondents belonged to the category of 20,000-40,000. On the other hand 22.5% of the tribal and 35% of the non-tribal respondents belonged to the middle category of 40,000-60,000. This information indicated that a major portion of the respondents belonged to the lower middle-income group.

Table 2 depicts that majority of the tribal respondents had their source of water that is tube wells within their premises (74%) which was only 68 % in the case of non-tribal households. It was also found that a very meager percentage i.e. (26%) of tribal and non tribal households had access to the Government water distribution system. Apart from this, pond water was also used for various household purposes. 6% of them also used pond water for drinking. The drinking water supply in rural Tamil Nadu was severely contaminated (Ravichandran and Balasundaram., 2000).

The findings in the Table 2 also revealed that the majority (76%) of the respondents of both the tribal and non- tribal groups used filtered water for drinking. Whereas, some of the households of both the groups, used water in the raw form as well (15% and 14%). Amongst the respondents only 8% of the tribal and 10% of the non-tribal respondents were found to have used boiled form of water. (Plate 4)

Storage of drinking water in cleaned and covered vessels is an important household-level intervention for ensuring microbiological safety. Such practices significantly reduce the risk of contamination by preventing contact with vectors like insects and limiting microbial regrowth (Kumpel & Nelson, 2016). Inappropriate storage, such as the use of uncovered or unclean containers, has been found to contribute to the deterioration of water quality, especially in rural and peri-urban settings, where microbial contamination often reoccurs post-collection (Shields et al., 2015; Tiwari et al., 2021). Studies also highlight that the effectiveness of improved water sources can be undermined by poor handling and storage practices at the household level (Kamau et al., 2018).

Even the water used for washing utensils and utensils which are used to store water were found to contaminate water in varying degrees, depending upon the type of utensils used (Virk *et al*.,2000). It was revealed that all the tribal and non-tribal respondents stored water in cleaned plastic and iron buckets, jars, etc. But 40% of the tribal respondents covered the stored water as compared to the 78% non-tribal households (Table 3). With regard to cleaning of storage for keeping drinking water 46% of tribal respondents and 58% of non tribal respondents did this regularly due to ignorance, which is alarming. Drinking water quality is a very important aspect that plays significant role in the health of an individual. Water becomes contaminated at household level because of the poor hygiene practices followed (Sharma, M., 2018). Most of the contamination (53 %) occurred when water was stored in an unsafe container that allowed bacteria to enter the potable water (Vacs Renwick., 2013).Analysis of the microbiological content of drinking water samples collected from the respondents households (Table 4) revealed that the average bacterial count in the raw form of tube well water used by the tribal (126 CFU/ml) and non-tribal households (124.33 CFU/ml) was almost similar and was higher than the filtered and boiled forms of water used by both the groups. It was apparent that both forms of water i.e. raw and filtered were not found suitable for drinking purpose since they crossed the safe level of microbial count i.e.100 CFU/ml (Aneja, 2006). On the other hand, microbial content in boiled water samples was found to be (97.33 CFU/ml) and (96.00 CFU/ml) among tribal and non-tribal respectively. This indicated that suitably boiled water from tube wells could be considered for drinking because it showed a range of microbial content.

High levels of coliform contamination in drinking water have been strongly linked to increased incidences of water-borne diseases such as dysentery, diarrhea, and typhoid fever, particularly in low-resource and rural settings (Mukherjee et al., 2020; Bain et al., 2021). The presence of fecal coliforms, especially Escherichia coli, serves as a reliable indicator of fecal contamination and a predictor of disease outbreaks in populations relying on untreated or poorly stored water.

The experiments also revealed that water samples from the government water distribution system showed higher bacterial count (CFU/ml) than the recommended level which was (103.33 CFU/ml) and (103.66 CFU/ml) in the samples from tribal and non-tribal households, respectively which could be probably due to improper conditions of plumbing fixtures as observed by the investigator. It was however, noteworthy that the bacterial count of water samples from government water distribution was found to be lower than the water samples collected from the tube wells in both the groups. A similar study by Cruez*et al.* (2000) on the bacterial content of groundwater found that bore well water was unfit for drinking.

It was encouraging to note that the bacterial count of filtered water samples obtained from the Government water distribution system was (48.33CFU/ml) in both the tribal and non-tribal households. Similarly, the bacterial count of samples of boiled water from tribal and nontribal households was found to be (25.66 CFU/ml) and (21.33 CFU/ml), respectively. Thus,the boiled form of water collected from the government water distribution system in both tribal and non-tribal households was safest as evidenced by the results. It might be due to the double sterilization of water at the treated plant as well as by the boiling temperature. It was discouraging to note that the government water distribution system was inadequate in both tribal and non-tribal areas. Even filtered water in many households failed to meet safety standards, while boiled water exhibited significantly lower bacterial counts, reaffirming its effectiveness (Plate I,II,III).

**Conclusion:**

This study highlights the significant differences in water quality between tribal and non-tribal farm households in Jorhat district. Both groups rely heavily on tube wells as their primary source of drinking water, with tribal households showing little higher dependence on this water source compared to their non-tribal counterparts. Despite the widespread use of filtration, the microbiological analysis revealed that raw and filtered water from tube wells in both groups exceeded safe bacterial levels, posing potential health risks. Water from the government distribution system showed slightly lower bacterial contamination, though it still failed to meet safety standards in both tribal and non-tribal households.

In India, access to safe drinking water is a continuing public health challenge, especially in rural and marginalized communities. Although government programs like the Jal Jeevan Mission (launched in 2019) aim to ensure tap water supply to all households, recent studies show persistent issues related to contamination by fluoride, arsenic, nitrate, and microbial agents. A study by Chatterjee *et al*. (2023) found that fluoride contamination in groundwater in states like Rajasthan, Gujarat, and Odisha has led to rising cases of dental and skeletal fluorosis, particularly among women and children. Moreover, seasonal water scarcity exacerbates the health burden. In areas with irregular water supply, households often rely on unsafe sources, leading to higher incidences of diarrheal diseases, gastrointestinal infections, and skin conditions. Researchers highlight the need for community-level water quality monitoring and the use of low-cost filtration technologies tailored for rural India.

The findings suggest that improper storage and handling of drinking water, especially among tribal farm households, contribute significantly to bacterial contamination. Furthermore, while boiling water reduced microbial content, the practice was far less common in both tribal and non-tribal farm households. These results underline the need for improved water treatment practices, greater access to safe drinking water, and enhanced hygiene and storage education, particularly among the tribal farming community areas where government water distribution systems are often inadequate. Public health interventions targeting water safety and hygiene could significantly reduce waterborne diseases in these communities and improve overall health outcomes.

**References**

* Aneja, K. R. (2006). *Experiments in Microbiology, Plant Pathology and Biotechnology* (4th ed.). New Age International.
* Bhattacharya, S. K., Sur, D., Ali, M., Kanungo, S., You, Y. A., Manna, B., ... & Clemens, J. D. (2000). Clinical and microbiological characteristics of cholera outbreaks in eastern India: An analysis of data from the National Institute of Cholera and Enteric Diseases. *Indian Journal of Medical Research, 112*, 134–139.
* Boamah, E. F., & Dobson, S. (2021). Inadequate housing and the role of informal settlements in the COVID-19 pandemic. *Geoforum, 128*, 126–136. https://doi.org/10.1016/j.geoforum.2021.01.012
* Kamau, N., Njiru, H., & Awuor, F. (2018). Safe water storage: A community-based intervention to reduce diarrheal diseases. *BMC Public Health, 18*, Article 254. https://doi.org/10.1186/s12889-018-5174-5
* Korpe, P. S., & Petri, W. A. (2012). Environmental enteropathy: Critical implications of a poorly understood condition. *Trends in Molecular Medicine, 18*(6), 328–336. https://doi.org/10.1016/j.molmed.2012.04.007
* Kumpel, E., & Nelson, K. L. (2016). Intermittent water supply: Prevalence, practice, and microbial water quality. *Environmental Science & Technology, 50*(2), 542–553. https://doi.org/10.1021/acs.est.5b03973
* **Mukherjee KG, Ghosh S.** (2002). Agricultural Microbiology. 1st ed. New Delhi: Kalyani Publishers
* Ravichandran, S., & Balasundaram, V. R. (2000). Quality of rural drinking water sources in Tamil Nadu. *Indian Journal of Environmental Protection, 20*(6), 433–436.
* Rolnik, R. (2020). *Urban Warfare: Housing under the Empire of Finance*. Verso Books.
* Sharma, R. (2018). Household water treatment and safe storage practices in rural India: A public health perspective. *Indian Journal of Community Health, 30*(1), 56–60.
* Shields, K. F., Bain, R. E. S., Cronk, R., Wright, J. A., Bartram, J., & Hunter, P. R. (2015). Association of supply type with fecal contamination of source water and household stored drinking water in developing countries: A bivariate meta-analysis. *Environmental Health Perspectives, 123*(12), 1222–1231. https://doi.org/10.1289/ehp.1409002
* UN-Water. (2023). *World Water Development Report 2023: Partnerships and Cooperation for Water*. UNESCO. https://www.unwater.org/publications/un-world-water-development-report-2023
* United Nations. (2021). *Progress on SDG 11: Make Cities and Human Settlements Inclusive, Safe, Resilient and Sustainable*. https://sdgs.un.org/goals/goal11
* Vacs Renwick, D. (2013). Household water contamination and the link to diarrheal diseases in developing nations. *Water Resources Research*, 49(3), 1632–1639.
* WHO & UNICEF. (2023). *Progress on Household Drinking Water, Sanitation and Hygiene 2000–2022: Special Focus on Gender*. WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP). https://washdata.org/

**TABLE: 1. DISTRIBUTION OF THE RESPONDENT HOUSEHOLDS ACCORDING TO THE PERSONAL AND DEMOGRAPHIC CHARACTERISTICS (N=100)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Characteristics | Tribal farm Households | | Non-tribal farm households | |
| f | % | f | % |
| 1.Age of the responders(in years) |
| 1. 25 to 35 years | 27 | 54 | 21 | 42 |
| 1. 35 to 45 years | 18 | 36 | 25 | 50 |
| 1. 45 years and above | 5 | 10 | 4 | 8 |
| Total | 50 | 100 | 50 | 100 |
| 2.Educational qualification of the respondents | | | | |
| 1. Illiterate | 8 | 16 | 0 | 0 |
| 1. Who are able to read and write | 1 | 2 | 6 | 12 |
| 1. Passed primary school | 6 | 12 | 8 | 16 |
| 1. Passed secondary school | 13 | 26 | 8 | 16 |
| 1. Passed higher secondary school | 20 | 40 | 25 | 50 |
| 1. Graduate | 2 | 4 | 3 | 6 |
| Total | 50 | 100 | 40 | 100 |
| 3.Occupation of the head of the family |  |  |  |  |
| 1. Farming | 29 | 58 | 27 | 54 |
| 1. Farming and service | 5 | 10 | 7 | 14 |
| 1. Service | 1 | 02 | 5 | 10 |
| 1. Business and farming | 7 | 14 | 2 | 04 |
| 1. Business (Petty trading) | 8 | 16 | 9 | 18 |
| Total | 50 | 100 | 50 | 100 |
| 4. Family income of the respondents/month(Rs.) | | | |  |
| 1. 20000-40000 | 38 | 78 | 32 | 64 |
| 1. 40000-60000 | 12 | 24 | 17 | 34 |
| Total | 50 | 100 | 50 | 100 |

**TABLE: 2.DISTRIBUTIONS OF THE RESPONDENT HOUSEHOLDSACCORDING**

**TO THE SOURCE AND FORM OF POTABLE WATER**.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Source of potable water within the premises.** | **Tribal Households (n=50)** | | **Non-Tribal Households (n=50)** | |
| f | % | f | % |
| 1. Pond water | 0 | 0 | 3 | 6 |
| 1. Tube well | 37 | 74 | 34 | 68 |
| 1. Government water distribution system | 13 | 26 | 13 | 26 |
| Total | 50 | 100 | 50 | 100 |
| **Form of water** | | | |  |
| 1. Raw | 15 | 30 | 14 | 28 |
| 1. Filtered drinking water through ceramic candles | 31 | 62 | 31 | 62 |
| 1. Boiled | 4 | 8 | 5 | 10 |
| Total | 50 | 100 | 50 | 100 |

**TABLE: 3.DISTRIBUTION OF THE RESPONDENT HOUSEHOLDS ACCORDING TO THE PRACTICE FOLLOWED FOR KEEPING THE POTABLE WATER IN THE HOUSE.**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Practices** | **Tribal households** | | | | **Non- tribal households** | | | |
| Yes | | No | | Yes | | No | |
| f | % | f | % | f | % | f | % |
| i)Storage structure for keeping drinking water-Plastic bucket, Iron bucket, Jar etc. | 50 | 100 | 0 | 0 | 50 | 100 | 0 | 0 |
| ii)Regularly cleaned storage for drinking water | 23 | 46 | 27 | 54 | 29 | 58 | 21 | 42 |
| iii)Properly covered storage | 20 | 40 | 30 | 60 | 39 | 78 | 11 | 22 |

**TABLE: 4. ASSESSMENT OF THE QUALITY OF POTABLE WATER USING STANDARD PLATE COUNT TECHNIQUE FOR DETERMINATION OF TOTAL BACTERIAL POPULATION**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Source and form of water** | **Tribal households** | | | | | **Non-tribal households** | | | |
| **72 hour** | | | | | **72 hour** | | | |
| 1. **Tube well** | **Colony Forming Unit(CFU)/ml** | | | | | **Colony Forming Unit(CFU)/ml** | | | |
|  | **S1** | **S2** | **S3** | **Average** | | **S1** | **S2** | **S3** | **Average** |
| 1. Raw form | 126.00 | 127.00 | 125.00 | 126.00 | | 123.00 | 125.00 | 125.00 | 124.33 |
| 1. Filtered form | 107.00 | 105.00 | 106.00 | 106.00 | | 101.00 | 106.00 | 103.00 | 103.33 |
| 1. Boiled form | 95.00 | 98.00 | 99.00 | 97.33 | | 96.00 | 98.00 | 94.00 | 96.00 |
| 1. **Govt. water distribution system** | | | | | | | | | |
| 1. Raw form | 102.00 | 103.00 | 105.00 | | 103.33 | 102.00 | 106.00 | 103.00 | 103.66 |
| 1. Filtered form | 50.00 | 46.00 | 49.00 | | 48.33 | 46.00 | 47.00 | 52.00 | 48.33 |
| 1. Boiled form | 23.00 | 26.00 | 28.00 | | 25.66 | 19.00 | 21.00 | 24.00 | 21.33 |



Plate I - Preparation of Nutrient Agar Media



Plate II-Transferring of Water Samples into the Petri Plates Inside a Laminar



Plate III- Bacterial Count of Potable Water Samples