STUDY FOR MANAGEMENT OF SLUDGE AND TRANSFORMATION INTO BIO SOLIDS

CODE: PR-12011/1/2024-O/O DIR (T-III) NMCG

Annual Report 2024–2025















A

PROJECT REPORT

ON

STUDY FOR MANAGEMENT OF SLUDGE AND TRANSFORMATION INTO BIO SOLIDS

CODE: PR-12011/1/2024-O/O DIR (T-III) NMCG

Patanjali Organic Research Institute Pvt. Ltd. (PORI)

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About the Project

The Ganga River, a lifeline for over 450 million people and revered as "Ganga Mata," faces severe pollution from untreated sewage, industrial effluents, and organic waste, resulting in toxic sludge accumulation along its 2,525 km course. As per CPCB report, approximately 3,000–5,000 million liters per day (MLD) of sewage, with only 25–37% treated, and 1,176 MLD of untreated discharge from 97 towns/cities, including 20% industrial waste, contribute to this. The 350 km stretch between Kannauj and Allahabad, particularly Kanpur, is the most polluted, with 1,072 grossly polluting industries (GPIs) releasing effluents. Biochemical Oxygen Demand (BOD) levels rise from 2.8 mg/L to 4.9 mg/L in Varanasi, exceeding safe bathing standards. This sludge, laden with fecal matter, microplastics, and ash from 30,000 annual cremations (300 metric tons), causes 1.5 million child deaths annually from waterborne diseases, ecological damage, and cultural desecration as per WHO Report.

Ganga's sludge crisis stems from:

- **Sewage Overload**: 15% of Uttar Pradesh households practice open defecation, and only 50% of wastewater treatment plants (WWTPs) are functional (WHO, 2019; National Mission for Clean Ganga [NMCG], 2023).
- **Industrial Pollution**: Kanpur's 400+ tanneries and other GPIs release toxic effluents and microplastics (Indian Institute of Technology [IIT] Kanpur, 2017; Banaras Hindu University [BHU], 2020).
- **Cultural Practices**: Cremation ash and religious bathing elevate pathogen loads (UNEP, 2019).
- **Infrastructure Gaps**: Only 37% of 72,368 MLD sewage is treated, with policy gaps in fecal sludge management (NMCG, 2023; Down to Earth, 2019).

These factors degrade water quality, harm biodiversity (e.g., fish kills, microplastic bioaccumulation), and threaten public health and cultural heritage (WHO, 2019; UNEP, 2019).

Under the **National Mission for Clean Ganga (NMCG)**, a program of the Government of India for the rejuvenation of the Ganga River and its tributaries, multiple interventions have been undertaken, including the **construction and upgradation of sewage treatment plants (STPs),** river surface cleaning operations, solid waste management, afforestation initiatives, community participation, awareness campaigns and partnerships with research institutions.

The project's primary goal is to transform this environmental adversity into an opportunity for sustainable agriculture and ecological restoration. It focuses on optimizing sludge treatment by removing moisture, eliminating pathogens, reducing toxic contaminants, and enhancing nutrient content (NPK and micronutrients) to produce value-added biosolid products compliant with the Fertilizer Control Order (FCO) and the Environmental Protection Act. Beyond laboratory and treatment innovations, the project extends to field-level applications through feasibility studies in five Uttarakhand districts, including Haridwar, to evaluate biosolids for natural farming, assessing crop productivity, transition periods, cost–benefit ratios, and logistics.

The initiative also emphasizes community engagement by building the capacity of Farmer-Producer Organizations (FPOs) to promote the adoption of sludge-derived biofertilizers at the grassroots level. The project integrates scientific innovation, policy advocacy, and community participation to address sludge management in India. By fostering sustainable sludge management, the project aims to improve water quality, reduce waterborne diseases, protect biodiversity, and preserve the Ganga's cultural and spiritual significance, creating a replicable model for river restoration and sustainable development.

Objectives

- To develop and optimize techniques for removing excess moisture from sludge, improving its stability, handling, and storage efficiency
- To assess and implement effective treatment methods for reducing toxic heavy metal concentrations and organic pollutants, ensuring the sludge meets safety standards for agricultural use as per FCO Guidelines.
- To identify and apply advanced disinfection processes for the removal of all pathogens, minimizing risks of disease transmission and environmental contamination.
- To enhance the concentration of essential macronutrients (Nitrogen, Phosphorus, and Potassium - NPK) and micronutrients in treated sludge, improving its effectiveness as a biofertilizer for sustainable agriculture.
- To prepare value-added products from bio solids and ensuring that the biosolids are compliant with norms set in the Environmental Protection Act and Fertilizer Control Order (FCO).
- To conduct a feasibility study of biosolids for natural farming in 5 districts of Uttarakhand (including Haridwar) factoring in aspects of crop productivity, transition period, cost benefit analysis, logistics and operations.
- Identification and capacity building of Farmer Producer Organizations (FPOs) near Haridwar area for adoption of natural farming through sludge derived biosolids.

Executive Summary

Introduction and Global Context

Rapid urbanization and industrial expansion have led to a dramatic increase in global sludge generation, exceeding 45 million tons annually, with urban wastewater treatment plants accounting for the majority (Giwa, 2023). Sludge, if mismanaged, emerges as a potent environmental pollutant, contaminating soil, degrading water bodies, and posing substantial risks to public health through the spread of pathogens and heavy metals. This challenge intensifies the strain on landfills and sewage infrastructure, necessitating innovative and sustainable management strategies.

In response, the circular economy paradigm has gained traction, emphasizing the transformation of waste into resources. Sewage sludge, when treated, yields biosolids—stabilized organic matter rich in essential nutrients like nitrogen, phosphorus, and organic carbon. These biosolids hold immense potential as soil conditioners and organic fertilizers, reducing dependency on synthetic alternatives and enhancing soil fertility. However, contaminants such as heavy metals and pathogenic coliforms hinder their direct application, requiring advanced treatment to ensure safety.

In India, the National Mission for Clean Ganga (NMCG), under the Namami Gange Programme, aligns with the Hon'ble Prime Minister's vision for sustainable development. This initiative integrates with Swachh Bharat and Namami Gange objectives to convert wastewater into valuable resources. A pilot project was initiated in Uttarakhand at the Jagjeetpur Sewage Treatment Plant (STP) in Haridwar to demonstrate the safe conversion of Ganga sludge into biosolids, funded by NMCG and executed with stringent scientific and regulatory protocols.

Project Rationale and Objectives

The project's foundation lies in addressing the overlooked crisis of sludge management in developing regions, where inadequate infrastructure exacerbates environmental degradation. Traditional methods like landfilling and incineration are unsustainable, while modern approaches offer opportunities for resource recovery. The rationale includes minimizing environmental risks, promoting agricultural sustainability, and supporting river conservation efforts.

Key objectives encompass:

1. Establishing standardized treatment procedures to produce safe biosolids compliant with Central Pollution Control Board (CPCB) standards.
2. Identifying and bridging technological gaps in sludge processing for scalability.
3. Conducting field trials to validate biosolids' efficacy in agriculture.
4. Enhancing capacity through training for STP operators and agricultural stakeholders.
5. Contributing to broader goals of sustainable waste management, Ganga rejuvenation, and reduced chemical fertilizer use.

Detailed Methodology

The project adopted a comprehensive, multi-phase methodology to ensure robust outcomes:

Sludge Treatment Process

- **Standard Operating Procedures (SOPs)**: Developed to comply with environmental norms, these SOPs focused on pathogen reduction, heavy metal stabilization, and nutrient preservation. Processes included anaerobic digestion, composting, and chemical stabilization to transform raw sludge into biosolids.
- **Compliance and Monitoring**: All steps adhered to CPCB guidelines, with continuous monitoring for contaminants to guarantee the final product's safety.

Experimental Framework

- **Laboratory and Pilot-Scale Trials**: Initial lab tests optimized treatment parameters, followed by pilot-scale implementation at Jagjeetpur STP to assess real-world feasibility.
- **Field Application Trials**: Biosolids were applied in agricultural plots near Haridwar. Trials involved multiple crops, measuring parameters such as germination rates, yield, biomass, and soil nutrient levels pre- and post-application.

Capacity Building and Stakeholder Engagement

- **Training Programs**: Workshops and hands-on sessions trained over 50 farmers on soil testing, natural and organic farming, AgriTech innovations and Post harvest engagements.
- **Awareness Initiatives**: Community outreach promoted the benefits of biosolids, addressing misconceptions and encouraging adoption.

Technology Evaluation

The project reviewed global practices:

- Treatment of hazardous raw sludge into safe, processed sludge.
- Transformation of processed sludge into biofertilizers.
- Application of organic fertilizers to farmers' fields.
- Full traceability of soil testing and fertilizer recommendations using geospatial technology.
- Preharvest management via the Harit Kranti Application, including cadastral mapping, stakeholder mapping, and farmer-focused tech services.
- Marketing of agricultural produce through the Annadata E-Market Place.

Key Findings and Outcomes

The pilot project delivered promising results, substantiated by empirical data:

Environmental and Safety Compliance

- Testing revealed that treated biosolids contained heavy metals and pathogens well below CPCB permissible limits, ensuring no adverse impacts on ecosystems or health.

Nutrient Composition and Agronomic Value

- Biosolids showed elevated organic carbon and nitrogen levels, positioning them as superior soil amendments.
- Phosphorus and other micronutrients further enhanced their fertilizer potential.

Technology-Enabled Solutions for Modern Agriculture

Implementation of advanced soil testing for precise nutrient analysis and tailored fertilizer recommendations. Alos, utilization of the Harit Kranti Application for streamlined preharvest management, including crop monitoring and resource optimization. Integration of Annadata E-Market Place to connect farmers directly with buyers, ensuring fair pricing and market access. Leveraging geospatial technology for real-time tracking and data-driven decision-making in farming operations. Moreover, the promotion of sustainable agriculture through the use of biofertilizers derived from processed sludge, enhancing soil health and productivity.

Agricultural Performance Metrics

Parameter	Improvement Observed	Notes
Crop Germination	Significant enhancement	Faster and higher rates compared to controls
Biomass Production	Increased yield	Greater plant growth and productivity
Soil Fertility	Improved organic matter	Long-term soil health benefits

Field trials across various crops confirmed these gains, with biosolids outperforming traditional fertilizers in nutrient delivery and soil structure improvement.

Scalability and Implementation Insights

- The process demonstrated viability for larger-scale adoption, with minimal modifications needed for other STPs.
- Economic analysis indicated cost savings through reduced landfill use and fertilizer imports.

The Jagjeetpur pilot exemplifies how scientific innovation can turn environmental liabilities into assets. By recycling Ganga sludge into biosolids, the project advances the circular economy, mitigates pollution, and bolsters sustainable agriculture. It directly supports Namami Gange's aims of wastewater valorization, capacity building, and river ecosystem preservation, fostering a cleaner Ganga and greener environment.

Broader implications include:

- Alignment with Sustainable Development Goals (SDGs) on clean water, sustainable cities, and responsible consumption.
- Potential for nationwide replication to manage India's vast sludge output.

Recommendations for future action:

1. **Policy Frameworks**: Enact supportive regulations for biosolid production and distribution, including incentives for adoption.
2. **Investment in Technology**: Fund upgrades to STPs with advanced treatment systems to enable widespread biosolid generation.
3. **Research Expansion**: Initiate long-term studies on biosolid impacts, including multi-year field monitoring and contaminant fate analysis.
4. **Public and Stakeholder Engagement**: Expand awareness campaigns to farmers, policymakers, and communities to build trust and drive usage.
5. **Scaling Strategy**: Pilot expansions to additional Ganga basin sites, integrating with national missions for holistic waste management.

This project charts a path toward sustainable sludge management, transforming challenges into opportunities for environmental stewardship and agricultural resilience.

Acknowledgement

The project titled “Study for Management of Sludge and Transformation into Bio-Solids” is an integral component of the esteemed Namami Gange Programme, a flagship initiative launched in June 2014 by the Government of India to rejuvenate the Ganga River through pollution abatement and ecological restoration. We are privileged to contribute to this mission of profound environmental and cultural significance.

We extend our deepest gratitude to the National Mission for Clean Ganga (NMCG), Ministry of Jal Shakti, Government of India, for entrusting us with this significant project and for their unwavering guidance and support. This initiative, focused on transforming Ganga sludge into value-added bio-solids, has been a vital opportunity to advance the mission of restoring and preserving the Ganga River.

Our sincere appreciation goes to Shri Rajeev Kumar Mital, Director General, and Shri Nalin Kumar Srivastava, Deputy Director General, NMCG, for their visionary leadership and steadfast encouragement. We also acknowledge the invaluable contributions of Shri Brijendra Swaroop, Executive Director (Projects), and Shri Bhaskar Dasgupta, Executive Director (Finance), along with the entire NMCG team, whose insightful feedback and timely support were pivotal in shaping the project’s success.

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Our profound thanks go to the dedicated project team, contributors, and subject matter experts at Patanjali Organic Research Institute and Patanjali Research Foundation. Their collaborative efforts, from sludge collection and analysis to its transformation and practical implementation, were instrumental in achieving the project’s objectives. We also extend our appreciation to farmers and local communities for their adoption of innovative technologies, including soil testing, the Harit Kranti Application, and the Annadata E-Market Place, which have enhanced traceability, sustainability, and agricultural productivity.

Our Inspiration & Mentors



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Founder, Patanjali Institute



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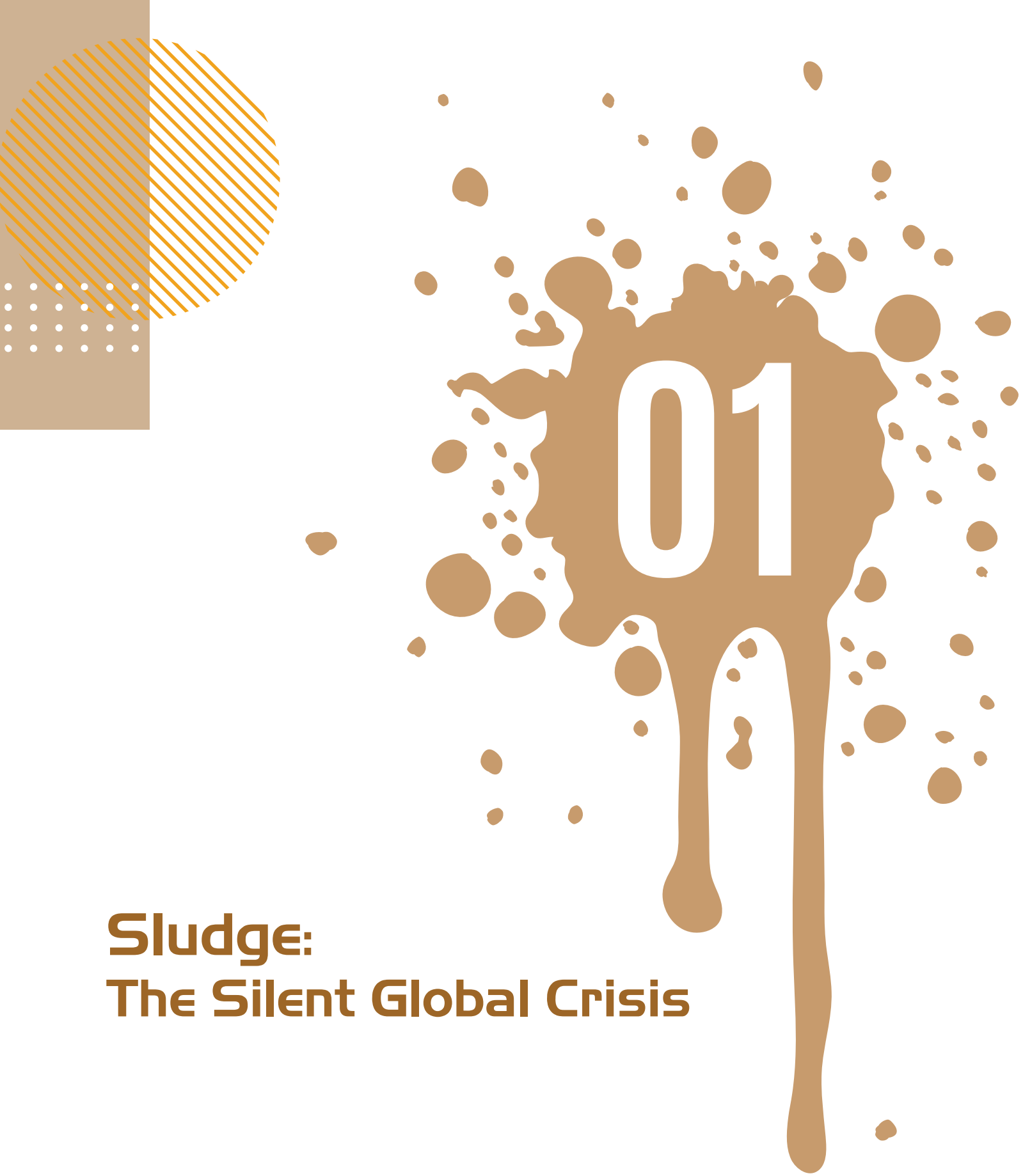
SECTION I

BACKGROUND



Sludge:
The Silent Global Crisis

Semi-solid byproduct formed during wastewater treatment, where solid and organic materials are separated from water to produce a thick, muddy substance, is referred to as sludge (Kumar & Chopra, 2016). Its composition varies with wastewater sources and treatment methods, typically comprising a complex mixture of organic and inorganic matter, heavy metals, nutrients, pathogens, and microbial populations (Akhter et al., 2020; Szeląg et al., 2021). Sludge can be categorized into primary, secondary, and tertiary types based on the treatment stage: primary sludge, generated during sedimentation, is rich in organic and inorganic solids such as sand, grit, fecal matter, and food particles; secondary or biological sludge, produced during biological treatment, consists mainly of microbial biomass and requires stabilization to reduce pathogens and volume; and tertiary sludge, produced during advanced treatment, contains lower volumes but may include chemical residues from processes like filtration, precipitation, and oxidation. It originates from domestic sewage, industrial effluents, and stormwater runoff, river waste, primarily consists of residential wastewater, industrial effluents often contain process-specific chemicals, and stormwater carries suspended solids and organic matter from surface runoff (Lee et al., 2017; Gong et al., 2012; Prado et al., 2014). Although domestic sludge is over 99.9% water, its treatment generates sludge that, after anaerobic digestion and mechanical dewatering, typically contains about 80% moisture and 20% dry solids (Rulkens, 2004). Given its nutrient-rich composition, sludge is increasingly recognized as a valuable resource for soil conditioning, nutrient recovery, and energy generation; however, its physical, chemical, and biological properties must be thoroughly assessed to ensure environmentally safe management, disposal, or beneficial reuse while minimizing risks to human health and ecosystems. A detailed breakdown of the physical, chemical, and biological components of sewage sludge is provided in Table 1.1.

Table 1.1. Physiochemical and biological properties of sludge

Parameters	Observed values in raw sewage
pH	5.0-8.0
Total solids	0.83-12.0
Volatile solids (% of TS)	30.0-88.0
Moisture	Not more than 95%
Proteins (% of TS)	15.0-41.0
Phosphorus (% of TS)	0.8-11.0
Potassium (% of TS)	0.4-3.0
Silica (% of TS)	10.0-20.0

Parameters	Observed values in raw sewage
Organic acids (mg L' HAc)	200.0-2000.0
Total coliforms (CFU/g dry wt)	10^4-10^8
Fecal coliforms (CFU/g dry wt)	10^7-10^9
Fecal Streptococci (CFU/g dry wt)	10^3 -10^5
Salmonella sp. (CFU/g dry wt)	10^2-10^3
Enteric virus (PFU/g dry wt)	10^2-10^4

Source: Rulkens, 2004; Gong et al., 2012; Prado et al., 2014; Sahet al, 2015; Lee et al, 2017; Lamastra et al., 2018; Akhter et al., 2020; Szeląg et al., 2021)

1.1 Sludge Generation and Management in the 21st Century: Global Estimates, European Trends, and the Indian Scenario

The rapid pace of urbanization and industrialization has significantly increased the volume of sludge and wastewater generated globally. As a consequence, large quantities of sludge are produced during the wastewater treatment process. According to some studies, an average of 2.7 billion tons of sludge was produced worldwide in 2019, with estimates ranging from 2.3 to 3.1 billion tons (Altieri et al., 2023; Kiselev et al., 2024). In 2019, Germany stands out as the largest producer, creating 1749.86 thousand tons, and 1708.70 thousand tons in 2021 (Eurostat 2024). In contrast, Poland has shown considerable stability, with an increase from 574.64 thousand tons in 2019 to 580.66 thousand tons in 2022. Hungary shows considerable growth, increasing from 227.89 thousand tons in 2019 to 248.08 thousand tons in 2022, representing a 9% rise (Eurostat 2024). Czechia likewise exhibits a considerable growth tendency, rising from 221.09 thousand tons in 2019 to 243.76 thousand tons in 2022, representing a 10.3% rise. The EU average sludge generation rate for these years is roughly 250 thousand tons (Eurostat 2024). Only about half of the 60,000 wastewater treatment plants worldwide treat the 360–380 km^3 of wastewater generated annually in 2020; this amount is expected to rise by 24% by 2030 and 51% by 2050 (Di Giacomo et al., 2022). For example, it is estimated that 60 million tons of sludge are produced annually in China, with a 10% yearly growth rate (Siddiqui et al., 2023). Similarly, some 50 million tons of sludge are produced annually in the European Union (Mishra et al., 2022). Sludge management continues to be a major problem, with the removal of sludge from various industrial processes being acknowledged as an environmental burden on society. Global sludge production is increasing, harming human health and the environment, particularly in developing countries.

Similarly, in India, solid waste generation is expected to cross 300 million tons in the year 2047, whereas the generation of hazardous and inorganic contaminants is estimated to reach 4.5 million and 290 million tons, respectively (Singh et al., 2020). According to the CPCB (Central Pollution Control Board) report, about 72,368

MLD (million liters per day) of sludge is generated whereas the installed capacity of the sewage treatment plant was only 31,841 MLD (43.9%). Of this installed capacity, the developed and operationalized capacity was 26,869 MLD (84 percent). Of the total operationalized capacity, 20,235 MLD (75%) was the actual utilized capacity. In other words, out of a total of 72,368 MLD sludge generated every day, only 20,235 MLD is treated (CPCB | Central Pollution Control Board, 2023). The distribution of sludge generation around the states of India is given in figure 1.1.

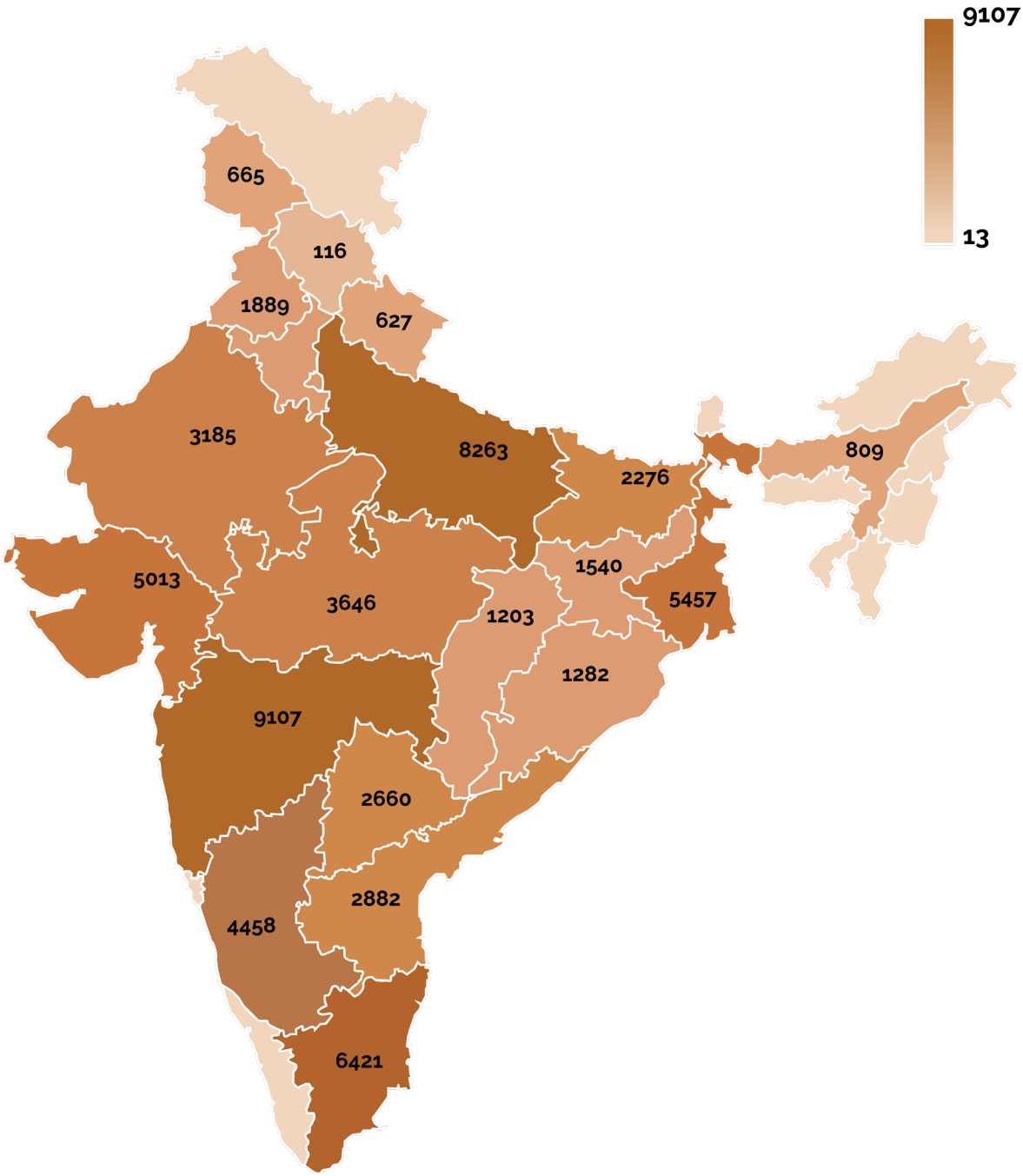


Figure 1.1 Sludge generation in different states of India (MLD) (Source: CPCB, 2023).

1.2 Sludge Generation and Environmental Burden in the Ganga River Basin

Sludge accumulation is a serious issue in the Ganga River Basin, and it exhibits a distinct flow pattern. The upper Himalayan sections of the river has very little pollution, but when it passes through important cities like Kanpur and Varanasi, the middle section sees a dramatic increase in sludge accumulation. Heavy sludge deposits result from the large influx of untreated sludge and industrial waste into this slow-moving river (Jain et al., 2018; CPCB, 2013). The lower portion of this pollutant load, which passes through Bihar and West Bengal, eventually settles in the Hooghly-Kolkata urban region before arriving at Ganga Sagar (Sharma et al., 2020). Due to their significant industrial activity and huge urban populations, West Bengal and Uttar Pradesh produce the most sludge in the Ganga basin. The majority of wastewater produced in Uttar Pradesh, which is home to cities like Kanpur and Varanasi, is left untreated, resulting in the production of enormous amounts of sludge (CPCB, 2021; NMCG, 2023). Similarly, West Bengal is the second-largest producer of sludge in the basin due to the high sewage contributions of its Ganga-front municipalities, especially the Kolkata metropolitan region (CPCB, 2021). It was estimated that, after every hamlet in the Ganga Basin states (Uttarakhand, Uttar Pradesh, Bihar, Jharkhand, and West Bengal) is declared Open Defecation Free (ODF), some 180 million litres of faecal sludge per day (MLD) would be produced. About 60% of garbage goes straight into the river in major Ganga towns, with only 15% of faecal sludge being cleansed. For instance, just 30 of the 246 kilolitres produced per day in Varanasi is managed correctly. Less than half of the 2,953 MLD of sludge generated along 97 river villages gets treated. This untreated influx poses a major risk to aquatic ecosystems and public health since it heavily burdens the river with organic pollutants, heavy metals including chromium, cadmium, and lead, as well as viruses (Shukla et al., 2021; Trivedi et al., 2010). The Ganga's inadequate sludge management causes heavy metals like zinc, chromium, and cadmium to accumulate in sediments, harming aquatic life, changing riverbed ecosystems, and possibly poisoning soil, water, and the human food chain (Chakraborty et al., 2024). The Ganga's dilution and self-purification are diminished by declining river flows brought on by unpredictable rainfall, over-extraction, and climate change, which causes sludge formation, particularly between Kannauj and Prayagraj where stagnant zones develop (Shukla et al., 2021; Balkrishna et. al., 2024). According to research studies, dried sludge's high organic matter content makes it an effective soil conditioner and fertilizer. However, it also has drawbacks, such as the presence of heavy metals and pathogens, which require suitable treatment before use (Jain et al., 2018). In the section given below, the risks associated with the direct use of Ganga sludge has been emphasized.

1.3 Environmental and Health Risks of Direct Sludge Usage

Using sludge as fertilizer or for landfilling may offer a potentially sustainable waste management option; however, it is also associated with several significant environmental and health risks. These risks include odor nuisance, the presence of toxic substances such as heavy metals and pesticides,

the spread of pharmaceutical residues and their metabolites, the emerging threat of microplastics, and the presence of harmful pathogens (Rizzo et al., 2013; Gupta et al., 2019; Sharma & Singh, 2021). One of the primary concerns is the potential for soil contamination when sludge is applied to agricultural land. Contaminants present in the sludge can be absorbed by plants and accumulate in their tissues, leading to the contamination of crops and the animals that feed on them (Khan et al., 2018). Additionally, these pollutants can leach into groundwater, causing further environmental degradation and increasing the risk of widespread contamination (Singh & Agrawal, 2008).

Another major pathway through which sludge poses a risk to the food chain is via bioaccumulation. As animals consume contaminated feed or drink polluted water, the toxic substances can accumulate in their bodies over time, leading to health issues and making them potentially unsafe for human consumption (Ramesh et al., 2020). Moreover, when humans consume such contaminated animal products, these pollutants may bioaccumulate within the human body as well, posing long-term health hazards such as hormonal disruption, neurological disorders, and even cancer (Sims & Pierzynski, 2005).

Given the growing concern of scientific evidence on these threats, can we afford to ignore the consequences any longer? The detrimental impacts of sludge on the entire food chain are well-documented in various research studies. In the following section, we provide a detailed discussion on the ecological and health-related consequences associated with each major contaminant found in sewage sludge.

1.3.1. The major Threat: Heavy Metal Contamination

Most of the toxic heavy metals, including lead, thallium, cadmium, and antimony, are common in industrial operations and are substantial polluters of the environment. The sources of heavy metals are varied and distributed in environment; major ones can be depicted in figure 1.2 below.



Figure 1.2. Sources of Heavy Metals in Environment and their Detrimental Effects

1.3.1.1. Heavy Metal Contamination in Water Bodies

One of the most pressing environmental challenges today is the discharge of untreated or partially treated sewage into river systems, which poses severe threats to aquatic ecosystems and human health. Waste treatment facilities often generate residues, especially sludge from decanter discharges, that contain raw water particles and treatment chemicals. Improper classification, handling, and disposal of this sludge result in both quantitative and qualitative environmental issues (Sharma et al., 2022). Direct discharge of such contaminated sludge into water bodies should be avoided, as studies have demonstrated its detrimental effects on both soil and aquatic life.

A major concern associated with sewage sludge is the presence of heavy metals, introduced primarily through chemicals used during water treatment and various industrial effluents. These metals, due to their solubility, are easily transported through water and accumulate in river sediments, negatively affecting water quality and aquatic biodiversity (Masindi & Muedi, 2018). Over the past four decades, heavy metal pollution has been recognized as a significant global environmental issue, especially in river basins. During the late 20th century, approximately 22,000 tonnes of cadmium (Cd), 939,000 tonnes of copper (Cu), 783,000 tonnes of lead (Pb), and 1,350,000 tonnes of zinc (Zn) were released into the environment globally (Sharma, 2011).

The Buriganga River in Bangladesh offers a stark example, with reported concentrations of 126 ppm of Cd, 805 ppm of Pb, 5,274 ppm of chromium (Cr), and 595 ppm of arsenic (As) as of 2006 (Bhuiyan et al., 2015). Such alarmingly high levels pose serious risks to public health and call for immediate intervention and further research (Siddiqui & Pandey, 2019).

In India, the Ganga River, the country's most critical river system, faces extensive heavy metal contamination. It spans a basin area of 861,404 km² and supplies nearly 25% of India's total water resources (Siddiqui & Pandey, 2019). Flowing through 29 Class I cities, 23 Class II cities, and around 50 towns, the Ganga receives large volumes of domestic sewage, industrial effluents, municipal waste, and agricultural runoff, all contributing to the heavy metal load. These pollutants originate from both natural sources, such as weathering and erosion, and anthropogenic activities, especially urbanization and industrialization. The presence and distribution of heavy metals in the Ganga River system are illustrated in various studies, including figure 1.3, which outlines the spatial prevalence and intensity of contamination. Further, the negative impacts of these heavy metals can be depicted from table 1.2 and figure 1.4.

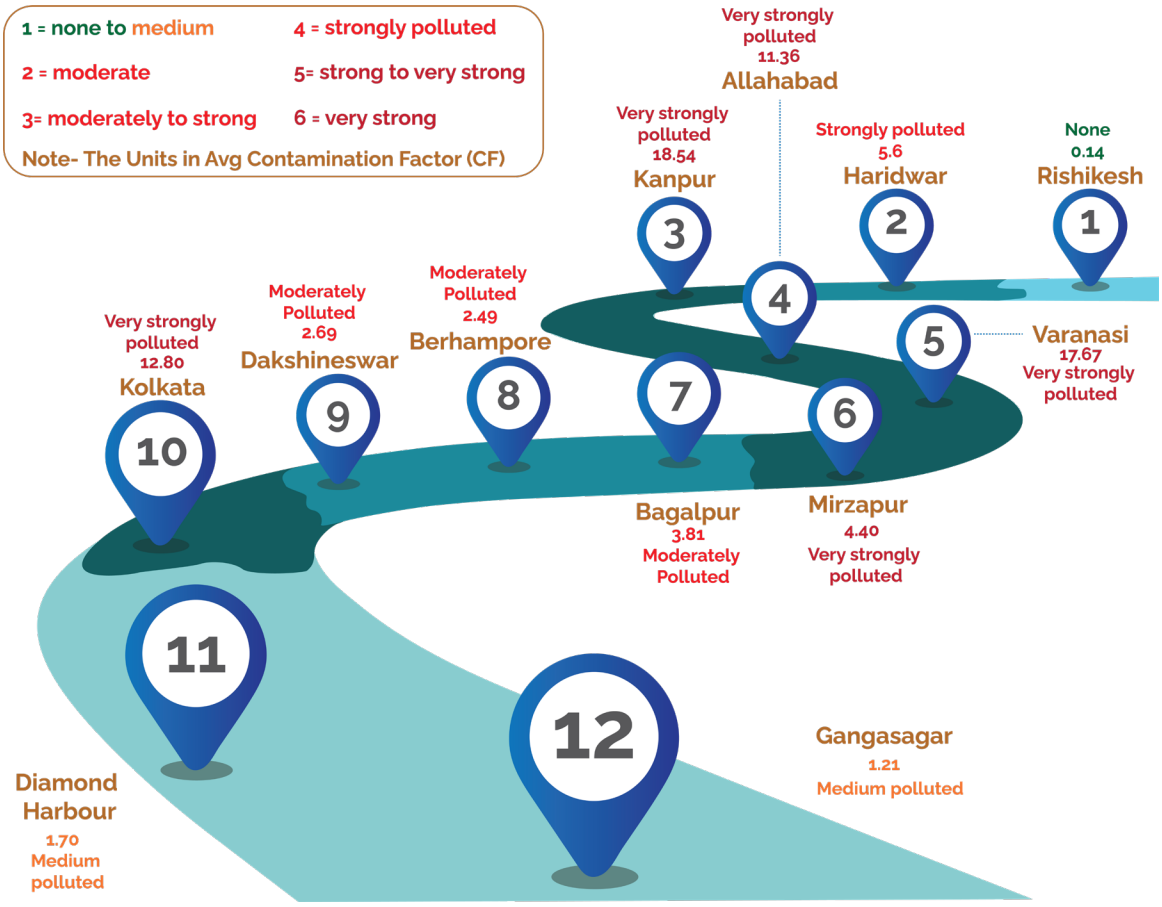
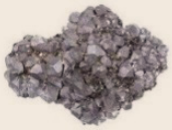


Fig 1.3. Heavy metal pollution and contamination prevalence across the Ganga River System (**Sources**: Chaturvedi and Pandey, 2006; Sarkar et al., 2007; Kar et al., 2008; Gupta et al., 2009; Leena Singh et al., 2012; Rai et al., 2012; Haritash et al., 2016).

Table 1.2. Effect of Heavy Metals on Plant and Human Systems

Heavy Metals	Occurrence in sludge and Sources	Permissible Dose(mg/l) (WHO)	Effect on Plants	Effect on Human	Mechanism of Toxicity
Arsenic 	Insecticides, herbicides, fungicides, algicides, sheep dips, wood preservatives, and dyestuffs, Arsenic-based drugs	0.05	Reduction in Leaf number chlorosis, necrosis Reduction in shoot and root growth, Overproduction of reactive oxygen species (ROS),	Cardiovascular and peripheral vascular disease, developmental anomalies, neurologic and neurobehavioral disorders, diabetes, hearing loss, portal fibrosis, and hematologic disorders. cancers of the bladder, kidney, skin, and liver	Inhibition of various mitochondrial enzymes, Inhibit DNA repair, Genotoxic

Heavy Metals	Occurrence in sludge and Sources	Permissible Dose(mg/l) (WHO)	Effect on Plants	Effect on Human	Mechanism of Toxicity
Cadmium 	Alloys, Pigments, and Batteries	0.005	Trigger the synthesis of reactive oxygen species, Hinder the essential nutrients and water, and Modify Photosynthetic machinery	Decreases bone mineral density and causes osteoporosis, Pulmonary dysfunctions emphysema,Decreases in olfactory function. Human carcinogenic	Single-strand DNA damage and disrupts the synthesis of nucleic acids and proteins
Chromium 	Industrial Welding, Chrome Plating, Dyes and Pigments, Leather Tanning, and Wood Preservation	0.1	Chlorosis in the leaves, damaging root cells, Affecting transpiration and nitrogen assimilation	Renal damage, allergy and asthma, and cancer of the respiratory tract, ulcers in the stomach, and small intestine, anemia, sperm and male reproductive system damage	Lipid peroxidation, mitochondrial dysfunction, cancer development, chromosomal abnormalities, DNA strand breaks, DNA fragmentation
Lead 	Paints, Ceramic Products, Caulking, Pipe Solder, Batteries	0.05	Inhibition of ATP production, lipid peroxidation, DNA damage	Toxic to kidneys, liver, central nervous system, hematopoietic system, endocrine system, and reproductive system	Mimic the actions of calcium and interact with proteins.
Mercury 	Electrical Industry Dentistry (Dental Amalgams)	0.001	Decrease in photosynthetic rate	Gastrointestinal toxicity, neurotoxicity, and nephrotoxicity	Increase the production of ROS, alter calcium homeostasis, increased mitotic index and polypoidal aberrations

Sources: Bertrand Pourrut et al., 2011; Azevedo & Rodriguez, 2012; Tchounwou et al., 2012; Abbas et al., 2018; Sharma et al., 2020; Zhao et al., 2021

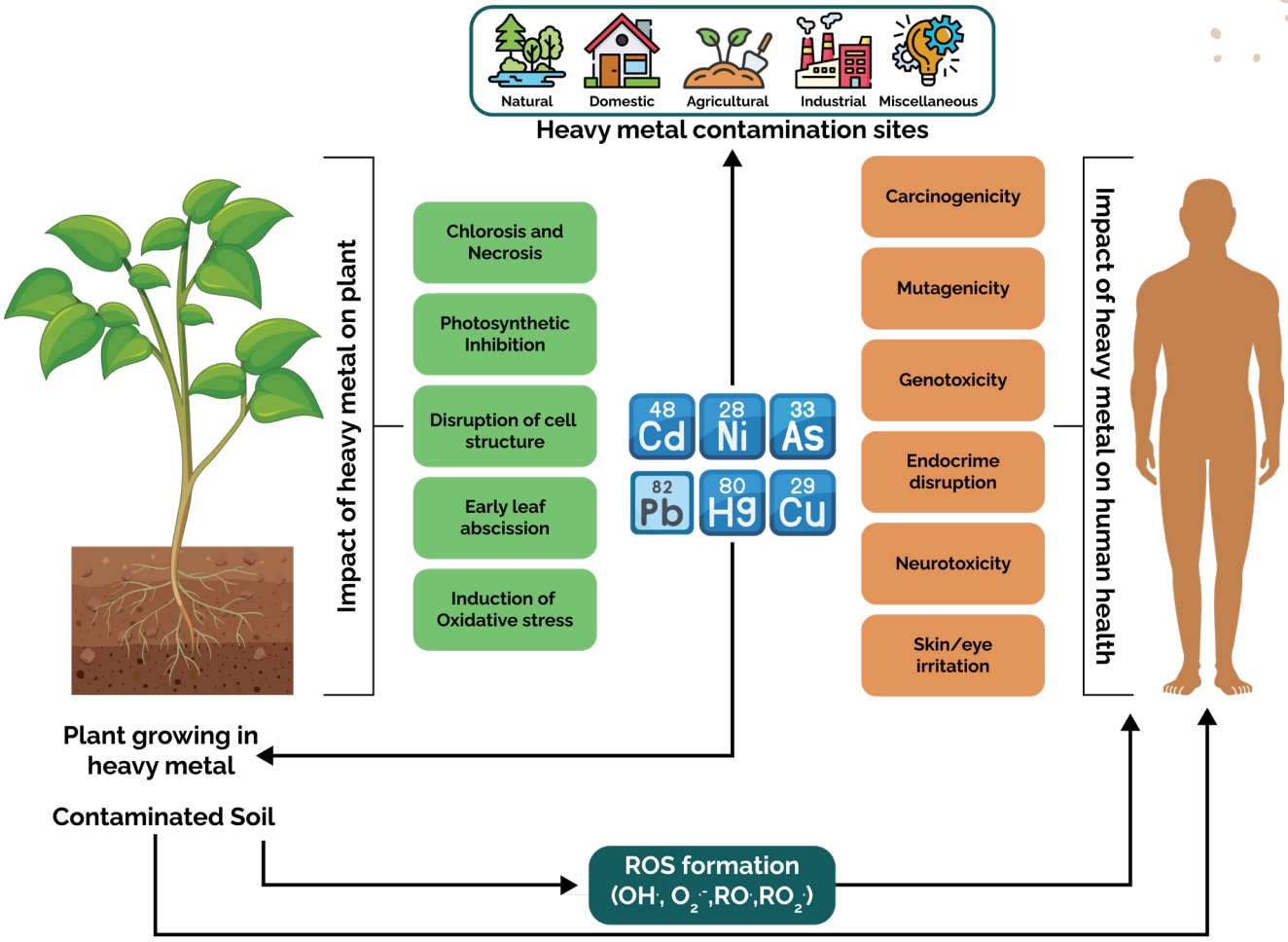


Figure 1.4. Bioaccumulation of heavy metal in food chain

1.3.2. The persistent threat: Pesticides

Pesticides are chemical agents used to manage pests by either controlling, destroying, repelling, or attracting them. They offer several advantages, such as rapid effectiveness, the ability to manage large-scale infestations, and improved crop yields through the reduction of pest-related losses. However, due to their physicochemical and toxicological properties, pesticides are increasingly associated with adverse environmental and health effects. Their widespread use in agriculture has significantly contributed to the pollution of soil, water, and air. Notably, many pesticides exhibit characteristics such as high lipophilicity, long half-lives, bioaccumulation potential, and the ability for long-range environmental transport, which contribute to their persistence in the environment even years after application (Ponce-Robles et al., 2017). A number of these persistent pesticides have also been identified in sludge, as outlined in table 1.3.

Table 1.3. **Pesticides and their estimated concentrations found in sludge.**

Compounds	Concentration range(mg/kg) found in Sludge
Azole	10-1166
Benzimidazole	1.41-7.31
Chloroacetanilide	2.24
Organophosphorus	0.05-77.88
Triazine	2.59-0.061
Glyphosate	200–2900
Aminomethylphosphonic acid	2300–33,300
Chlorpyrifos	0.45–703
Diazinon	9.59–20.1
Hexythiazox	2.21–4.84
Imazalil	395–1,082
Pyriproxyfen	22.2–25.5
Thiabendazole	11.4–186 Source

Source: Ravindran et al., 2016

1.3.2.1. Pesticide Pollution in Agricultural and Urban Environments

Pesticide contamination of water bodies and soils is primarily driven by large-scale agricultural activities, including agricultural runoff and irrigation. Highly soluble and polar pesticides are frequently detected in wastewater at concentrations in the nanograms per liter range (Campo et al., 2013). Although agriculture is the dominant source, urban sources, especially wastewater treatment plants (WWTPs), have gained attention for their contribution to pesticide pollution. In WWTPs, pesticides tend to accumulate in sewage sludge.

Studies by Masia et al. (2015) reported chlorpyrifos as the most frequently detected pesticide, found in 83% of soil samples (up to 65.3 ng/g) and in 90% of sewage sludge samples (560–703 ng/g). Other commonly identified pesticides in sewage sludge include thiabendazole, imazalil, diazinon, pyriproxyfen, and hexythiazox. While thiabendazole and imazalil are primarily used as postharvest fungicides, the others are extensively applied in urban areas and are regularly documented in WWTPs. Additional detected substances include carbofuran, isoprostane, and triazine metabolites like nabumetone-diethyl and terbuthylazine-diethyl, all widely used as herbicides and insecticides. These compounds often accumulate in river sediments. Soil analysis also revealed the presence of pesticides like chlorpyrifos, thiabendazole, pyriproxyfen, terbuthylazine, and metolachlor, the latter two being common herbicides applied near the soil surface.

Among the detected pesticides, organochlorine pesticides (OCPs) are of particular concern. OCPs, such as DDT, hexachlorocyclohexane (HCH), aldrin, and dieldrin, are persistent organic pollutants (POPs) known for their environmental persistence, toxicity, and bioaccumulation. Though once widely used to control diseases like typhus and malaria, OCPs are now banned in most industrialized countries (Aktar et al., 2009). Nevertheless, they continue to be used in many developing Asian nations due to their low cost and effectiveness (Gupta, 2004; FAO, 2005; Lallas, 2001). According to pesticide usage data, organochlorines account for about 40% of total pesticide use and are predominantly found in sewage sludge (Gupta, 2004; FAO, 2005). Despite global restrictions under the Stockholm Convention, the ongoing use of these substances in underdeveloped regions presents ongoing threats to ecosystems and human health. Table 1.4 and Figure 1.5 summarize the negative effects posed by these pesticides.

Table 1.4. The effect of commonly found pesticides (organochlorine) on animals and humans.

Chemical name	Persistence in environment	WHO classification based on rat oral LD_{50}	Effect on animals	Effect on Human being
Dichlorodiphen-yltrichloroethane	High Persistence; Half-life: 2–15 years	Moderately hazardous	Mice: Liver tumors, liver changes; Birds: Egg shell thinning; Fish: Affects membrane function	Prickling sensation in the mouth, nausea, dizziness, confusion
Dicofol	Moderate persistence; Half-life: 60 days	Moderately hazardous	Rats: Decrease in body weight and acute neurotoxicity; Dogs: Inhibition of ACTH	Headache, nausea, vomiting, and poor appetite
Endosulfan	Moderate Persistence; Half-life Alpha Isomer: 35 days Beta Isomer: 150 days	Highly hazardous	Rats: Immunosuppression, neurological disorders, congenital birth defects	Decreases white blood cell count and macrophage migration, adverse effects on the humoral and cell-mediated immune system
Polychlorinated Biphenyls	Moderate Persistence; Half-life: 10 days to Half-year	Highly – Moderately hazardous	Fishes, rats, monkeys, and mice: Cancer, Hodgkin's lymphoma, decreased birth weight, and decreased size of the thymus gland	Neurological disorders and short-term memory

Source: Cummings & Gray, 1989; Ravindran Jayaraj et al., 2016

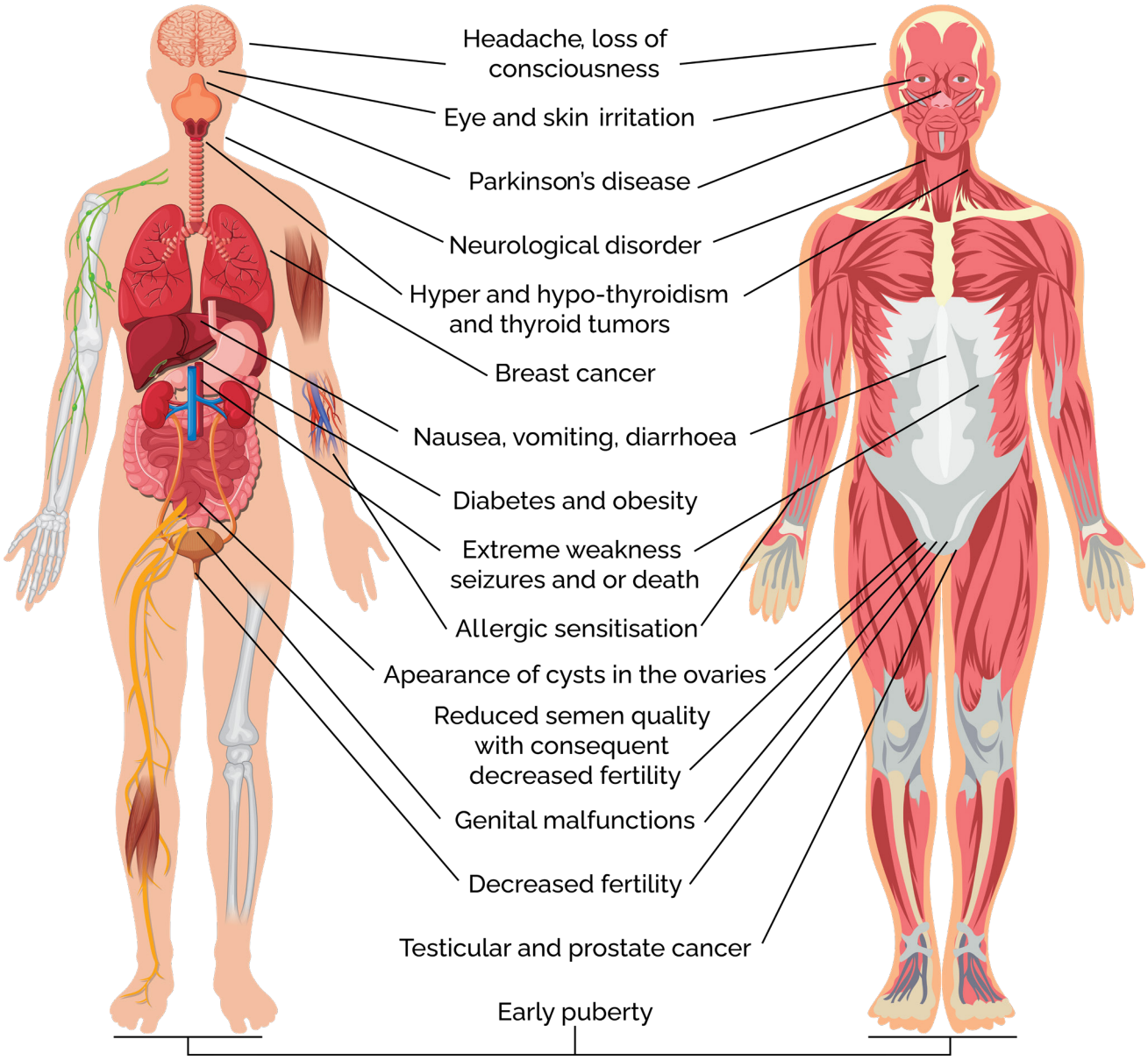


Figure 1.5. Human Health Risks Associated with Pesticide Exposure

1.3.3. The anthropogenic threat: Pharmaceutical products and their metabolites

Pharmaceutically active substances (PhACs) are anthropogenically produced pollutants that are continually discharged into the environment and have the potential to significantly affect ecosystems and human health. Intakes that are high in PhAC are handled in wastewater treatment facilities before being released into the environment (WWTPs). PhACs in wastewater effluents are present due to the inadequate removal or degradation of these pollutants in WWTPs.

1.3.3.1. Sorption and Mobility of Pharmaceuticals in Soil

The extent to which pharmaceutical contaminants migrate through the soil profile largely depends on their sorption to soil particles. Sorption affects both the bioavailability and environmental persistence of these substances. A higher sorption capacity in soil typically leads to reduced mobility and bioavailability, influencing how long these compounds persist and how much organisms are exposed to them.

Kodeová et al. (2016) investigated the behavior of several active pharmaceutical ingredients (APIs) including carbamazepine, atenolol, metoprolol, trimethoprim, sulfamethoxazole, clindamycin, and clarithromycin in 13 different soil types. The study found that soil properties significantly affect pharmaceutical half-lives. Carbamazepine exhibited the greatest persistence, followed by clarithromycin, trimethoprim, metoprolol, clindamycin, sulfamethoxazole, and atenolol. In general, soils with higher sorption capacities reduced the mobility and prolonged the half-life of these compounds. However, in fertile soils like chernozem, characterized by high organic matter, good structure, and biological activity, shorter half-lives were observed due to more active degradation processes (Kodeová et al., 2016).

In another study, Borgman and Chefetz (2013) explored how biosolid application and irrigation with reclaimed effluents influence pharmaceutical mobility in soils. Their column-leaching experiments showed that reclaimed water increased the mobility of weakly acidic drugs in biosolid-amended soils, whereas fertilizer application enhanced the retardation of leaching. The findings underscore the role of irreversible sorption in limiting pharmaceutical movement. Importantly, the authors emphasize that realistic environmental concentration data should be used over model simulations at exaggerated doses to better understand pharmaceutical behavior in real-world scenarios (Borgman & Chefetz, 2013). These studies collectively highlight the complex interaction between soil type, organic matter, and external inputs (e.g., sludge, effluents) in governing the environmental fate of pharmaceuticals. Figure 1.6 presents the accumulation of pharmaceuticals in sludge-amended soil.

1.3.3.2. Ecotoxicological effects of pharmaceutical products

Current knowledge regarding the bioaccumulation of pharmaceuticals in organisms and along trophic chains is limited. However, studies have detected pharmaceutical residues such as fluoxetine and sertraline in fish tissues, indicating their potential to bioaccumulate in aquatic organisms (Nikolaou et al., 2007). Antibiotics like tetracyclines and fluoroquinolones, due to their high sorption coefficients in soils, show low bioavailability. This reduces their likelihood of affecting higher terrestrial organisms. So far, limited evidence suggests that common soil fauna such as earthworms, collembola and enchytraeids are not significantly impacted by veterinary antibiotics like oxytetracycline and tylosin.

One of the most pressing concerns related to pharmaceutical contamination is the development of antimicrobial resistance (AMR). AMR caused by environmental exposure to antibiotics poses a serious threat to human and animal health. This issue has been increasingly

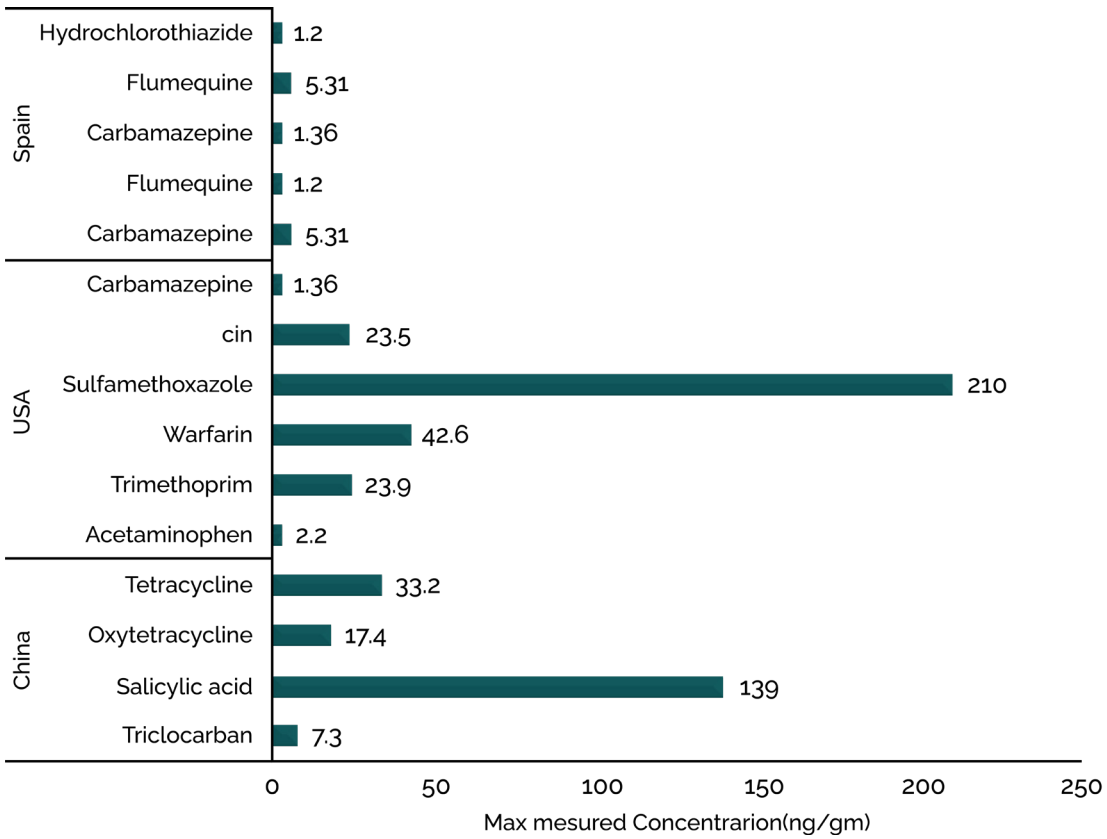


Figure 1.6. Pharmaceutical products found in sludge-amended soils (Source: Kodeová et al., 2016).

recognized in recent years (Deloitte for EC, 2015). Despite these concerns, the ecotoxicological impacts of pharmaceuticals in soil ecosystems remain poorly studied**,** with far more research focused on aquatic environments (Gworek et al., 2019; Gworek et al., 2020; Pal et al., 2013). Among the most harmful substances to aquatic life are neomycin, trimethoprim, sulfamethoxazole, and enrofloxacin (Gworek et al., 2019). These compounds may pass through wastewater treatment plants partially or completely unmetabolized, entering surface or groundwater and potentially affecting aquatic species at multiple trophic levels. Ecotoxicity studies have also shown that pharmaceuticals can significantly disturb microbial populations. For instance, tetracycline has been found to inhibit the growth of nitrifying bacteria, indicating possible long-term disruptions to microbial ecological functions essential for nutrient cycling (Katipoglu-Yazan et al., 2015). The overall ecotoxicological effect of pharmaceuticals has been shown in Figure 1.7.

1.3.3.3. Pharmaceutical Pollution and Its Environmental and Health Impacts

Human medications are now recognized as emerging pollutants by UNESCO, with their identification and removal deemed critical under the 2030 Agenda for Sustainable Development (UNESCO, 2020). Though pharmaceutical concentrations in treated wastewater are

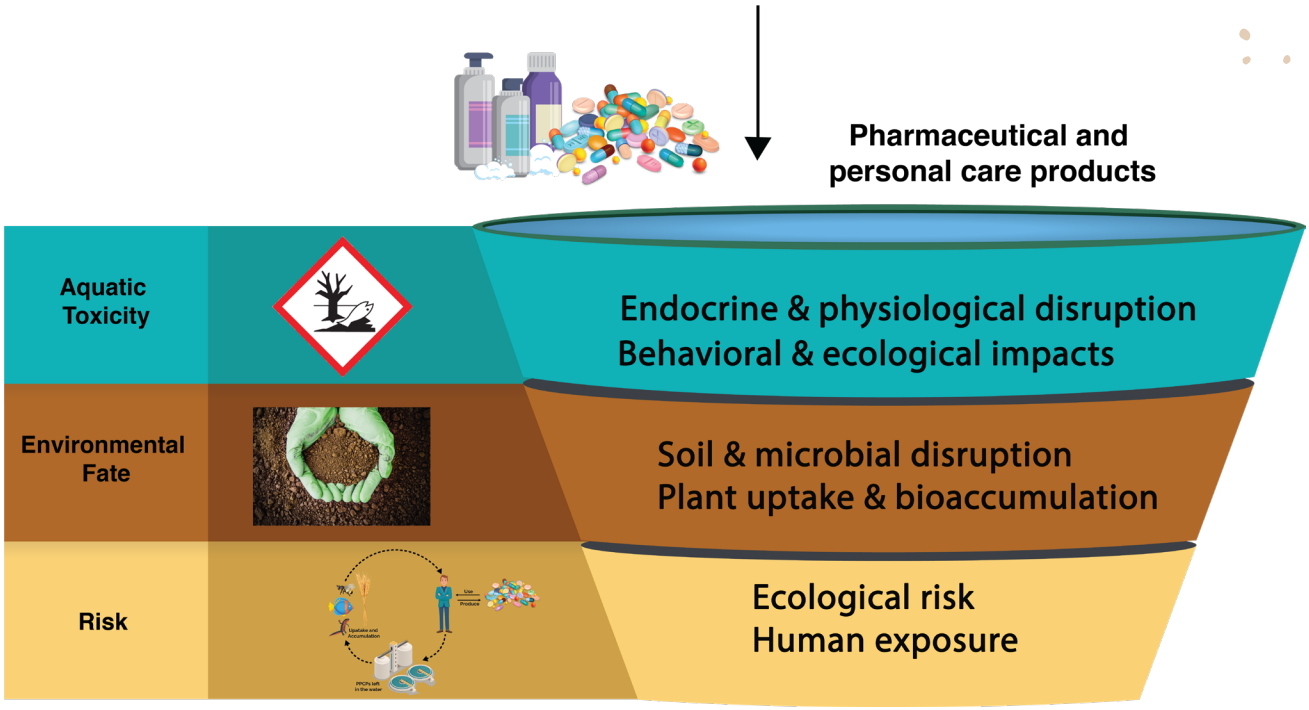


Figure 1.7. Ecotoxicological Effects of Pharma products

typically below 100 ng/L (Li et al., 2021), these trace levels complicate risk assessment. Despite their low concentrations, certain drug classes such as beta-blockers, antibiotics, anticancer agents, and endocrine disruptors have been shown to cause severe ecological damage, including mortality and reproductive dysfunction in aquatic species (Godlewska et al., 2021; Ortuzar et al., 2022).

The long-term effects and environmental fate of many pharmaceuticals remain under-researched (aus der Beek et al., 2016). Given the vast number of drugs and the complexity of assessing combined low-dose, long-term exposures, the full scope of the issue remains unclear (Kümmerer, 2019). The German Environment Agency estimates that about 10% of marketed drugs pose environmental risks. Among the most prevalent and harmful are hormones, antibiotics, antidepressants, anti-inflammatories, analgesics, beta-blockers, and anticancer drugs (Küster et al., 2010).

Hormones and Estrogens: Estrogens, from birth control and livestock growth hormones, are particularly problematic. Around 700 kg/year of synthetic and 30,000 kg/year of natural estrogens enter the environment from human sources alone. These hormones disrupt reproduction and physiology in both humans and wildlife, and are linked to increased risks of breast and prostate cancers (Adeel et al., 2017; Nelles et al., 2011; Trevino et al., 2015).

Antibiotics: Widespread antibiotic use, particularly during the COVID-19 pandemic, has led to environmental contamination and rising antibiotic resistance, a significant global health threat (Lai et al., 2021; Zainaba et al., 2020). Improper disposal by flushing further enhances the problem (Anwar et al., 2020). Chronic

exposure can negatively affect individuals with pre-existing conditions such as obesity or diabetes (Ianiro et al., 2016).

Antidepressants: Antidepressant pollution also surged during the pandemic (Rabeea et al., 2021). These compounds accumulate in aquatic organisms, causing cytotoxicity, genotoxicity, organ damage, and behavioral changes (Castillo-Zacaras et al., 2021). Their presence in shared habitats poses risks to human neurodevelopment (Abbey-Lee et al., 2018; Li et al., 2020).

Non-Steroidal Anti-Inflammatory Drugs (NSAIDs): NSAIDs such as ibuprofen, diclofenac, and naproxen are widely detected in soil, water, and even drinking supplies (Tyumina et al., 2020). Their chemical stability leads to persistent ecological harm, including oxidative stress, enzyme inhibition, reproductive disruption, and organ toxicity in aquatic organisms (Hodkovicova et al., 2022; Lister & Van Der Kraak, 2009; Xia et al., 2017).

Beta-Blockers: Beta-blockers, like metoprolol and propranolol, are highly soluble and resistant to degradation. They accumulate in the environment and are toxic to algae and aquatic life, prompting their classification as hazardous under EU Directive 93/67/EEC (Maszkowska et al., 2014).

Anticancer Drugs: Even at ng/L levels, anticancer drugs like cisplatin can cause severe ecological effects, including mutagenicity, carcinogenicity, and teratogenicity. These substances frequently contaminate hospital and pharmaceutical wastewater, with 58% of anticancer drugs detected in such effluents (Dan et al., 2021; Roque-Diaz et al., 2021).

1.3.4. The Emergent Threat: Micro Plastics

Microplastics (MPs) are a growing environmental concern, originating from various sources such as plastic microbeads in personal care products, industrial processes (Gatidou et al., 2019), textile fibers from washing machines (Yadav et al., 2023), and the degradation of larger plastic items into secondary MPs (Shiu et al., 2022). These MPs are commonly transported via domestic waste streams to wastewater treatment plants (WWTPs), where they may enter aquatic environments or accumulate in sewage sludge (Ben-David et al., 2021).

Although WWTPs are not specifically designed to remove MPs, significant reductions in MP concentrations between influent and effluent have been reported, ranging from 58.8% to 99.9% depending on the treatment technology (Liu et al., 2021). Approximately 79% of MPs entering WWTPs end up in sludge (Ziajahromi et al., 2021), with global sludge MP concentrations ranging from 1,000 to over 300,000 particles/kg (Nguyen et al., 2022). In China, an average of 10,280 particles/kg were reported, comprising fibers, fragments, and films (Yuan et al., 2022).

1.3.4.1. Potential risk of MPs

The risk posed by MPs depends on their particle size, chemical composition, and capacity to adsorb and transport contaminants such as heavy metals, persistent organic pollutants, pharmaceuticals, and personal care products (Hamidian et al., 2021; Yin et al., 2021). Polymers found in SS can be categorized into five hazard levels using a risk algorithm, with level five being

the most hazardous, comprising monomers that are mutagenic and carcinogenic (Li et al., 2020). Common SS polymers like polypropylene, polyethylene (HDPE, LDPE, LLDPE), and vinyl acetates are generally classified as low risk, although smaller MPs are more harmful due to their ability to penetrate cells (Fiorentino et al., 2015). MP toxicity is further influenced by factors such as surface charge, the presence of toxic additives, bio-persistence, and their role as carriers for pathogens and pollutants (Banerjee & Shelver, 2021). With increasing plastic use, MPs have become prevalent in irrigation water and soils, especially where sludge is used as fertilizer, affecting soil nutrients and microbial balance (Jiang et al., 2023). Studies have shown that polyethylene MPs (180–300 µm) impair coelomocyte viability and earthworm reproduction (Kwak & Ann, 2021), and high concentrations can block plant water uptake and accumulate in plant tissues (Shi et al., 2022ab; Wang et al., 2019a). MPs also disrupt microbial communities essential for soil health and contribute to inflammatory responses in exposed animals (Leslie et al., 2017), raising serious concerns for agriculture, food safety, and public health. A representative figure has shown the transmission of microplastics (Figure 1.8).

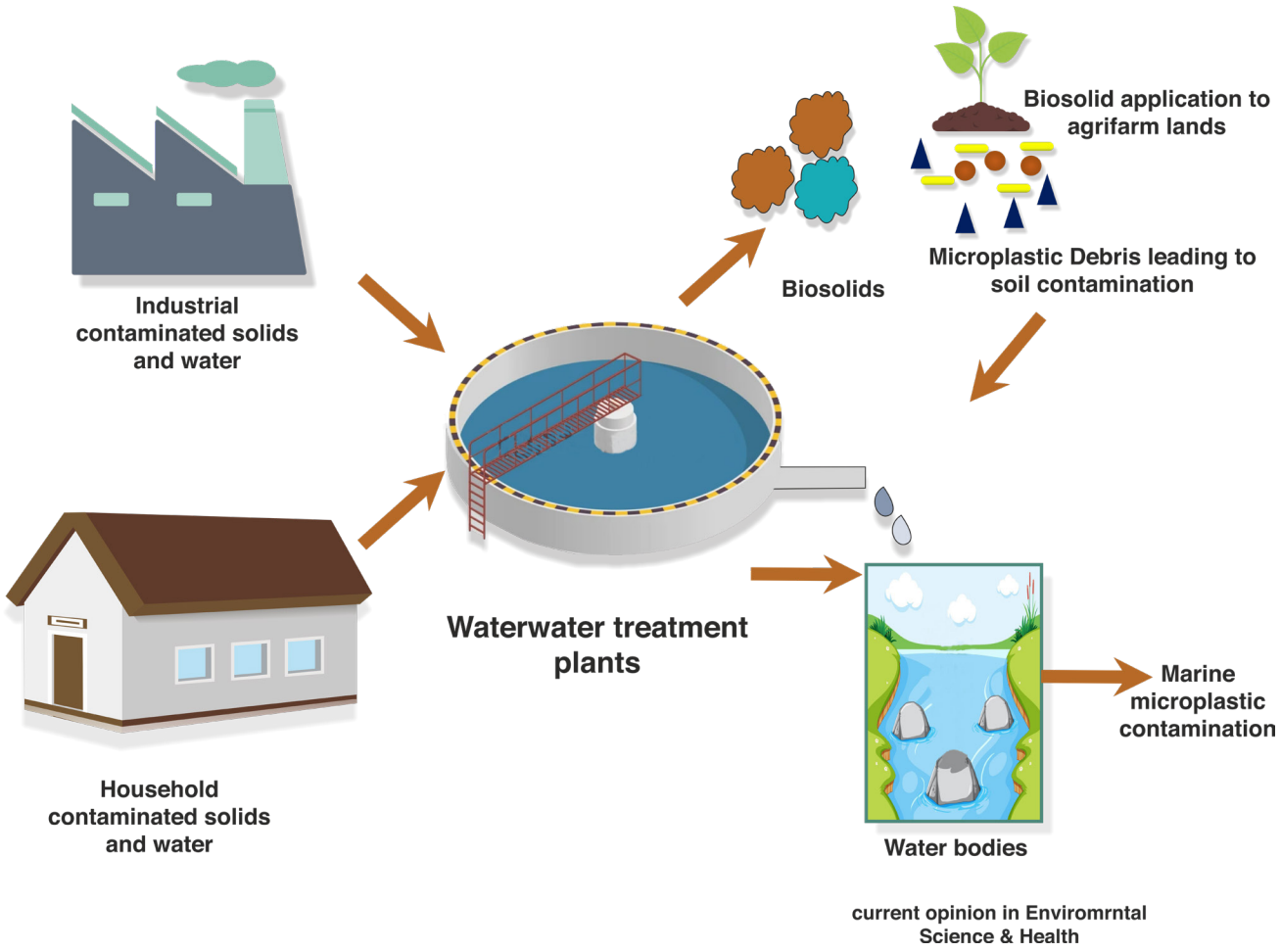


Figure 1.8. The transmission of microplastics

1.3.4.2. Effect of Accumulation of Microplastics on Human health

Although a direct and conclusive link between microplastics (MPs) pollution and severe human health effects has yet to be established (Dermawan et al., 2022), growing evidence suggests that MPs can adversely impact multiple biological systems. Kurniawan et al. (2021), along with Prata et al. (2020, 2021) and Yang et al. (2022), classified the potential health impacts of MPs across various levels such as chemical, cellular, tissue, organ, and major systems including digestive, respiratory, endocrine, reproductive, and immune systems. MPs may enter the human body through inhalation, ingestion via contaminated food, or skin contact with dust particles or consumer products (Nguyen et al., 2022). Although dermal absorption is considered a less significant route, nanoplastics (<100 nm) can potentially penetrate the skin and cause toxicity (Kataria et al., 2022). MPs and their additives, such as bisphenol A and phthalates, are linked to endocrine disruption and skin irritation. Studies have shown that MPs can trigger foreign body responses and chronic low-grade inflammation, with different materials (e.g., polyester vs. silk sutures) showing varied inflammatory effects (Revel et al., 2018). MPs also induce oxidative stress in human epithelial cells (Schirinzi et al., 2017) and may contribute to liver dysfunction and neurotoxicity by altering oxidative balance, energy metabolism, and lipid profiles in animal models (Revel et al., 2018). In agricultural settings, MPs in sludge can affect plant development, e.g., promoting early tomato plant growth but reducing fruit yield (Hernández-Arenas et al., 2021). Moreover, MPs can adsorb and release heavy metals and organic pollutants (Mao et al., 2020) although they may also serve as indicators for monitoring pollution levels (Zhang et al., 2015). Overall, the presence of MPs in sewage sludge presents multiple exposure risks to humans through environmental and food chain pathways. The overall transmission and consequences of MPs on human health have shown below (Figure 1.9).

1.3.5. The Live Threat: Pathogenic microorganisms

With the corresponding rapid rise of towns and cities, the amount of human waste has significantly increased. Sewage has been the source of large numbers of dangerous microbes, including bacteria, viruses, and protozoa parasites (US EPA 2003). Over 2000 children under the age of five die every day due to poor sanitation and tainted drinking water around the world (UNICEF 2013). Due to the discharge of treated sewage contaminated with harmful bacteria, various water sources, including seas, rivers, oceans, and surface water, have recently begun to pose health dangers for people (Wen et al. 2009; GarciaArmisen et al. 2011). According to Scott et al. (2003) treated sewage is the main source of fecal pollution in aquatic environments and contains a wide range of microbial pathogens that may be harmful to human health. The contamination of rivers and water bodies by pathogenic bacteria like *Salmonella* spp., *Shigella* spp., *P. aeruginosa*, *S. aureus*, *E. coli*, *V. cholera, Y. enterocolitica*, & *C. jejuni* increases because of the transmission of infectious pathogenic organisms into rivers and water bodies from sewage effluent discharge (US EPA 1988). People who eat seafood that

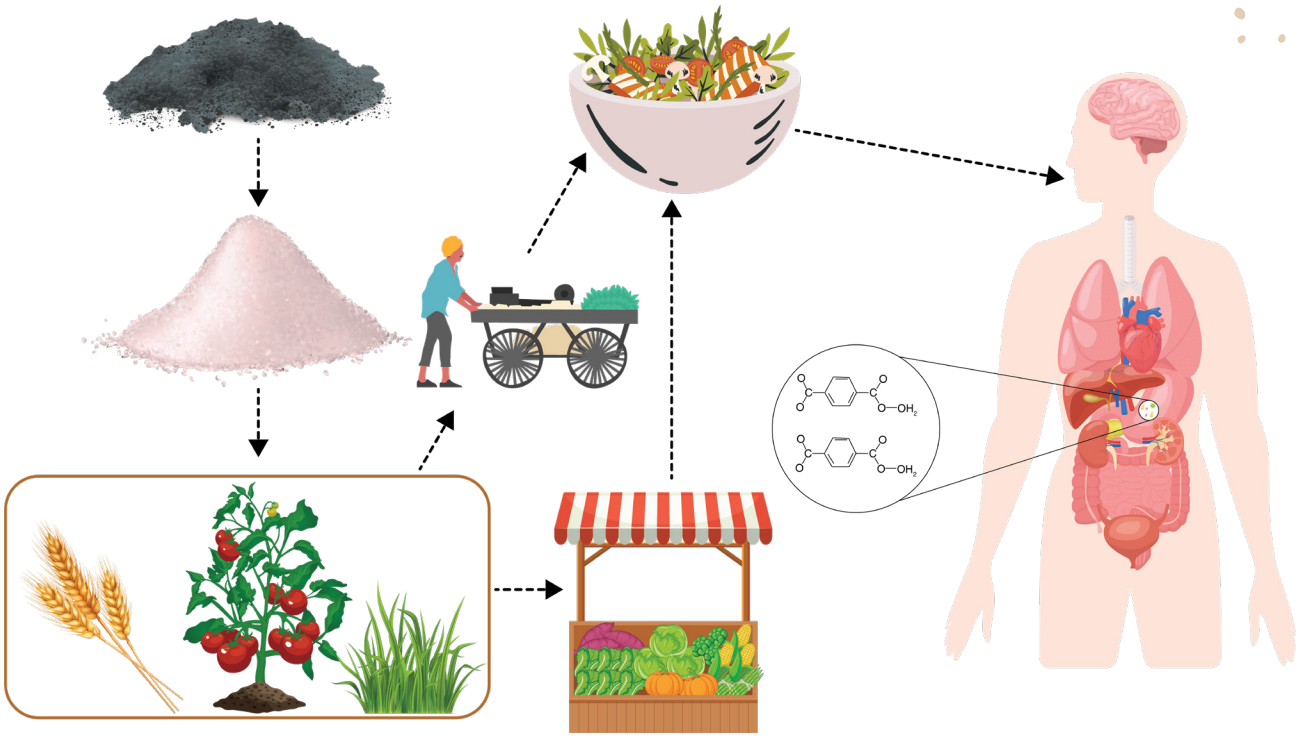


Figure 1.9. Transmission and accumulation of microplastics

has been contaminated by polluted effluent run the risk of developing life-threatening illnesses (WHO 2001). Polluted wastewater discharges commonly contaminated sea life, especially fish, cockles, and prawns. According to Santhiya et al. (2011), *Vibrio* spp., *Pseudomonas* spp., *Salmonella* spp., *Shigella* spp., and the coliforms group were substantially present in the seas and sediments polluted with discharged treated sewage in Morocco. According to Al-Sabahi et al. (2009), an average of 2200 CFU/100 mL of E. coli was found in three surface water bodies that were downstream of the STP in Ibb, Yemen, which processed sewage. After the plant, *E. coli* levels rose from 0 CFU/100 mL in boreholes before it to 1100 CFU/100 mL in those same boreholes. Sand, water, organic materials, bacteria, trace metals, and other substances are all present in biosolids. Biosolids are advantageous and secure to utilize as soil conditioners and fertilizers for agricultural purposes due to their moisture content, humus like qualities, and important nutrients for plants (County 2005). However, the transfer of pathogenic microorganisms to humans directly or indirectly, with the direct transmission of microbial pathogens taking place via the consumption of effluent-irrigated vegetables, is what raises concerns about the reuse of treated sewage and biosolids in agriculture (Heyman 2004). The main source of harmful bacteria is when sewage effluents are used to irrigate fresh vegetables. Even with cleansed veggies, some of those pathogens can persist (Ronner and Wong 1993). When sewage effluents are dumped into the rivers, lakes, and canals that provide irrigation water to farmlands, illness might spread indirectly (Cotruvo et al. 2004). Biosolids applied to agricultural fields

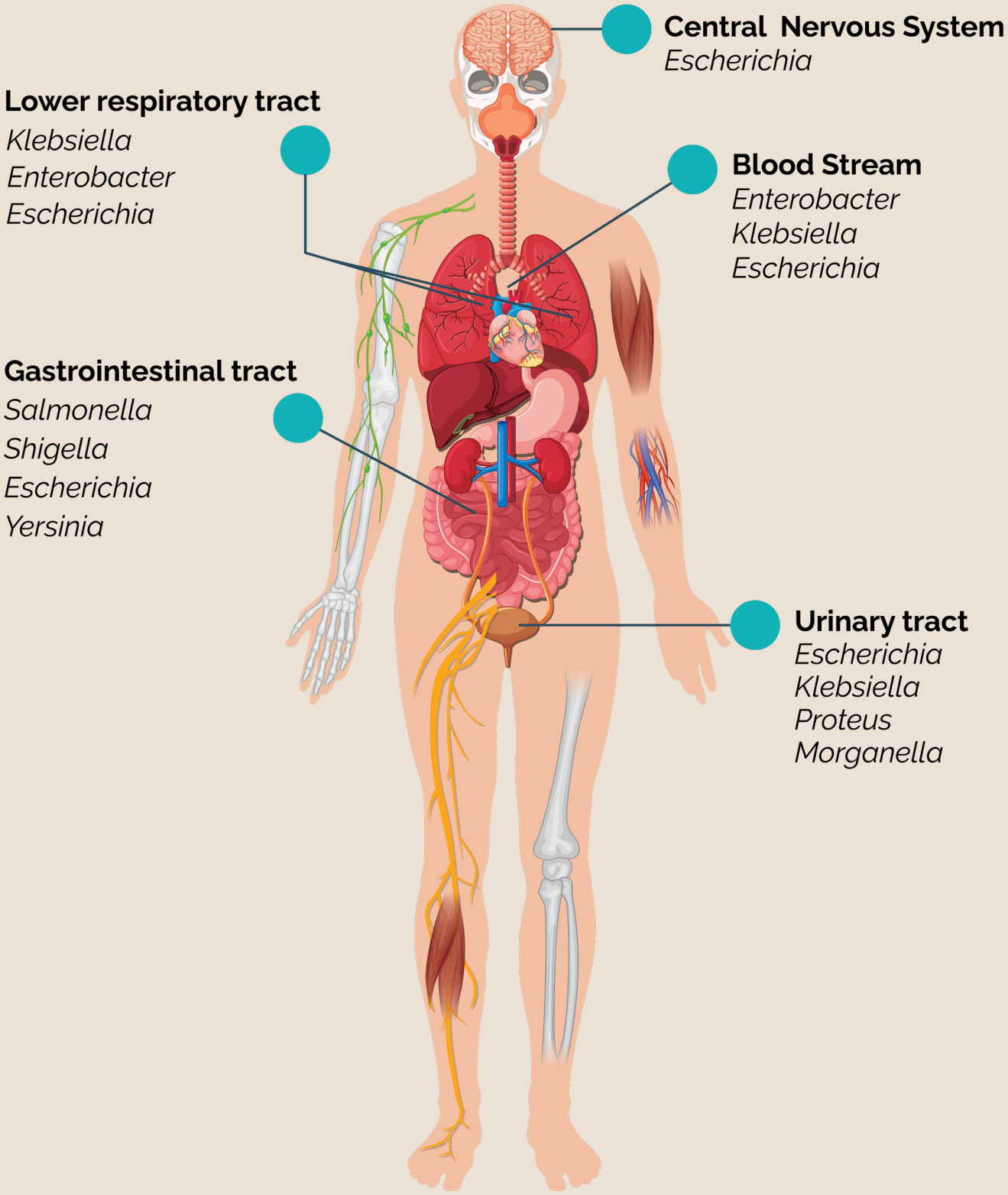


Figure 1.10. Coliforms and their infection site

may include pathogens that contaminate food, water, and feed (Carlander 2006). The indirect infection pathway affects more individuals and animals than the direct infection channel. Plants might acquire dangerous germs, enabling them to ascend the food chain. There have been reports of pathogens migrating through the soil, tainting groundwater that might taint drinking water, and tainting surface water because of runoff and erosion (Sahlstrom et al. 2006). The overall causative agents along with their site of infection have been depicted in figure 1.10.

1.3.5.1. Pathogenic bacteria in treated sludge and biosolids.

Treated sludge and biosolids often contain a range of pathogenic microorganisms, primarily those transmitted via the fecal-oral route, including bacteria, viruses, and parasites (US EPA, 2003; Wen et al., 2009). Bacteria pose a particular risk as they can survive and multiply in the environment without a host (Ceustermans et al., 2007). The type and density of pathogens in sluge depend on local public health, population density, presence of hospitals and industries, and treatment processes (Harrison et al., 1999). Environmental factors such as temperature, sunlight, moisture, pH, and organic content influence their survival (Ibenyassine et al., 2007). Among enteric bacteria, *Salmonella* spp. are the most commonly detected and environmentally resilient, surviving a wide temperature range and harsh conditions (Espigares et al., 2006; Alvarez-Ordonez et al., 2011). They are reliable indicators for pathogen reduction in biosolids (US EPA, 1995; 2003), and have been isolated from various treatment stages (Burtscher & Wuertz, 2003; Sahlstrom et al., 2004). In India, *Salmonella* newport has been identified in clinical and food samples, with poultry and milk as major sources (Pavan et al., 2016). *Shigella* spp., another critical pathogen, has a very low infectious dose (10–100 organisms) and causes dysentery and diarrhea (Niyogi, 2005). It is often found in untreated sewage, biosolids, and water, with major outbreaks reported across India (Taneja & Mewara, 2016). *Shigella dysenteriae* type 1 was responsible for major epidemics in West Bengal and Tripura, while *S. flexneri* and *S. sonnei* have caused recent water- and food-borne outbreaks. *Escherichia coli* O157:H7, a dangerous enterohemorrhagic strain, causes severe gastrointestinal illness and hemolytic uremic syndrome (Kaper et al., 2004; Fijalkowski et al., 2014). It can persist in the environment without a host (Qing et al., 2010), and has been isolated from sewage, surface waters, and food across India, especially seafood (8.4%), milk (1.81%), and water samples (1.6%), showing widespread distribution (Riley et al., 1983). The presence of such pathogens in treated waste underscores the critical need for effective sewage treatment and biosolid management to protect public health.

Clostridium perfringens, a Gram-positive, spore-forming anaerobe commonly found in sludge, is highly resistant to heat, UV, and disinfectants, making it a conservative marker for contamination (Lepeuple et al., 2004; Alonso et al., 2004). Though its utility as a fecal indicator is debated, it can trace historical human waste contamination. Fecal indicator bacteria (FIB) such as *E. coli*, total coliforms, fecal coliforms, and enterococci are widely used to estimate pathogen risk in sewage and biosolids due to their ease of detection and correlation with pathogens (US EPA, 2003). Studies report strong associations between *E. coli* and other pathogens, with enterococci

offering added resilience in environmental samples (Bitton, 2005b; APHA, 2008). Additionally, sewage effluents are reservoirs of antibiotic-resistant bacteria; high levels of multi-drug resistance in *E. coli*, *E. faecalis*, and *Salmonella* spp. have been observed in Malaysia and India (Al-Gheethi et al., 2013c; Yadav et al., 2022). In India, major rivers like the Ganga and Yamuna show high coliform contamination, prompting the Ministry of Environment and Forests (2008) to highlight coliforms as critical indicators of water pollution, necessitating stricter monitoring and management. Coliform prevalence in different cities of India can be depicted in figure 1.11.

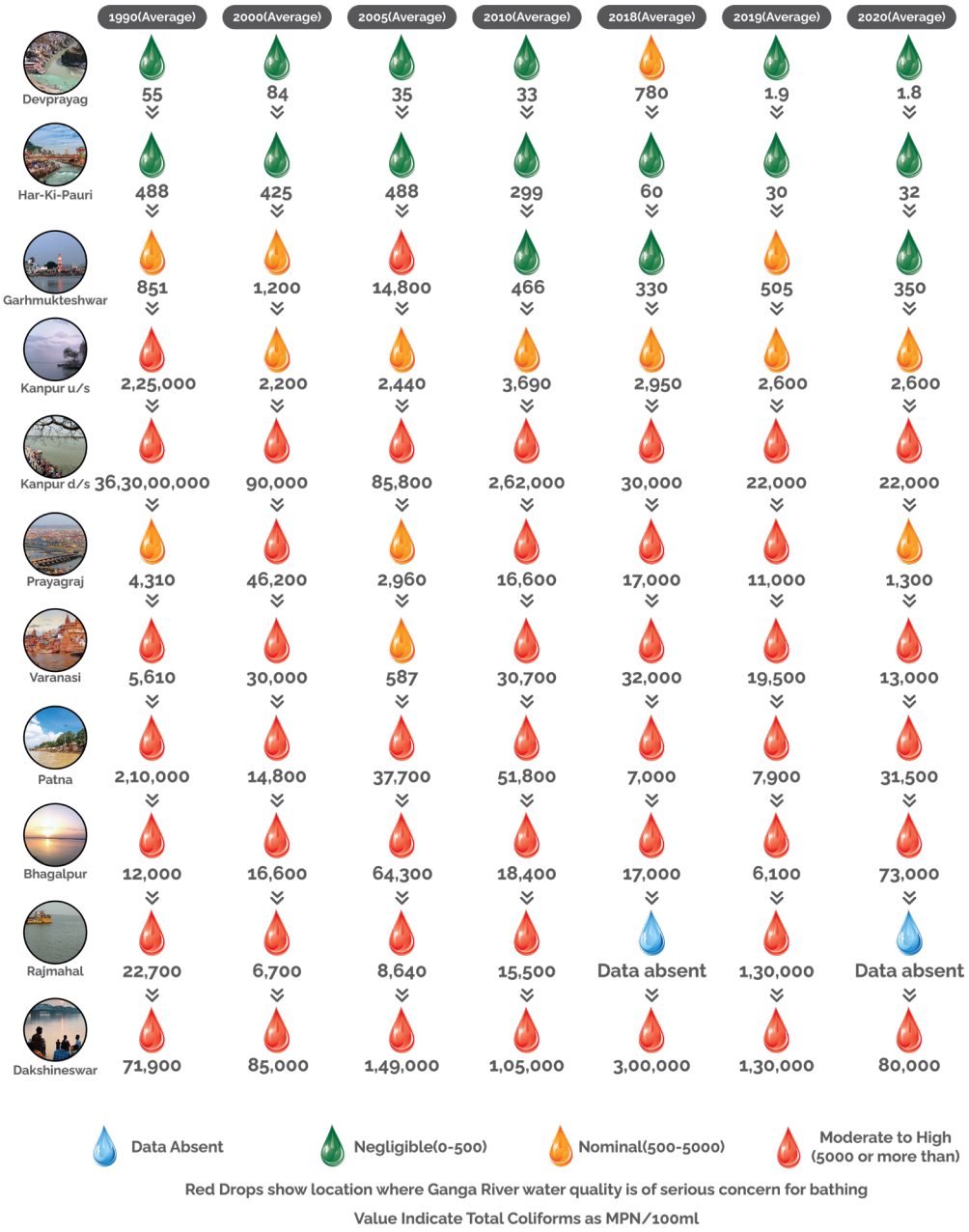
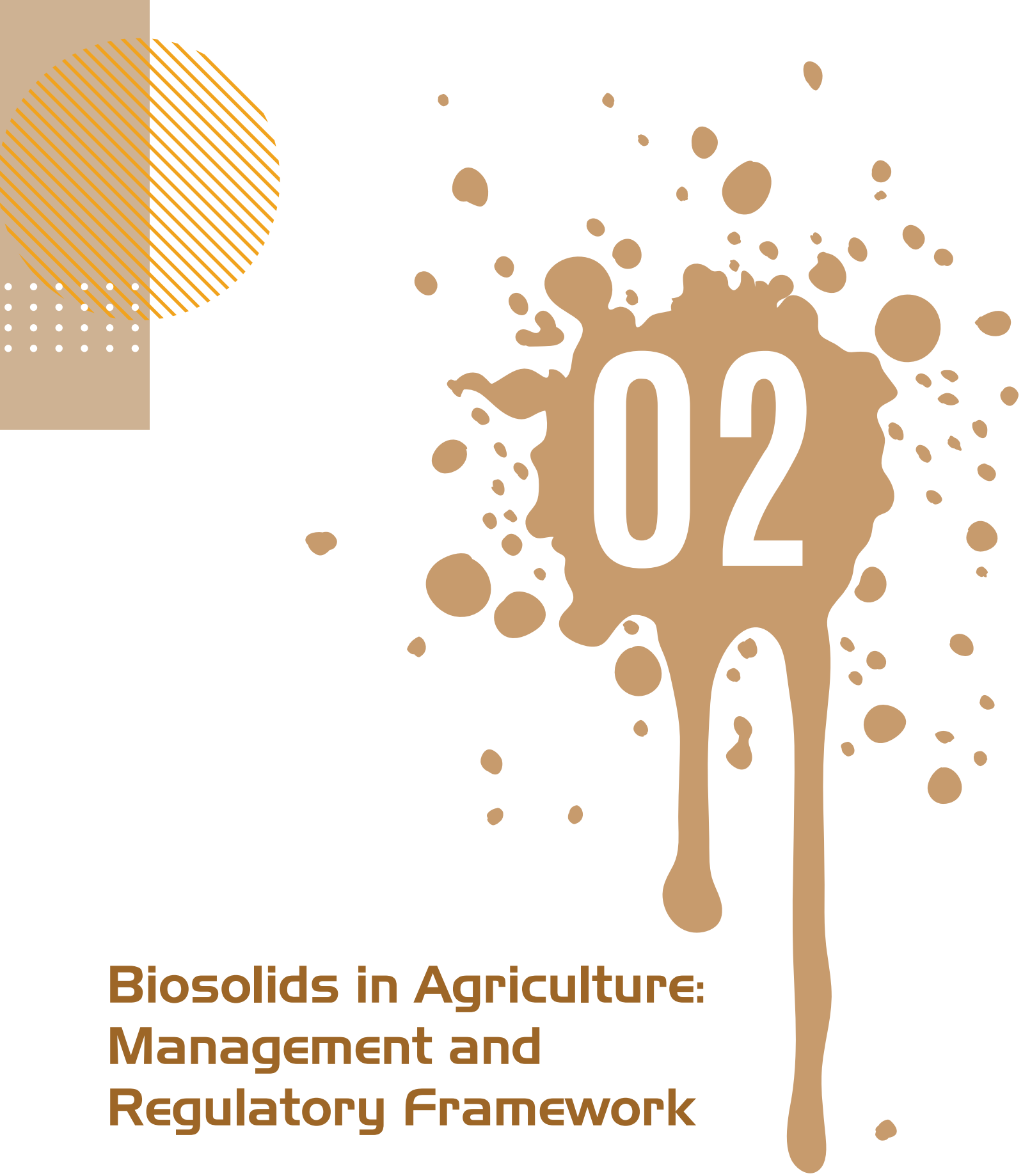


Figure 1.11. Coliform prevalence in different cities of India along the Ganga River Basin (Source: CPCB, 2013).

1.3.5.2. Viruses, pathogenic protozoa, and worms

Sludge is expected to contain a broader diversity of human viruses than other environmental samples, but current detection methods remain limited. Traditional techniques like cell culture and immunological assays are constrained by time, sensitivity, and inability to detect certain viruses such as noroviruses and astroviruses (Monpoeho et al., 2004). Molecular methods like qPCR, gene chips, and metagenomic sequencing offer more promise, though metagenomics is underutilized in sludge due to limited virus-specific databases and less historical focus (Guajardo-Leiva et al., 2020). Despite this, over 40 human viruses, including emerging ones like coronavirus HKU1 and klassevirus, have been identified in sludge, with some, like SARS-CoV-2, raising new concerns due to uncertain fate during sludge treatment (Bardi & Oliaee, 2021). Most studies have focused on nonenveloped viruses such as enteroviruses, which are more resistant to treatment and used as standard indicators (Jebri et al., 2014). However, these may underestimate the overall viral risk, highlighting the need for further research on enveloped viruses and better enrichment techniques (Yang et al., 2020). Sludge also harbors protozoan pathogens like *Giardia*, *Cryptosporidium*, and *Entamoeba*, which cause gastrointestinal illnesses and are used as protozoan indicators (Benito et al., 2020). Worm eggs, used to assess the biosafety of sludge applied to agricultural land, are another concern, with their inactivation rate serving as a key marker for effective parasitic treatment (Amoah et al., 2018). In a study focusing on wastewater treatment plants in India, the prevalence of helminth eggs was found to be 83.3% in raw wastewater, 68.2% in treated wastewater, 68.6% in soil, and 44.2% in vegetables. This indicates a significant presence of helminth eggs in various environmental matrices associated with wastewater (Gupta et al., 2009). Another study conducted in Coimbatore, India, found that the concentration of helminth eggs in wastewater samples ranged from 0 to 44 eggs per liter, with an average of approximately 10 eggs per liter. The study identified nine different species of helminths, including *Ascaris lumbricoides, Trichuris trichiura*, and hookworm species. The highest concentration recorded was 44 eggs per liter in a sample from a single-family house (Grego et al., 2018).



Biosolids in Agriculture: Management and Regulatory Framework

Given the immediate hazards to the environment and public health, sludge management is crucial. However, sludge management is a capital-intensive component, accounting for nearly 50% of the total cost of wastewater treatment and contributing up to 40% of the greenhouse gas emissions associated with the process (Leu et al., 2013). For many communities, the financial burden of sludge management is a major worry. Transportation, treatment, and disposal are just a few of the cost categories that can be used to categorize sludge management expenses. Depending on the scale of the plant and the characteristics of the initial wastewater, these expenditures can make up between 40 and 60 percent of the total plant costs. The handling of sludge has a considerable economic impact. A study of India's fecal sludge treatment costs found that a total of 908.1 lakh will be required for the operation of 7 STPs spread around the country. Operational costs, capacity building costs, and replacement costs make up the total cost (SCPB, 2018). A summary has been presented in figure 2.1

By producing bioenergy and fertilizer, proper sludge management can lower the costs of waste disposal and open prospects for income generation. The cost of soil amender or biofertilizer production is much less than chemical fertilizer production. The demand for biofertilizers has increased in recent years due to their benefits. They are affordable and inexpensive; it costs only 2.60 Indian Rupees per kg to supply the equivalent nutrient of chemical fertilizer worth 11.65 Indian Rupees per kg (Nurhafizhoh Zainuddin et al., 2021). However, the technique also has a number of disadvantages, including the presence of heavy metals in sludge may be harmful to both plant and human system. The existence of harmful bacteria poses a serious concern for consumers. Further, poor management can create environmental and health risks, increasing the expense of restoration and raising the possibility of legal liabilities. Therefore, to understand the noble process of generation and utilize the sludge as soil amender sustainably and safely, an understanding of rules and regulations is of utmost importance.

2.1. Regulations and Standards Across Countries for Sludge Application

The management and application of sludge in agriculture are subject to specific regulations and standards designed to protect environmental and public health. In the United States, the Environmental Protection Agency (EPA) regulates sludge through the 40 CFR Part 503 rule, which classifies biosolids into Class A and Class B, each with distinct treatment and safety requirements for land application (EPA, 2021). The European Union's Sludge Directive (86/278/EEC) imposes stringent limits on contaminants and mandates comprehensive treatment and monitoring to

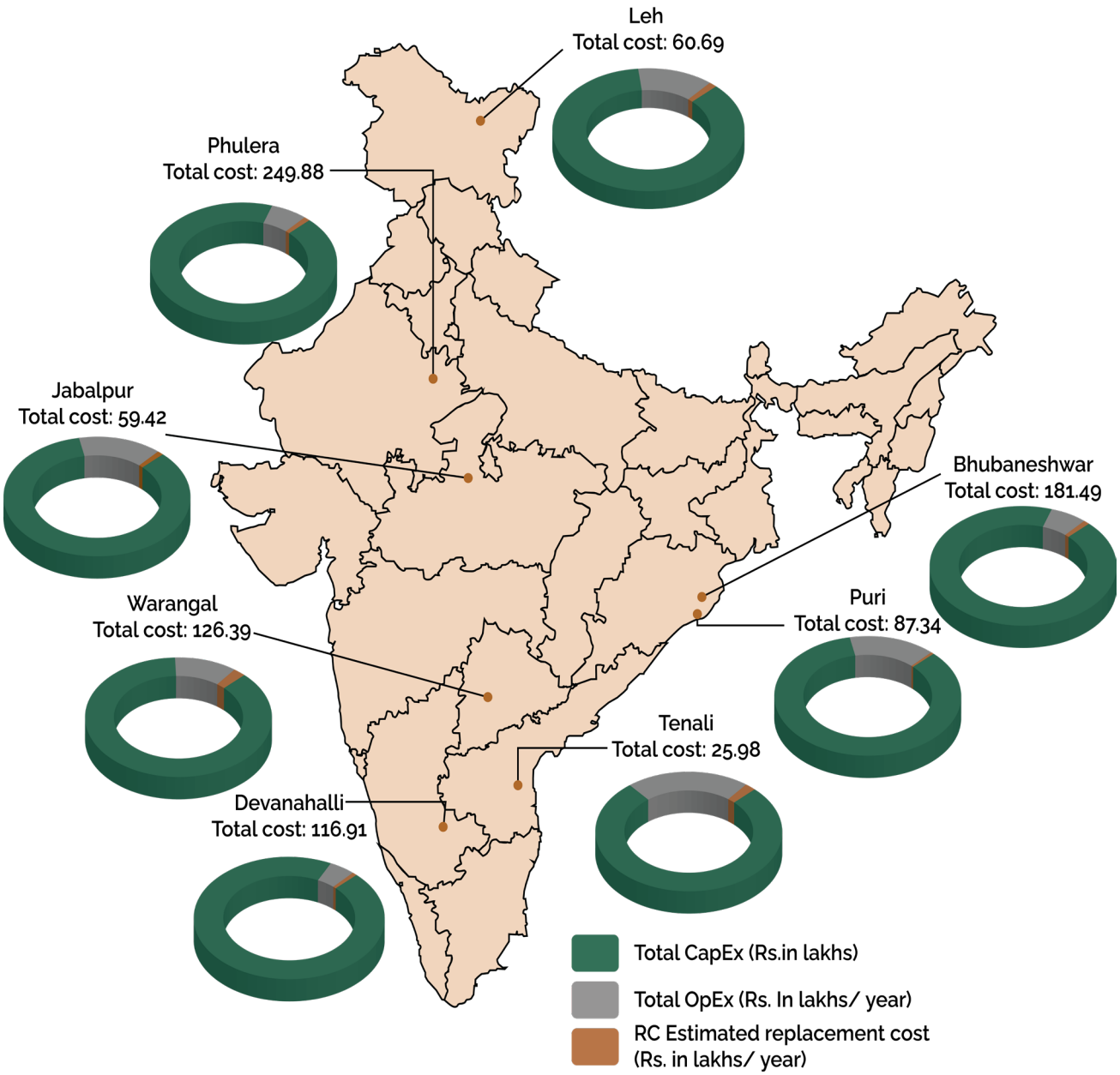


Figure 2.1. STPs around India and their total cost (Source: SCPB, 2018).

safeguard soil, water, and plant health (European Commission, 2022). Japan's Waste Management and Public Cleansing Law prioritizes advanced treatment technologies and resource recovery, ensuring that treated sludge meets high safety standards for various uses, including agriculture (Ministry of the Environment, Japan, 2020). In China, the national standard GB 4284 outlines quality criteria and treatment processes for sludge, aiming to improve treatment practices and address contamination challenges amid rapid industrialization (China National Environmental Monitoring Center, 2021). These regulations reflect regional priorities and technological capabilities, establishing a framework to ensure the safe and effective use of sludge in agriculture.

Table 2.1. Regulatory Frameworks for Sludge Use in Different Countries

Country	Regulation/ Guideline	Sludge Utilization in Agriculture	Treatment Methods	Key Statistics	References
USA	40 CFR Part 503 (EPA)	60% of biosolids are used in land application	Class A & B treatment standards, composting	Approximately 60% of biosolids are used in agriculture	EPA, 2021
European Union	EU Sludge Directive (86/278/EEC)	50% of sewage sludge is used in agriculture	Advanced treatment technologies, stringent monitoring	Around 50% of sewage sludge is utilized in agriculture	European Commission, 2022
Japan	Ministry of the Environment regulations	70% of treated sludge is used in agriculture, construction, and as fuel	Incineration, advanced treatment, resource recovery	About 70% of treated sludge is utilized across sectors	Ministry of the Environment, Japan, 2020
China	National standards and regulations (e.g., GB 4284)	30% of sludge is used in agriculture	Various treatment methods, ongoing improvements	Approximately 30% of treated sludge is applied to agricultural land	China National Environmental Monitoring Center, 2021

2.1.1 Regulations for Sludge Management in the European Union

Sludge management and treatment in the European Union (EU) are governed by a robust legal framework comprising both broad policy directives and specific technical regulations. These include overarching framework directives that provide general waste management principles, and more detailed laws focusing directly on sludge processing, recycling, disposal, and emissions control. The Waste Framework Directive (Directive 2008/98/EC) serves as a cornerstone of EU waste policy. It outlines a hierarchical approach to waste management: prevention, preparation for reuse, recycling, recovery (including energy recovery), and finally, disposal. Although the generation of sewage sludge is inevitable, the directive promotes reuse and recycling, including organic recycling and energy recovery, to minimize environmental impact.

The Water Framework Directive (Directive 2000/60/EC) complements this by aiming to achieve good qualitative and quantitative status for all water bodies. It indirectly addresses sludge management by controlling the application of materials to land, thus protecting water resources from contamination. This directive integrates and updates previous ones, such as Directive 2008/1/EC on integrated pollution prevention and control (IPPC) and Directive 2010/75/EU on industrial emissions, which sets emission standards and regulates waste incineration.

Further reinforcing sustainable sludge use, Directive 2009/28/EC on the promotion of energy from renewable sources encourages the energy recovery from biodegradable waste, including sludge. The "Technical Report on End-of-Waste Criteria for Biodegradable Waste"

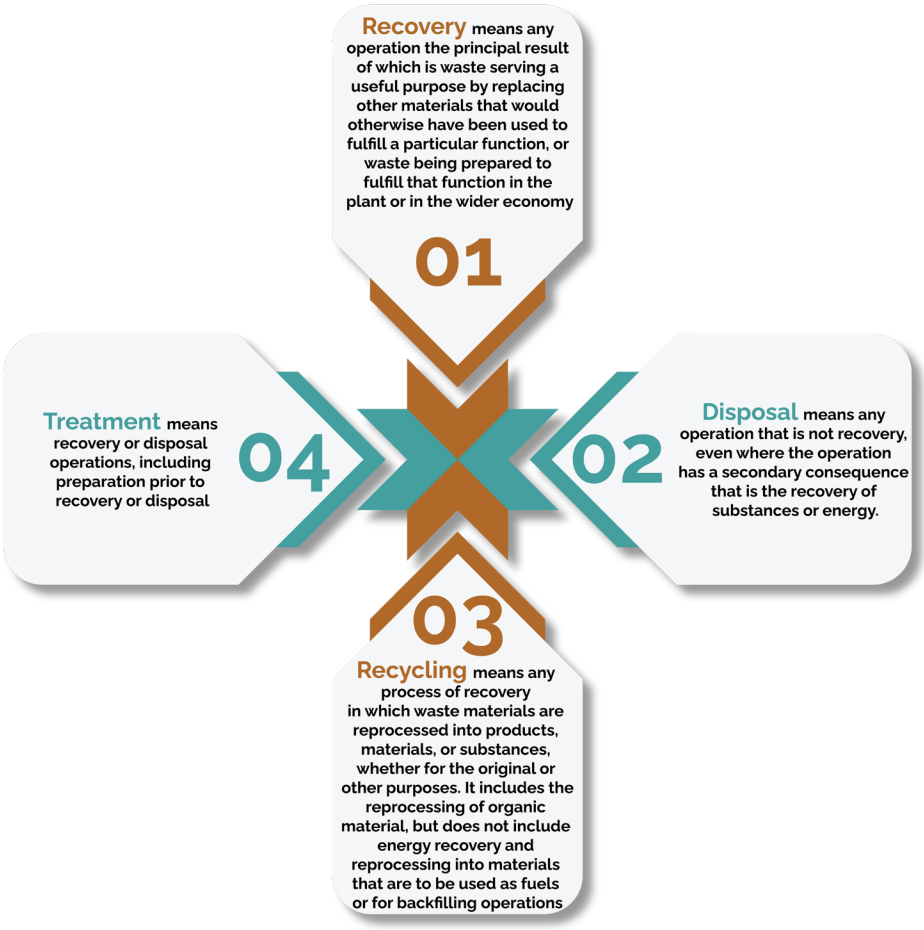


Figure 2.2. Methods for sludge management as per the European Union (Source: Wiśniowska et al., 2019)

also lists sewage sludge as an acceptable input material, acknowledging its potential reuse as fertilizer when properly treated and free from contaminants.

Perhaps the most sludge-specific regulation is the Urban Waste Water Treatment Directive (Directive 91/271/EEC). It mandates the monitoring, reporting, reuse, and safe disposal of municipal sewage sludge, especially for agglomerations. Article 14 of this directive requires that sludge be reused wherever appropriate, provided that adverse environmental effects are avoided. Supporting this, Council Directive 99/31/EC on waste landfilling imposes restrictions on the storage and landfilling of sludge to encourage better treatment practices. These methods are provided in figure 2.2.

Agricultural Application: In the European Union (EU), sludge reuse through direct agricultural application and composting remains the dominant strategy in EU-15 countries, accounting for 53% of sludge management, followed by incineration at 21%. For final sludge disposal, landfilling**,** incineration, and agricultural reuse are permitted. By 2020, about 47% of EU sludge (6 million tons/year) was expected to be used in agriculture. This is governed by Directive 86/278/EEC, which

promotes safe sludge reuse while limiting heavy metal concentrations in soil and sludge to protect health and the environment. Countries like Spain, Portugal, France, and the UK widely apply sludge in agriculture, while others like Netherlands and parts of Germany restrict or ban it. German laws, however, set strict contaminant limits for safe reuse. Overall, EU policies support sustainable sludge use with strict environmental safeguards. The permissible limits of heavy metals in sludge as per the directive and for individual countries are given in table 2.2. To mitigate the risk of harmful substances, EU and Turkish regulations stipulate that PCB levels in sludge must be below 0.8 mg/kg (dry weight) for agricultural use.

Table 2.2. Comparative account of heavy metals permissible limit as per the directive in different nations.

Country	Cd	Cr	Cu	Hg	Ni	Pb	Zn
EU Directive 86/278/EEC	20–40	Not limited	1000–1750	16–25	300–400	750–1200	2500–4000
France	20	1000	1000	10	200	800	3000
Germany	2	80	600	1,4	60	100	1500
Greece	20–40	500	1000–1750	16–25	300–400	750–1200	2500–4000
Italy	20	Not limited	1000	10	300	750	2500
Spain	20–40	1000–1750	1000–1750	16–25	300–400	750–1200	2500–4000
Sweden	2	100	600	2.5	50	100	800
Working Document on Sludge (3rd Draft)	10	1000	1000	10	300	750	2500
Proposal of directive 2010	10	1000	1000	10	300	750	2500

(Source: Wiśniowska et al., 2019)

The Fertilizer Law aligns with the requirements of the 86/278/EEC Directive, but goes a step further by imposing additional restrictions on organic micropollutants alongside heavy metals (Kelessidis & Stasinakis, 2012). In light of these regulations, Greece has taken significant steps toward reducing the volume of sludge that ends up in landfills. The 86/278/EEC Directive has been formally incorporated into Greece's national legal framework through Ministerial Decision 80568/4225/91, with the country adopting stricter limits for heavy metal concentrations, including separate thresholds for Cr(VI) and Cr(III), and setting a national target to reduce sludge disposal to landfills to 5% by 2020 (Kalavrouziotis et al., 2016; Ministry of Environment & Energy, 2020).

In the United Kingdom, the agricultural use of sludge is actively encouraged. While the UK was still a part of the European Union at the time, it established a national legislative framework for the use of sludge in agriculture that adhered to the 86/278/EEC Directive, with concentration limits for heavy metals enforced to protect environmental and public health (DEFRA, 2012). In addition, the UK introduced the Safe Sludge

Matrix, a guideline developed by Water UK and ADAS to ensure the safe and responsible application of sewage sludge on agricultural land. This matrix distinguishes between "conventionally treated" and "enhanced treated" sludge, corresponding roughly to the U.S. EPA Part 503 Class B and Class A pathogen reduction standards, respectively, thereby providing clear guidance on pathogen control (ADAS, 2018).

In Sweden, the application of sludge in agriculture is governed by the SNFS 1994:2 Act, which regulates heavy metal concentrations in both soil and sludge (Naturvårdsverket, 1994). Sweden has among the strictest maximum permissible levels for heavy metals in the EU, with cadmium inputs limited to 0.75 g/ha/year and similarly stringent limits for lead, copper, zinc, and mercury (Svensson et al., 2016). Furthermore, Sweden and several other EU countries have established upper limits for selected organic micropollutants such as nonylphenols and PAHs in sludge, reflecting an increasing trend toward controlling a broader spectrum of potentially hazardous substances to ensure safer and more sustainable land application (Gómez-Garrido et al., 2024). Upper limits of organic polluatnts are defined by some countries, given in table 2.3.

Table 2.3. Upper limits of organic pollutants in different countries

Organic Pollutant	EU draft	Denmark	Sweden	Lower and upper Austria	Austria Carinthia	France	Germany	Germany proposed limits	Slovenia	Czech Republic
AOX	500	-	-	500	500	-	500	400	140	500
DEHP	100	50	-	-	-	-	-	-	-	-
LAS	2600 - 5000	1300	-	-	-	-	-	-	-	-
NP/NPE	50 - 450	10	50	-	-	-	-	-	-	-
PAH	6	3	3	-	6	Fluoranthene 4 Benzo(b) fluoranthene 2.5 Benzo(a) pyrene 1.5	-	Benzo(a)pyrene 1.0	-	-
PCB	0.8	-	0.4	0.2	1	0.8	0.2	0.1	<0.05	0.6
PCDD/F	10^{-4}	-	-	10^{-4}	$0.5*10^{-4}$	-	10^{-4}	$0.3*10^{-4}$	-	-
Other Com-pounds	-	-	-	-	-	-	-	2-Mercapto-benzothiazole +2-hydroxyben-zothiazole 0.6 Tonalid 15 Glalaxolide 1	-	-

Source: Gómez-Garrido et al., 2024

Several European countries have also introduced pathogen standards for sludge to safeguard soil and public health (European Commission, 2024a). Since the introduction of the Sewage Sludge Directive in 1986, numerous efforts have been made to revise and update the regulatory framework to reflect current environmental and health challenges. Although many of these revisions have yet to be fully implemented, they indicate the evolving direction of EU legislation. A notable example is the *Third Working Document on Sludge* (ENV.E.3/LM 27.04.2000; Brussels), which proposed redefining sewage sludge and establishing upper limits for a range of organic micropollutants, heavy metals, and biological hazards, highlighting a shift toward more comprehensive and precautionary regulatory measures (European Commission, 2000).

More recently, the EU has adopted a recast of the *Urban Wastewater Treatment Directive*, introducing stricter requirements for sludge monitoring and treatment. These include the implementation of quaternary treatment in larger plants to remove micropollutants, the application of extended producer responsibility to pharmaceutical and cosmetic producers, and systematic monitoring for pathogens, antimicrobial resistance, microplastics, and PFAS (European Commission, 2024b, 2024c). Collectively, these measures demonstrate a regulatory evolution from heavy-metal control toward comprehensive management of emerging contaminants and public health risks. The permissible limits for pathogens in sludge in different countries are given in table 2.4.

Table 2.4. Standards for pathogens in sludge for different countries

Country	Specifications for *Salmonella*	Specifications for other pathogens
Poland	May not be used for agriculture if there is any *Salmonella*.	Fecal Streptococci:<100g
France	8 MPN/10g d.m.	Enterovirus 3MPCN/10g d.m. Helminth eggs: 3/10g d.m.
Finland	Not to be detected in 25g	*Escherichia coli* < 0 cfu
Italy	1000 MPN/g d.m.	-
Luxembourg	-	*Enterobacteria*: 100/g no eggs of worm likely to be contagious
Hungary	-	Fecal *E.coli* and fecal *Streptococci* decrease below 10% of original number
Denmark (only for advanced treated sludge)	No occurrence	Fecal *Streptococci*: <100/g

(European Commission, 2024a)

2.1.2. Regulations in Asian countries

The methods and legal frameworks used for sludge management vary considerably across Asian nations. In many middle-income Asian countries, sludge is frequently applied to

agricultural land, as this is considered one of the most cost-effective alternatives to landfilling (Yang et al., 2015). Research from China and Russia indicates that land application and agricultural reuse remain preferred options for sludge disposal due to lower costs and potential nutrient recycling benefits (Liu et al., 2022; Wei et al., 2018).

China, which produces a large annual volume of sludge, has established a comprehensive regulatory framework for its management. Sludge management is governed by the *Environmental Protection Law* (2014), the *Environmental Pollution Prevention and Control Law of Solid Wastes* (2020 revision), two administrative regulations, and more than 30 national standards that collectively provide the foundation for environmental and public health protection (Yang et al., 2015; Zhang et al., 2021).

Across Asia, limits for heavy metals in sludge differ by country, reflecting local soil conditions, agricultural practices, and policy priorities (Ravindran et al., 2023). Some countries, such as Japan and South Korea, follow strict standards aligned with or exceeding EU thresholds for cadmium, lead, and mercury, whereas others have more lenient guidelines, allowing for higher land-application rates of sludge (Singh & Agrawal, 2019). Different Asian countries have different limits for heavy metals (Table 2.5).

Table 2.5. Permissible limits of heavy metals in sludge for use in agriculture for different Asian countries

Country	Key Heavy Metals Covered	Limit or Standard (mg/kg dry weight)	References
Japan	Pb, Cd, Cu, Zn, Ni	Pb ≤ 500, Cd ≤ 5, Cu ≤ 500, Zn ≤ 2,000, Ni ≤ 300	Tanaka et al., 2023
China	Cd, Hg, As, Cr, Cu, Zn, Ni	*GB 4284-84*; Cd ≤ 5 (acid soils) / 20 (neutral soils), Pb ≤ 1,000, Cu ≤ 500, Zn ≤ 2,000, Cr ≤ 1,000	Yang et al., 2015; Zhang et al., 2023
India	Cr, Cd, Ni, Pb, Zn, Cu	No uniform national sludge-heavy-metal limit	Singh & Agrawal, 2019
South Korea	As, Cd, Cr, Cu, Ni, Pb, Zn, Mn	Municipal/compost standards exist; unified national sludge limits not publicly available	Kim et al., 2020
Malaysia	Pb, Cd, Cr, Cu, Zn, Ni	General environmental quality standards exist; centralized sludge limits not publicly documented	Lee et al., 2021
Thailand	Pb, Cd, Cr, Cu, Zn, Ni	No centralized national sludge limits; soil quality standards sometimes used	Pasda, 2006
Vietnam	As, Cd, Pb, Cu, Zn, Cr	Local regulations/soil standards applied; no clear national sludge limits	Nguyen et al., 2019
Indonesia	Pb, Cd, Cu, Zn, Ni, Cr	General wastewater/soil standards exist; national sludge limits not found	Santoso et al., 2020
Pakistan	Pb, Cd, Cr, Ni, Fe	NEQS covers effluent/water; no explicit sludge-heavy-metal limits found	Ahmed et al., 2021

2.1.3. Authoritative Bodies for Framing of Regulations in India

Proper management of sludge is crucial for a country as well as its people. Hence, the roles assigned to different people should be clear and well-defined as to which governing body holds responsibility for which type of work. In India, for instance, various ministries work in close cooperation with state boards to achieve different standards (Jayathilake et al., 2019). The Ministry of Urban Development plays a lead role in technical and planning support, training and capacity building, funding of schemes, building awareness, and research support for the management of sludge. In turn, it works with the support of state and city-level authoritative bodies. The Ministry of Environment, Forest and Climate Change makes sure that all states comply with environmental laws during the entire process while working closely with state pollution control authorities. The responsibility of the Ministry of Social Justice and Empowerment is to eliminate incorrect practices for sludge management as well as monitor the progress achieved at various levels. In addition to this, all state governments and authoritative bodies within the states ensure all the programs are running as per the directions of the Government to achieve the best possible outcome. Like this, various ministries and authorities are responsible for the framing of laws related to the management of sludge to protect the environment. The pictorial depiction of the Governmental authorities for the development of rules and regulations is given in Figure 2.3.

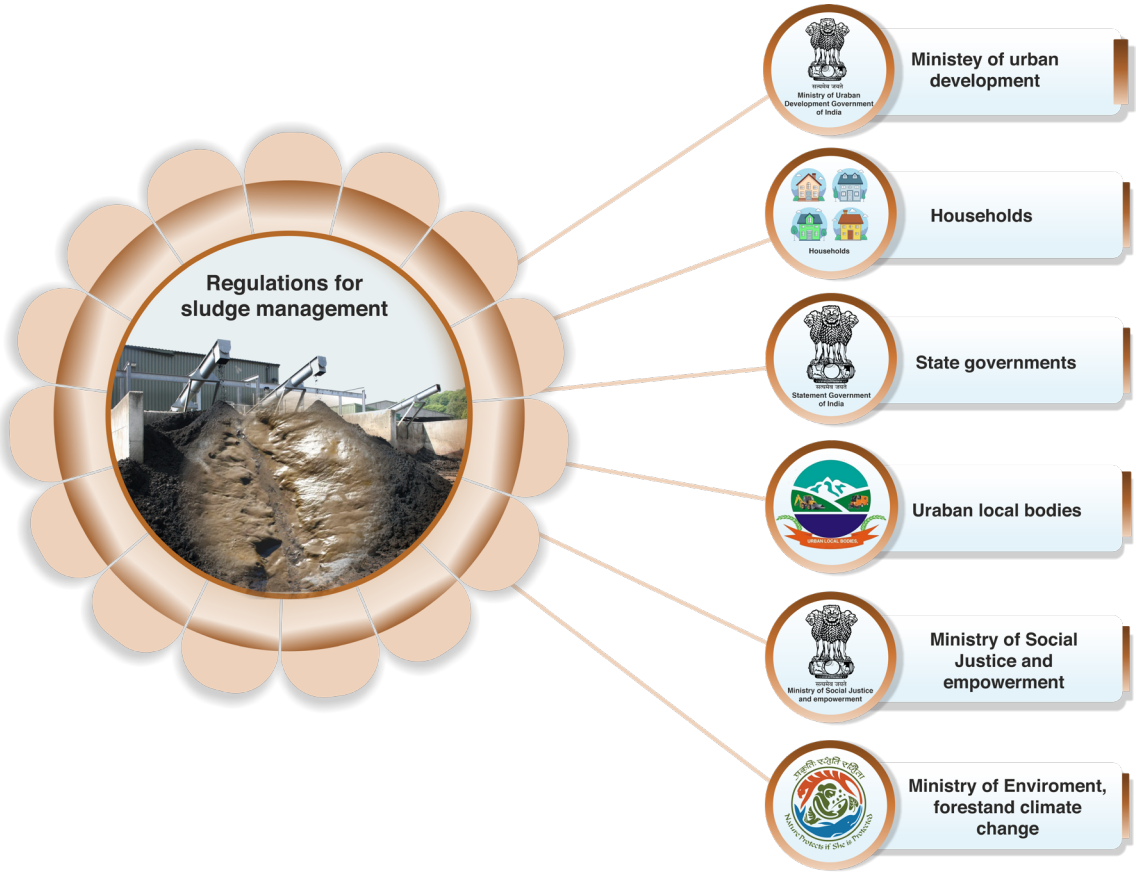


Figure 2.3. Authoritative bodies for framing regulations on sludge management in India

After 16 years, the Municipal Solid Wastes (Management and Handling) Rules 2000 were replaced by the updated Solid Waste (Management and Handling) Rules 2016 by the Union Ministry of Environment, Forest, and Climate Change (MoEF&CC). The word "municipal has been removed" because the rules' jurisdiction has been expanded beyond Municipal areas to include outgrowths in urban agglomerations, census towns, notified industrial townships, areas under the control of Indian Railways, airports, airbases, ports, and harbors, defense establishments, special economic zones, State and Central government organizations, places of pilgrimage, religious significance, and historical sites (Ray and Rahaman, 2016).

The SWM regulations from 2016 place a strong emphasis on source segregation of waste, which is essential for turning waste into wealth through recovery, reuse, and recycling. Before giving their waste to authorized rag pickers, waste collectors, or local bodies, waste generators (individuals, event or gathering organizers, hotels and restaurants, all resident welfare and market associations, gated communities, and institutions with an area greater than 5000 sq.m., and SEZ) are required to separate their waste into three streams: biodegradable, dry (plastic, paper, metal, wood, etc.), and domestic hazardous waste (diapers, napkins, mosquito repellents, etc. The concept of partnership in Swachh Bharat has been introduced. Bulk and institutional generators, market associations, event organizers, and hotels and restaurants have been made directly responsible for segregation and sorting the waste and managing in partnership with local bodies (Ray and Rahaman, 2016).

Regulations and Guidelines for Sludge Capture and Containment

It is extremely difficult to handle and dispose of the biosolids produced by India's current and planned sewage treatment plants (STPs). Due to the absence of dedicated sludge management legislation in India, sludge treatment has largely been ignored, and as a result, 80–90% of existing STPs merely thicken and/or dewater sludge to reduce the volume for transportation. As India moves toward developing proper sludge management protocols, at a minimum, it must adopt dewatering and anaerobic digestion processes that meet at least Class B standards (Cambi, 2023). Globally, the production of Class A biosolids is gaining momentum, with over 130 facilities now using thermal hydrolysis processes (THP) for advanced anaerobic digestion. These systems offer multiple benefits, including lower lifecycle costs than other advanced treatment technologies, reduced spatial footprint, up to four times higher biogas production per reactor volume, 20–50% more volatile solids destruction, significant reductions in biosolid transport volume (sometimes by half), improved biosolid quality through reduced pathogens and odour, reduced carbon footprint, and the possibility of using the biosolids as marketable biofertilizers. India is witnessing a major shift in its wastewater and sludge management strategies, as cities like Mumbai, Delhi, and Chandigarh have initiated tenders mandating Class A sludge treatment, while the National Mission for Clean Ganga (NMCG) has directed all STPs under its jurisdiction to explore Class A-level treatment options. This forward-

looking approach is further supported by the development of new STPs, increasing public-private partnerships (PPPs), and the enforcement of stringent discharge regulations. Municipalities are now increasingly aligning circular economy principles, particularly in the reuse of treated wastewater and sludge. However, despite these advancements, India's waste management sector continues to grapple with the challenges posed by rapid urbanization and rising per capita waste generation.

Rules and Regulations for Treatment Plants

Treatment plants must be regulated in accordance with CPCB legislative standards. The guideline regulations address issues including the STP technology to adopt, STP site, STP operation, and STP maintenance to ensure the safe and efficient operation of the machinery (Netsol Water, 2022). These regulations have been made by the Central Pollution Control Board (CPCB) in order to achieve proper and appropriate waste treatment. This also helps in maintaining the desirable standards before the waste is dumped away somewhere or is reused for a purpose. The factors or points that have been covered by CPCB in the formation of the guidelines is provided in figure 2.4.

Prescribed Standards for treatment

When the sludge is completely treated, the waste generated should meet certain criteria as highlighted in table 2.6.

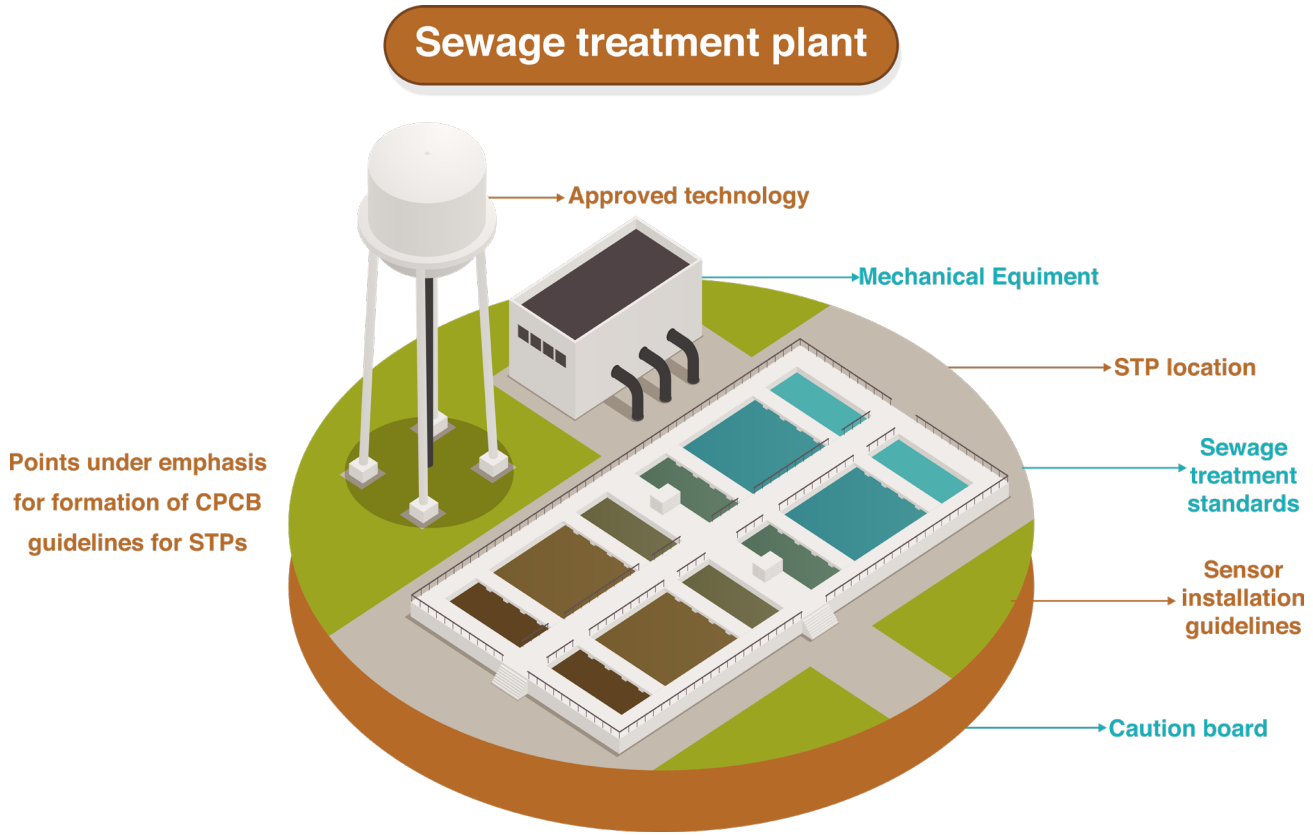


Figure 2.4. Key CPCB Parameters for STP Guideline Standardization

Table 2.6. CPCB prescribed standards for sewage treatment

S. No.	Parameter	Prescribed Standard
1.	pH	6.5-8.5
2.	BOD	<10 mg/L
3.	COD	<50 mg/L
4.	Suspended Solids	<10 mg/L
5.	Ammoniacal Nitrogen	<5 mg/L
6.	Total Nitrogen	<5 mg/L
7.	Fecal Coliform	<100 MPN/ml

Agricultural Application: In India, the *Solid Waste Management Rules, 2016* established guidelines restricting the final disposal and post-processing of fecal sludge, including applications in composting and landfilling, and standards were also introduced for the use of sludge in agriculture (Ministry of Environment, Forest and Climate Change, 2016). However, regulations currently in place are fragmented: the *Fertiliser (Control) Order, 1985* (amended 2009) governs organic fertilizers and compost but not treated sewage or fecal sludge (Department of Agriculture and Farmers Welfare, 1985). As a result, compost products are subject to quality standards such as C/N ratio and heavy metal limits, whereas sludge is not (Centre for Policy Research, 2021). There is no IS code specifically for sludge, but the Bureau of Indian Standards (BIS) has broad guidelines for soil amendments, covering heavy metals and pathogens, that also indirectly apply to biosolids (National Institute of Urban Affairs, SCBP, 2020). The US EPA Class A/B criteria are often referred to as interim guidelines by certain practitioners (United States Environmental Protection Agency, 1994). According to CPR research, Indian authorities are in the process of creating rules for the reuse of biosolids in recognition of this need, and currently India frequently uses analogy to apply FCO or EPA rules (Centre for Policy Research, 2021).



Treatment Technologies: Strength and Gap Identification

Various treatment technologies, such as physical, chemical, and biological, are used worldwide to stabilize sludge, making it safer for disposal or reuse. Common stabilization techniques include alkaline treatment, anaerobic and aerobic digestion, and composting (Suh & Rousseaux, 2002). Sludge disposal options such as landfilling, incineration, and land application in agriculture are widely practiced, though each has inherent limitations related to environmental safety, cost, or regulatory constraints.

As traditional disposal methods decline in feasibility, there is an increasing demand for more sustainable and cost-effective alternatives. Emerging solutions focus on recovering energy and valuable resources from sludge, such as producing biogas through anaerobic digestion (Appeles et al., 2008), extracting nutrients (Daneshgar et al., 2019), or converting sludge into value-added products like biodiesel and biochar (Callegari et al., 2018). This section aims to explore various sludge management strategies, emphasizing their environmental and economic benefits, potential value-added products, and a comparative SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis of each approach.

3.1 Mechanisms for sludge treatment and their end use

This section is divided into three sections, presenting the physical, biological, and chemical mechanisms used for the treatment of sludge and the generation of value-added end products. Physical mechanisms include dewatering, gravity separation, filtration, centrifugation, screening, incineration, and pyrolysis. These are the most widely employed mechanisms in current sludge treatment methodologies, and are generally considered to be robust. Biological mechanisms allow the removal and transformation of organic constituents, nutrients, and pathogens via the activity of microorganisms. Chemical mechanisms involve employing additives to optimise and control desired reactions, and are mainly used for disinfection and enhanced dewatering. Along with these mechanisms, their end products, such as biogas, syngas, vermicomposting, and biochar, are also very well explained with their impact in the environment. The overview mechanism for sludge and their end use is presented in figure 3.1.

3.1.1. Physical mechanisms for sludge treatment

1. **Gravity Separation:** Gravity separation relies on the sedimentation of suspended or flocculated particles in sludge, driven by the earth's gravitational pull (Jobin et al., 2015). It is the most widely used method for separating solids from liquids. Under still conditions, heavier particles settle based on factors such as particle size, concentration of suspended solids, and the degree of flocculation. Settling can occur through four distinct mechanisms: discrete particle settling, flocculent settling, hindered settling, and compression settling.

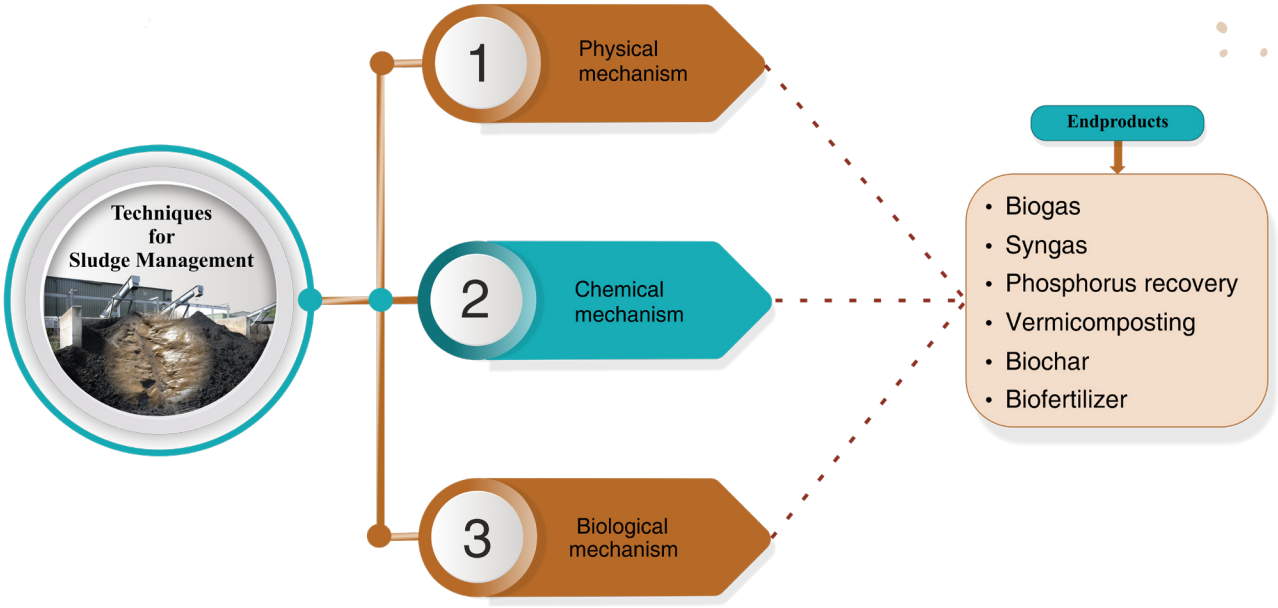


Figure 3.1. Mechanism for sludge treatment and their value added Products.

In sludge, solids are typically well-distributed and present in high enough concentrations that inter-particle forces become significant, preventing individual particles from settling freely. Instead, they settle collectively as a mass or "blanket," maintaining their relative positions. This is known as *hindered settling*, where the liquid rises through narrow spaces between adjacent particles. As the process continues, the accumulated sludge at the bottom of the tank becomes compressed under the weight of the solids, squeezing out more liquid. This stage is referred to as *compression settling*, which plays a key role in sludge thickening by gravity. Gravity separation is thus a fundamental physical method for sludge treatment.

2. **Filtration:** Filtration is another common technology for the separation of liquid – solid. Several filtration processes and their types are applied to water, wastewater, and treated sludge processing (Filter Presses for Sludge Treatment, 2023).

3. **Centrifugation:** Centrifugation is primarily employed for liquid–solid separation in wastewater sludge treatment. In this process, sludge is placed in a centrifuge that spins at high speed, generating strong centrifugal forces that accelerate the sedimentation of solids. These solids are driven outward and accumulate along the centrifuge walls, where they are compacted and concentrated. The separated liquid and solid fractions are then collected independently.

   Centrifugation serves both sludge thickening and dewatering purposes, utilizing nearly the same operational technique. However, dewatering requires more energy than thickening, as it involves removing a larger volume of water to achieve a higher concentration of solids. Following dewatering, the resulting product is often referred to as a "cake" having dry solids content of 50% or more. This semi-solid form does not flow freely and is typically handled using conveyor belts. In contrast,

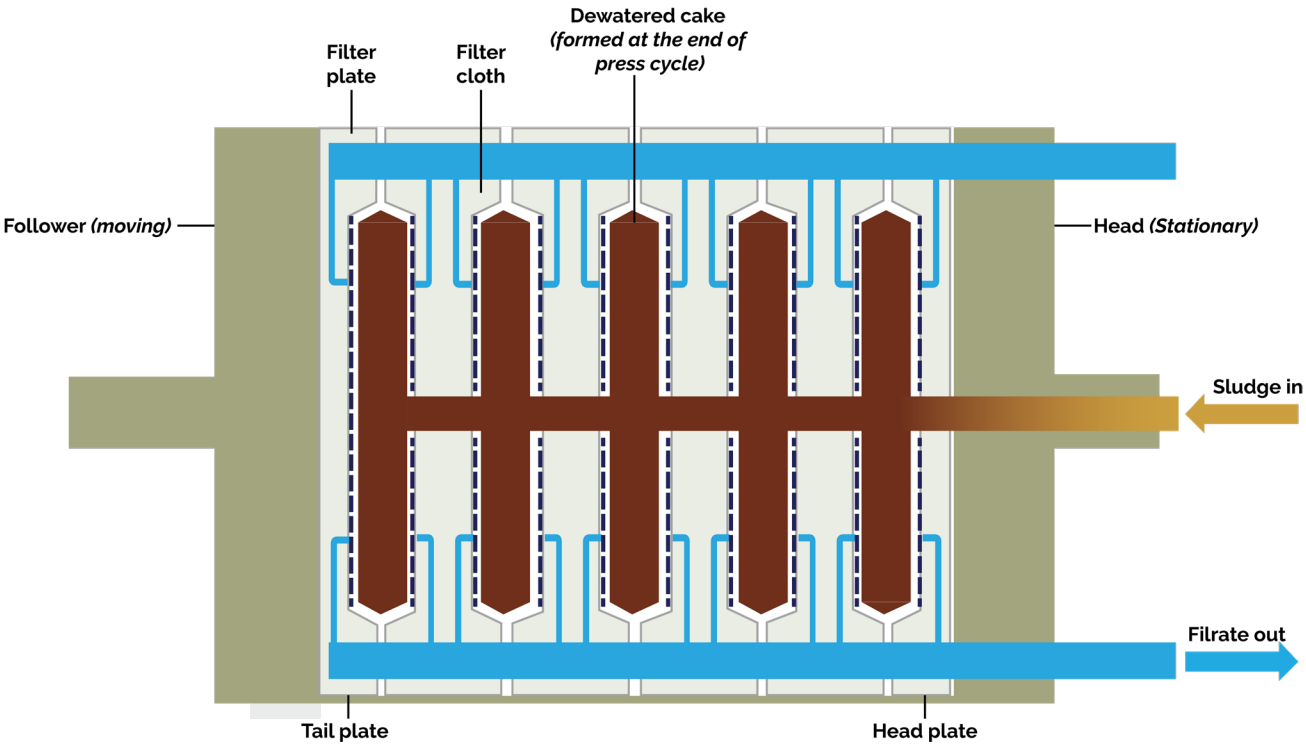


Figure 3.2. Filtration unit for the treatment of sludge (Source: ww.lenntech.com/library/sludge/presses/filterpress.htm#:~:text=Sludge%20treament,which%20require%20more%20sophisticated%20equipment.)

thickened sludge retains fluid characteristics and can be pumped.

The efficiency of centrifugation in terms of dewatering capacity and solids recovery is influenced by the quality of the feed sludge and the chemical dosing parameters. Solid bowl centrifuges are the most commonly used type for dewatering applications. These systems can be modified or optimized to enhance performance, yielding a drier solid output.

4. **Screening:** Screening is another important physical process used in sludge management. Bar screens are typically installed at the influent of a sewage treatment plant (STP) to remove municipal waste and large solid objects from the incoming sludge. This prevents clogging and damage to pumps and enhances the overall efficiency and quality of the treatment process and its end products.

Bar screens are usually placed at an inclined angle to the direction of the incoming flow, forming a physical barrier that captures larger solids, as illustrated in figure 3.3. The spacing between the bars is carefully designed to allow liquid and small particles to pass through while retaining larger debris. The effectiveness of screening is influenced by the velocity of sludge flow through the bars. For optimal performance, the flow rate should exceed the self-cleansing velocity by at least 0.3 m/s (Mara, 1976). The presence of the bars causes a head loss, which varies

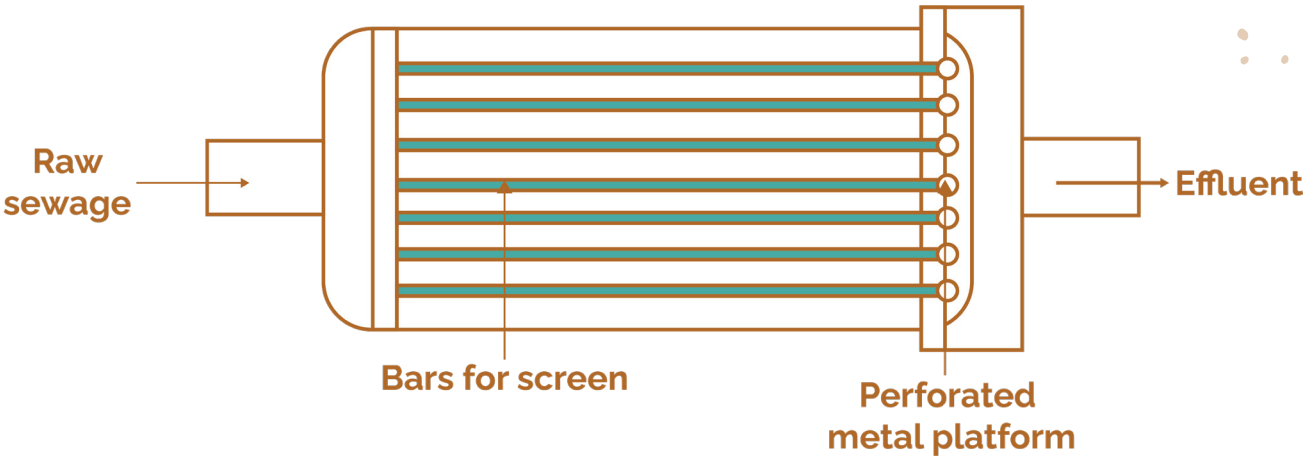


Figure 3.3. Sludge treatment through Bar Screening Process (Source: https://biologyreader.com/preliminary-treatment-of-wastewater.html)

depending on the quantity and type of solids captured. Proper design and maintenance of the bar screens are essential for ensuring uninterrupted operation and protecting downstream equipment.

5. **Incineration:** Incineration is one of the most effective methods for processing and managing sewage sludge, particularly in terms of significantly reducing its volume. This approach is especially valuable in densely populated regions like Japan, where large quantities of sludge are generated and land availability for disposal is limited. In such areas, incineration is widely adopted, with approximately 55% of sludge being incinerated (Samolada & Zabaniotou, 2014). Before undergoing conventional incineration, sewage sludge is typically pre-dried to achieve a dry solids content of 18% to 35% (Donatello & Cheeseman, 2013). Despite the energy requirements for drying, incineration is considered a cost-effective management method (Winkler et al., 2013).

   The primary byproduct of incineration is ash, which must be managed appropriately. These ashes can often be recycled or used as raw materials in the production of construction materials, contributing to resource recovery and sustainability in waste management practices. An overview of incineration utilization can be depicted in figure 3.4.

There are mainly two types of sludge incinerators that are used in the current scenario: A) Multiple Hearth Incinerators (MHI) and B) Fluidized Bed Incinerators (FBI)

A) **Multiple Hearth Incinerators (MHI):** The multiple hearth incinerator is one of the most commonly used devices for sewage sludge incineration. It typically consists of seven to nine refractory-lined hearths stacked vertically within a cylindrical steel furnace shell, which has a diameter of 6 to 8 meters. At the center of the furnace is a vertical rotating shaft equipped with horizontally framed rakes made from heat-resistant cast iron. These rakes are designed to move the sludge across each hearth and facilitate its downward movement through openings between the hearths.

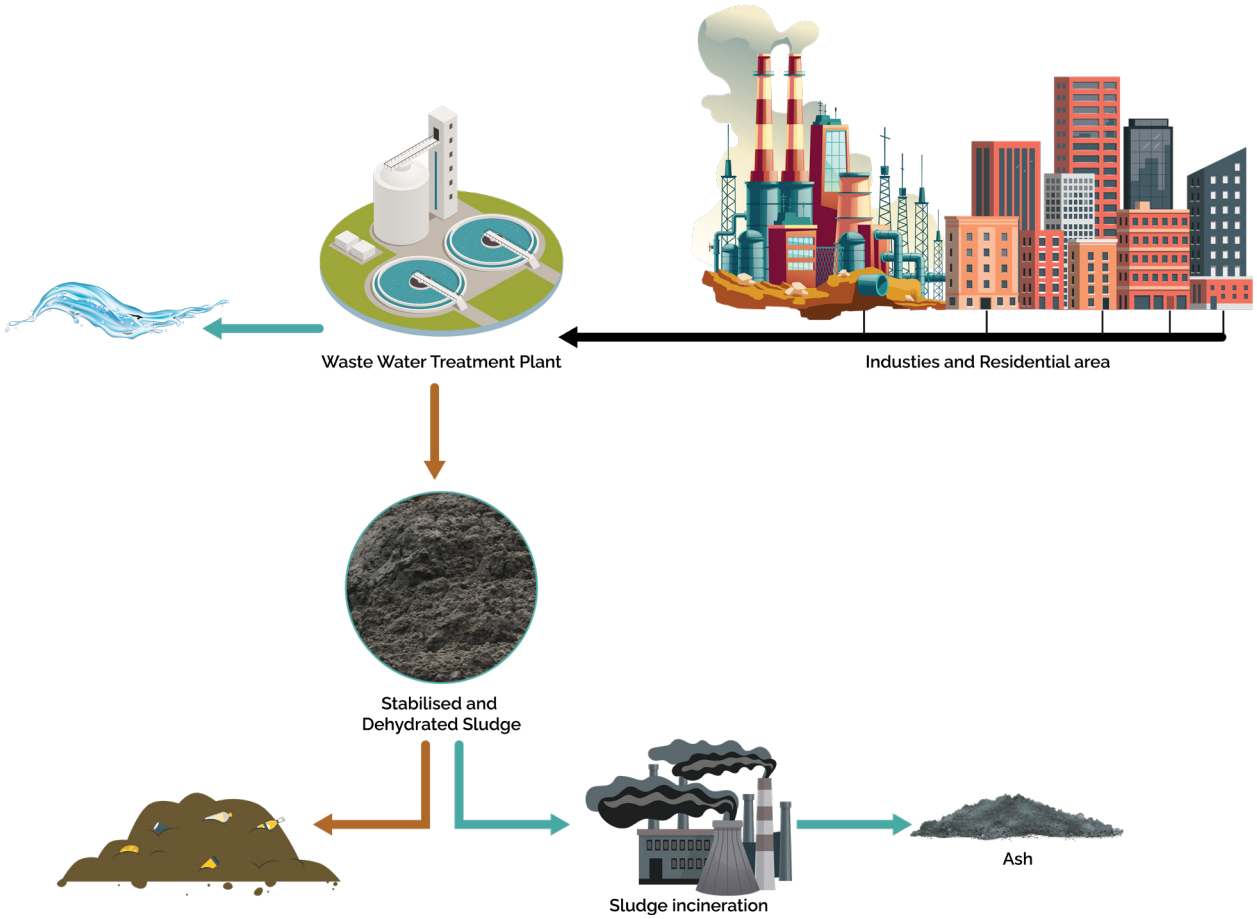


Figure 3.4. Incineration Process (Source: https://www.researchgate.net/figure/Estimated-production-of-sludge-and-ash-from-WWTPs-in-Croatia-after-2018_fig7_304890937)

Sludge is fed into the uppermost hearth using conveyor systems. From there, it gradually moves from one hearth to the next, assisted by the rotating rakes. As it travels downward, the sludge undergoes combustion, aided by diesel burners or fuel gas and approximately 50% excess air supply. The first hearth primarily functions as a drying zone, while combustion occurs in the middle hearths at temperatures ranging between 700°C and 900°C. The lower hearths serve to cool the resulting ash to around 300°C. To maintain optimal operating conditions, the vertical shaft and rakes are cooled using a blower system. The design allows for counter-current flow, where combustion gases move upward as the sludge moves downward. This reverse movement helps cool the gases and improves thermal efficiency. Combustion gases are collected through a dedicated outlet pipe and directed to air pollution control devices for further treatment (Turovskiy & Mathai, 2006).

A key advantage of the multiple hearth incinerator is its ability to utilize internal energy effectively, allowing hot flue gases to come into direct contact with the sludge, thereby enhancing thermal efficiency. However, the system also has notable drawbacks, including its large space requirements and high capital investment costs (Turovskiy & Mathai, 2006).

B) **Fluidized Bed Incinerators (FBI):** Fluidized bed incinerators are widely used across various industries for both drying and combustion processes. This type of incinerator consists of a vertical steel cylinder lined with refractory material. The top of the unit is dome-shaped, while the lower section tapers into a conical shape that facilitates even air distribution throughout the system.

At the base of the incinerator lies a distribution screen, above which heat-resistant sand particles which are typically 0.6 to 2.5 mm in diameter, are placed to a depth of approximately 0.8 to 1 meter. When air is blown through the distribution screen, it causes the sand to become fluidized, creating a turbulent, boiling-like motion that enhances mixing and combustion efficiency. Preheated air, along with other exhaust gases, is recycled and heated to temperatures of 600–700°C before being introduced into the system. Sludge is fed into the incinerator through an inlet, where it mixes with the fluidized sand and is carried into the combustion chamber. Within this chamber, temperatures reach between 900°C and 1000°C. As the sludge contacts the hot sand:

- Moisture rapidly evaporates,
- Volatile organic compounds are released and combusted,
- Carbonized residues undergo further oxidation,
- Mineral content is incinerated.

The result is an efficient and thorough combustion process. However, due to the high content of volatiles in the sludge, the temperature of the exhaust gases can be quite high. These gases are cooled using cold air before exiting the system (Turovskiy & Mathai, 2006). Although fluidized bed incineration significantly reduces the volume of sludge, it is not considered a complete disposal method. The remaining ash still requires proper management. Improper disposal of this ash poses environmental risks, such as heavy metal leaching and uptake by vegetation. Therefore, controlled landfill disposal remains the most appropriate and commonly used option for managing incinerator ash.

6. **Co-incineration:** When sewage sludge has a low calorific value, direct incineration becomes less efficient and may require supplementary fuel sources. In such cases, a co-incineration approach is often adopted, where sludge is incinerated along with other energy-rich materials such as coal, fuel oil, or natural gas. Alternatively, biogas generated within the treatment plant itself can serve as a renewable energy source. However, it is essential to evaluate whether using biogas in combined heat and power (CHP) systems such as gas turbines which is used for cogeneration of electricity and heat is more economically viable than utilizing it solely for sludge incineration.

When selecting an energy utility for co-incineration, economic feasibility should be balanced with the energy demand, which depends heavily on the calorific value of the sludge. One practical option is to transport sludge to combined heat and power plants or industrial boilers where it can be co-incinerated as a supplementary fuel, usually up to 10% by weight (Donatello & Cheeseman, 2013). This industrial synergy can be cost-effective, especially when sludge treatment facilities are located near existing incinerators or power plants, thereby reducing transportation and infrastructure costs (Liu et al., 2011).

Additionally, co-incineration with municipal solid waste (MSW) is another viable option that may offer both economic and environmental benefits (Lin & Ma, 2012). However, such integrated incineration processes generate residual ash, which must be carefully analyzed for chemical composition and ecotoxicological properties to determine appropriate disposal or reuse methods (Barbosa et al., 2011; Magdziarz & Wilk, 2013). Ash management strategies may vary depending on its origin, as coal ash typically contains fewer nutrients than sewage sludge ash and may require different treatment or disposal approaches (Donatello & Cheeseman, 2013). Therefore, thorough assessment and tailored management plans are critical in ensuring sustainable sludge co-incineration practices.

7. **Pyrolysis:** An alternative to conventional oxygen-based combustion for sewage sludge treatment is anaerobic pyrolysis. This process involves the thermal decomposition of sewage sludge in the absence of oxygen or under oxygen-limited conditions. Unlike incineration, pyrolysis does not burn the sludge directly but instead converts it into useful by-products through heat-driven chemical transformations (Spisona et al., 2011). The processed sludge can subsequently be utilized in the production of absorbents and other industrial raw materials. Pyrolysis is a sustainable sludge management technique that yields valuable products such as biochar, pyrolysis oils, and combustible gases. The quantity and composition of these outputs depend on the processing temperature and the presence or absence of gasifying agents (Samolada & Zabaniotou, 2014).

- At temperatures above 700°C, the process transitions into gasification, favoring the formation of syngas, primarily composed of hydrogen (H_2) and carbon monoxide (CO).
- At lower temperatures (350–500°C), the process remains within the pyrolysis range, resulting in a higher yield of biochar and gases containing a broader spectrum of compounds such as carbon dioxide (CO_2) and methane (CH_4).

Both the biochar and the gases produced can serve as alternative fuels. In particular, the gaseous fraction can be captured and recovered for energy generation, contributing to circular economy approaches in wastewater treatment (Rulkens, 2008). An illustrated diagram of the pyrolysis process is provided in figure 3.5, showing

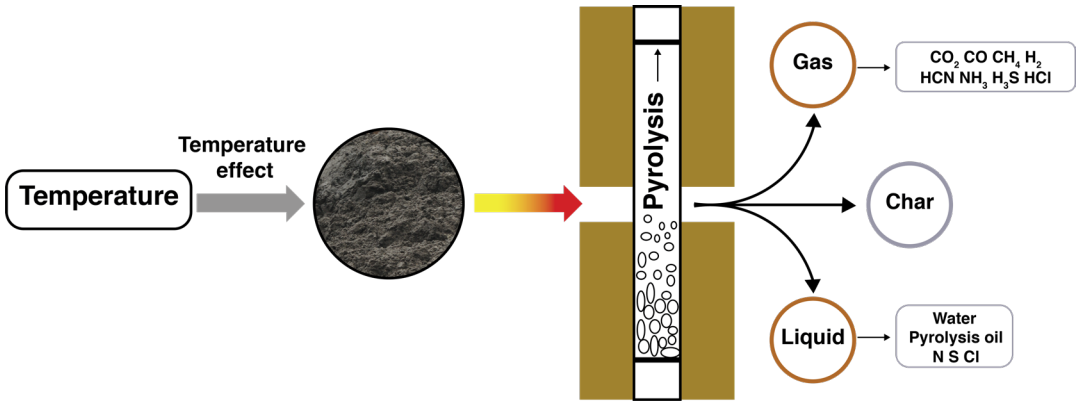


Figure 3.5. Schematic flow of high-temperature pyrolysis mechanism (Source: Liu et al., 2020)

the stages and resulting products of thermal treatment under oxygen-deficient conditions.

8. **Thermal conditioning:** Thermal conditioning is an effective sludge treatment method that enhances dewatering by applying a combination of heat and pressure. In this process, sludge is heated for 15–40 minutes at temperatures between 350°F and 400°F under a pressure of 1,720–2,750 kPa. There are two main types: low-pressure oxidation, where air is introduced, and heat treatment, which occurs without air. Both methods produce biologically stable sludge with superior dewatering characteristics. The high temperature and pressure in a closed reactor break down the sludge's gel-like structure, coagulate solids, and release bound water by hydrolyzing proteins and lysing cells, which causes solid particles to agglomerate and improves overall water removal efficiency (Dohányos et al., 2000).
9. **Solar drying:** The environmentally friendly and energy-efficient technique of solar drying sewage sludge employs solar energy, usually in greenhouse structures, to lower the volume and water content of sewage sludge, making its disposal and reuse more sustainable (An-nori et al., 2022). Although solar drying is widely applicable and a cost-effective, ecologically benign method of managing sewage sludge, it has significant drawbacks in terms of land utilization and climatic reliance.

Overview of the Process

- Dewatered sludge is placed within translucent greenhouse-style structures for solar drying, where the heat from the sun speeds up the evaporation of water.
- To improve uniform drying and avoid fermentation or odor issues, the sludge is frequently continually mixed, aerated, and distributed using mechanical turners and ventilation systems.
- At moderate ambient temperatures, drying cycles can last up to 30 days. The efficiency of drying cycles varies seasonally, reaching over 80% dry matter in the summer but only approximately 50% dry matter in the winter.
- The dried sludge can be burned for energy recovery or utilized as fertilizer because it is granular, lighter, and easier to handle (Karadirek et al., 2025).

Benefits of Solar Drying

- Low energy demand since solar energy is plentiful and cheap; turners and fans usually only require a tiny amount of electricity.
- Environmentally friendly, with a smaller carbon footprint and fewer greenhouse gas emissions than traditional drying, particularly when combined with renewable energy (Wasserman et al., 2025).
- Improved organic matter complexification, decreased pathogens, and improved sludge stabilization, which makes the sludge more appropriate for soil amendment.

Limitations

- Heavy metals are not eliminated by solar drying; the dried product's overall metal composition essentially stays the same.
- Due to the comparatively low intensity of solar radiation, installation requires extensive land areas.
- The local climate and sunshine length have a significant impact on performance; in cold, wet, or overcast weather, efficiency decreases.

- Covered greenhouses produce better results, but odor control and emission management are crucial, particularly in open or semi-open systems.
- In areas with little sunlight, additional heating or hybrid systems might be required to sustain drying rates during inclement weather.

SWOT analysis of the Physical Mechanism of Sludge Treatment

The overall SWOT analysis of the physical mechanism can be understood through figure 3.6



Figure 3.6. SWOT analysis of physical mechanism

3.1.2. Chemical mechanisms for sludge treatment

1. **Alkaline stabilization:** Alkaline stabilization is a chemical method designed to decrease sludge odor and the quantity of pathogenic organisms. This can be achieved by raising pH of the sludge using lime. Fly ash, lime kiln dust, or cement kiln dust are often used for alkaline stabilization because of their availability and low cost. In the lime stabilization process, lime is added to untreated sludge in sufficient quantity to raise the pH upto 12 or higher. The high pH creates an environment that is not favorable to the survival of microorganisms. This results in an odor reduction due to factors that cause putrification, and in a reduction of pathogens (Andreasen 2001). Lime addition to untreated sludge has been practiced for many years as a conditioning process to facilitate dewatering. However, the use of lime as a stabilizing agent has only recently gained recognition. Lime treatment at a pH higher than 12 for a period of 3 hours has been reported to achieve pathogen reduction. The lime stabilization does not destroy the organics necessary for bacterial growth, the sludge must be disposed off before the pH drops remarkably.
2. **Conditioning:** Conditioning is carried out prior to the dewatering process and positively impacts the effectiveness of the dewatering operation. Conditioning process involves the chemical and thermal processing (Wu et al., 2020). The objective of conditioning is to alter the sludge particle size, surface charges and particle interaction. In sewage sludge, the occurrence of colloidal particles with sizes ranging from 1 to 10 µm is mostly common. Biomass plays a vital role in trapping the particulates during biological treatment. The primary goal of the conditioning is to increase the particle size by encapsulating the smaller particles into large flocs. Coagulation and flocculation are being used to achieve this. Coagulation causes the particles to become less stable, lowering the intensity of repulsive forces between them. The agglomeration of thin solids and colloids takes place during flocculation (Mowla et al., 2013). The number of conditioning agents being used depends on the characteristics of the sewage sludge and the equipment employed for dewatering. There can be variations in fine solids and water content levels depending on how the sludge is transported through pipes and the duration of time the sludge is stored.
3. **Chemical conditioning:** Sludge particles are known to be positively or most often negatively charged. Chemical conditioners are chemical species have the opposite charges used to flocculate or coagulate the sludge colloids by charge neutralization and adsorption. In the inorganic conditioning, Ferrous sulfate, aluminum sulfate, and ferrous chloride are used for sewage conditioning, whereas in organic conditioning, long-chain polymers are used for conditioning (Mowla et al. 2013).
4. **Disinfection of liquid effluents:** Liquid effluents from settling tanks or drying beds typically require further treatment prior to

disinfection. Disinfection is considered as 'polishing' step to achieve a final reduction in pathogens in the sludge treatment mechanism. Disinfection refers to a reduction of pathogenic microorganisms (Strande and Brdjanovic, 2014). Chemical forms of disinfection include chlorination, ozonation, and ultra violet (UV), but it is also achieved through mechanical means such as usage of high quality of filters and membranes. Chlorination is the most widely used method of disinfection, and can be applied in either a solid or liquid form. Important design parameters include contact time, chlorine concentration, pathogen load, temperature, and other constituents in effluent. Chlorine is toxic to microorganisms, as it has a high capacity for oxidation, which damages cell membranes. The application of the chlorine compounds to waste water, usually done for the purpose of pathogens reduction. In some circumstances, chlorination may also provide chemical oxidation and odour control. Disinfection is generally operated by chlorination with sodium hypochlorite. The killing of microorganisms containing humic compounds by chlorination lead to the formation of various halogenated hydrocarbons. In many countries, chlorination is most common method for treatment of wastewater.

5. **Gamma-ray in sewage sludge treatment:** Radiation technology has emerged as a credible and effective method for addressing health hazards associated with sewage sludge, particularly in the removal of pathogens. By exposing sludge to high-energy gamma radiation, typically from radioactive sources like cobalt-60, pathogenic microorganisms are inactivated with a high degree of reliability and without leaving any residual radioactivity. This treatment not only ensures the hygienization of sludge but also facilitates its conversion into value-added products such as bio-fertilizers, soil conditioners, and even animal feed. The gamma rays penetrate the sludge, decomposing various organic pollutants and altering its physical and chemical properties. As studies have shown (Sabharwal et al., 2004), gamma irradiation effectively disinfects sewage sludge, with lethal effects on microbial populations increasing with radiation dose. For instance, an absorbed dose of 3 kGy can eliminate 99.99% of pathogens responsible for diseases like cholera, typhoid, and dysentery. The effectiveness of radiation treatment is influenced by two main factors: the radiation dose and the pollutant composition of the wastewater. Higher doses are needed for more heavily polluted sludge to ensure effective decomposition. Clean, irradiated sludge minimizes environmental risks such as nitrogen compound release and halocarbon emissions, both of which contribute to climate change. Consequently, sludge irradiation and pasteurization offer an environmentally friendly and economically viable solution for sustainable sludge management, while also presenting a beneficial alternative to the long-term use of chemical fertilizers, which degrade soil quality and fertility.

SWOT analysis of chemical mechanism of sludge treatment

The overall SWOT analysis of chemical mechanism is presented in Figure 3.7



Figure 3.7. SWOT analysis of chemical mechanism

3.1.3. Biological mechanisms for sludge treatment

1. **Composting of sludge:** Composting of sludge is an aerobic stabilization technique that serves to inactivate pathogens, reduce moisture content, and lower the overall mass of the sludge. The process begins by mixing dewatered sludge with bulking agents, which help in improving aeration and structural integrity of the composting mass.

Forced aeration and drying techniques are typically employed during the composting process, which not only enhance the efficiency of microbial degradation but also facilitate the recovery and reuse of bulking agents. Once composting is complete and the material is properly screened, the final product is stored and eventually utilized in agricultural or commercial markets. Several bacterial species play a crucial role during sludge composting. Dominant genera identified include *Bacillus, Geobacter, Lactobacillus,* and *Pseudomonas*, all of which actively contribute to the breakdown and stabilization of organic matter. Of particular importance is *Thermobacillus*, a bacterial genus found to dominate during both the thermophilic and cooling stages of composting. These microbial communities not only enhance organic decomposition but also assist in detoxifying heavy metals, making the final compost safer and more beneficial for soil application (Han et al., 2022). Some important factors include:

- The composting process is fundamentally a biochemical decomposition of organic matter, carried out by successive groups of microorganisms under optimized environmental conditions. The entire process typically unfolds in four distinct phases, each dominated by different microbial communities (Moretti et al., 2015; Bień & Wystalska, 2011).
- The first is the mesophilic phase, characterized by moderate temperatures, where microbial activity leads to a gradual rise in temperature. This stage usually lasts for a few days and initiates the breakdown of easily degradable organic substances.
- This is followed by the thermophilic phase, also known as the high-temperature decomposition phase. Here, temperatures can rise to 60–75°C, lasting from a few days to several days. During this phase, thermophilic microorganisms decompose most of the biodegradable organic matter, resulting in the release of carbon dioxide, water vapor**,** and ammonia. The high temperatures also ensure effective pathogen inactivation and accelerate the decomposition process.
- Next comes the transition phase, which may also be termed the composting or stabilization phase, typically lasting 3 to 5 weeks. In this stage, the temperature drops to around 30–40°C, and selected mesophilic bacteria and fungi become active again. They help in breaking down the more resistant organic substances, such as lignin, fats, waxes, and resins, leading to a significant reduction in moisture content and further stabilization of the compost.
- Finally, the process enters the maturation phase, also referred to as secondary composting, during which the material cools down further and reaches a steady state. This stage ensures the formation of a stable, mature compost that is safe for agricultural use.

The overall efficiency of the composting process is influenced by various factors, including the temperature, moisture content, oxygen availability, microbial composition, and the nature of the organic material being composted. The microbial strains involved, their population density, and the balance between different microbial groups play a critical role in determining the rate and quality of compost formation (Som

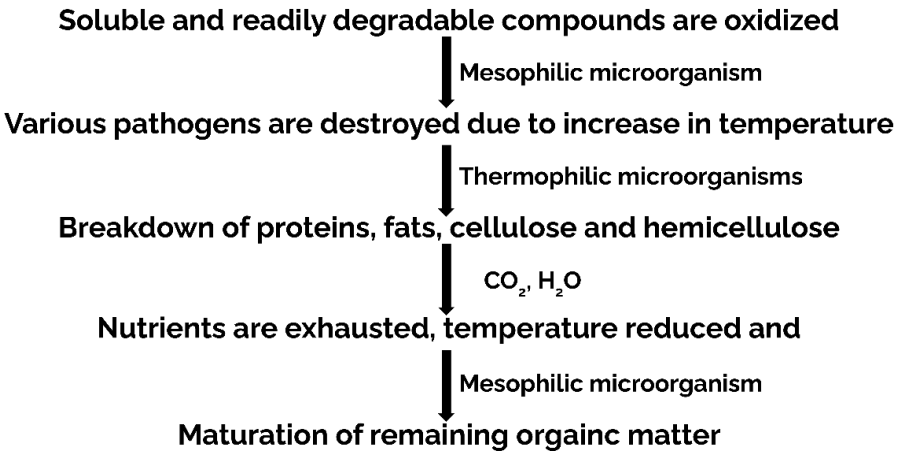


Figure 3.8. Steps involved in the composting of sludge

et al., 2009). Through composting, organic compounds in the sludge are transformed into stable forms that can be effectively used as fertilizers. The application of this compost to agricultural soils not only improves their physico-chemical properties such as moisture retention, aeration, and nutrient content, but also enhances the biological activity of soil microbiota, thereby enriching soil fertility and promoting sustainable crop growth. Moreover, composting conducted at thermophilic temperatures guarantees the sanitary safety of the final product, ensuring it is free from pathogens and suitable for use in farming practices (Tomati et al., 2010; Som et al., 2009). The complete composting procedure, including all key phases and their corresponding microbial activities, is visually represented in figure 3.8, which outlines the systematic transformation of sewage sludge into a valuable agricultural input.

2. **Aerobic degradation of sludge:** The biodegradation of sludge solids in the presence of oxygen is referred to as aerobic digestion. In this process, oxygen is introduced into the reactors in the form of fine air bubbles to support the metabolic activity of aerobic microorganisms. These microbes break down the organic matter in the sludge, converting it primarily into carbon dioxide (CO_2) and water (H_2O). Additionally, ammonia (NH_3) and other nitrogenous compounds are oxidized to nitrates (NO_3^-) through microbial action.

Unlike continuous-feed systems, aerobic digestion typically receives only intermittent input of organic substrate, which leads to a stage where the microbial population starts to decline due to limited food availability. During this phase, called endogenous respiration, the remaining microbes consume the cellular material of dead or dying microorganisms as an energy source. This process is key to reducing the overall solids content of the sludge. Aerobic digestion is especially advantageous for small to medium-sized wastewater treatment plants, typically those handling less than 20,000 m^3/day, as it generally requires lower capital investment compared to anaerobic systems. Similar to anaerobic digestion, aerobic digestion results in a stable sludge with reduced pathogenic load.

However, one of its main limitations is its high energy demand, as continuous aeration is necessary to supply oxygen. Moreover, unlike anaerobic digestion, which produces methane (a potentially recoverable energy source), aerobic digestion mainly yields CO_2 as the gaseous by-product, offering no energy recovery. Additionally, the mechanical dewatering of aerobically digested sludge tends to be more challenging (Song et al., 2010).

In extended aeration systems, sludge digestion takes place within the aeration tanks themselves. Under low food-to-microorganism (F/M) ratios, the influent organic matter is oxidized more completely, allowing the aerobic digestion process to initiate naturally. Given these operating conditions and simplicity, aerobic digestion is often recommended as a standalone, self-starting treatment method, particularly in decentralized or smaller treatment facilities.

$$C_5H_7NO_2 + 7O_2 + \text{bacteria} \rightarrow 5CO_2 + NO_3 + 3H_20 + H^+$$

3. **Activated Sludge Process:** The activated sludge process and its various modifications may be used where sewage is amenable to biological treatment. This process requires close attention and more competent operator supervision than some of the other biological processes. A treatability study may be required to show that the organics are amendable to the proposed treatment. Toxic loadings from industries and excessive hydraulic loadings must be avoided to prevent the loss or destruction of the activated sludge mass. If toxic influents are a possibility, a properly enforced industrial pretreatment program will prove extremely beneficial to the water waste treatment plant and will be required.

Principle

The activated sludge process is a widely used biological treatment method for removing organic pollutants from wastewater. It typically consists of three main components:

1. An aeration tank, which acts as a bioreactor,
2. A settling tank (also called a secondary clarifier), and
3. A return activated sludge (RAS) system.

In this process, oxygen or air is injected into raw, unsettled sewage within the aeration tank. This oxygen supports the metabolic activity of aerobic microorganisms that feed on the organic matter in the wastewater. As a result, the organic pollutants are broken down, and the sewage becomes aerated. The aerated sewage, often referred to as mixed liquor, is then directed into the settling tank, where solid particles, primarily activated sludge composed of microbial biomass, begin to separate from the liquid.

4. **Anaerobic degradation of sludge:** Anaerobic digestion is a multi-step biochemical process in which organic matter is stabilized in the absence of oxygen (Tyagi & Lo, 2013). Due to its high efficiency and adaptability, this process is suitable for a wide range of applications, from simple, small-scale septic tanks **to** highly automated, large-scale treatment plants that serve urban and metropolitan populations (Cordell et al., 2011). Anaerobic digestion involves a series of microbial and chemical reactions that transform complex organic compounds into biogas (primarily methane and carbon dioxide) and a stable digestate. This makes it a versatile and sustainable method for

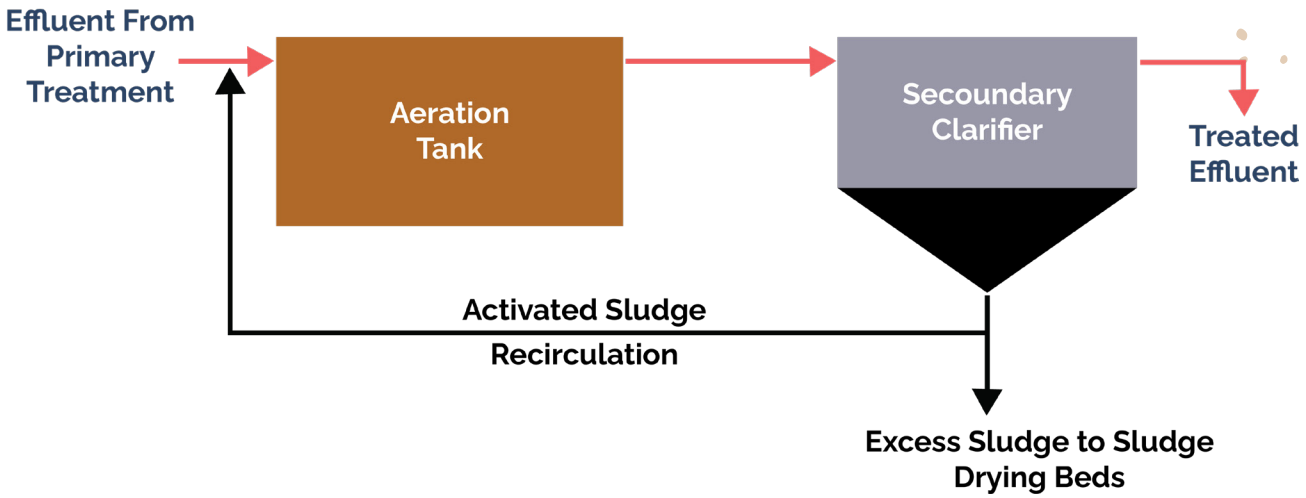


Figure 3.9. Flow diagram of activated sludge process (Source: https://www.sugarprocesstech.com/activated-sludge-process/)

treating various types of biodegradable waste, including municipal sewage sludge, agricultural residues, and industrial organic waste (Nasir et al., 2012).

Processing

In conventional activated sludge wastewater treatment plants, both excess activated sludge and mixed primary sludge are stabilized through anaerobic digestion, wherein bacteria convert organic matter into carbon dioxide (CO_2) and methane (CH_4). This process occurs within sealed anaerobic digesters, which are specially designed tanks that retain sludge for a defined detention period established during the system's operational planning. Within these digesters, solids and liquid sludge have equal retention times to ensure efficient degradation. The anaerobic digestion process is driven by three primary, interdependent groups of microorganisms: hydrolytic acidogenic, acetogenic, and methanogenic bacteria (Su et al., 2009). These microbial communities exist in a dynamic equilibrium, and their population balance can shift depending on environmental conditions such as temperature, pH, and substrate composition. Additionally, denitrifying and sulfate-reducing bacteria are also present and contribute significantly to sludge stabilization during the digestion process (Yang et al., 2012).

Anaerobic digestion typically occurs within a pH range of 6 to 8, with the system generally maintaining a neutral pH due to the buffering capacity of compounds such as ammonia, sulfide, and bicarbonates (Jiang et al., 2011). Maintaining a proper nutritional balance within the digester is crucial, not only for microbial activity but also for sustaining the rate of organic matter stabilization. Essential micronutrients include copper (Cu), iron (Fe), selenium (Se), and nickel (Ni), with iron (Fe) playing a particularly critical role due to its involvement in microbial metabolism (Neyens et al., 2004). In contrast, elements like nitrogen (N), phosphorus (P), and sulfur (S) are considered less critical in trace amounts.

Anaerobic digesters are widely adopted globally, in countries such as Germany, France,

and Chile where the biogas generated as a by-product is utilized at the industrial level for energy production, demonstrating the economic and environmental viability of this sustainable sludge management strategy (Rivière et al., 2009).

SWOT analysis of biological mechanism of sludge treatment

The overall SWOT analysis of biological mechanism can be depicted through Figure 3.10.

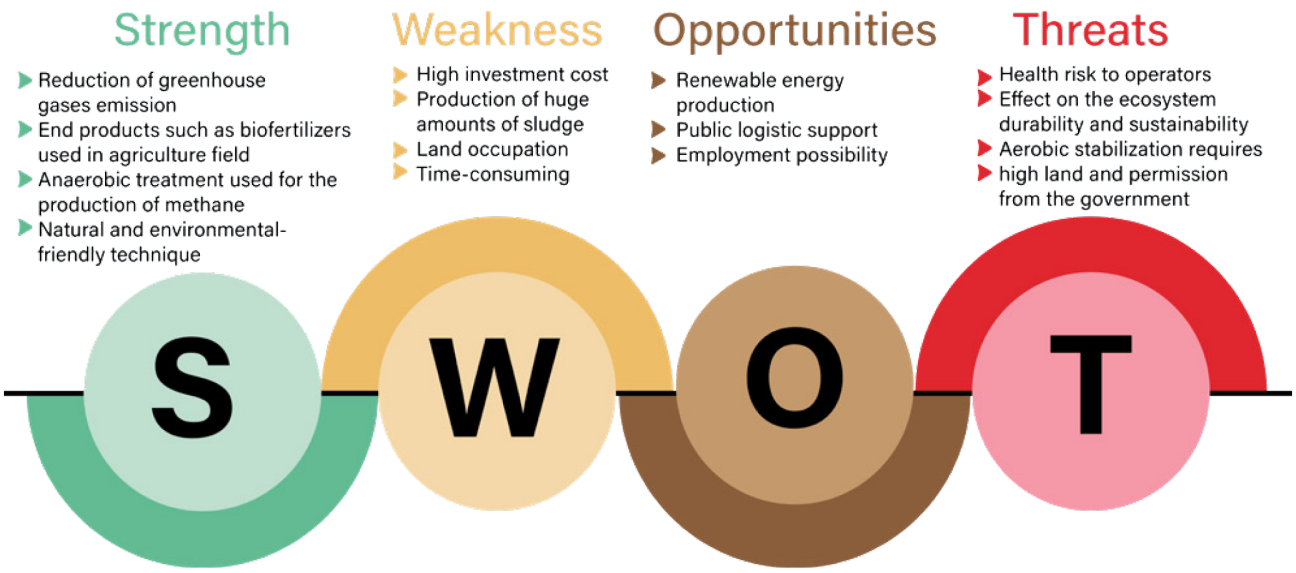


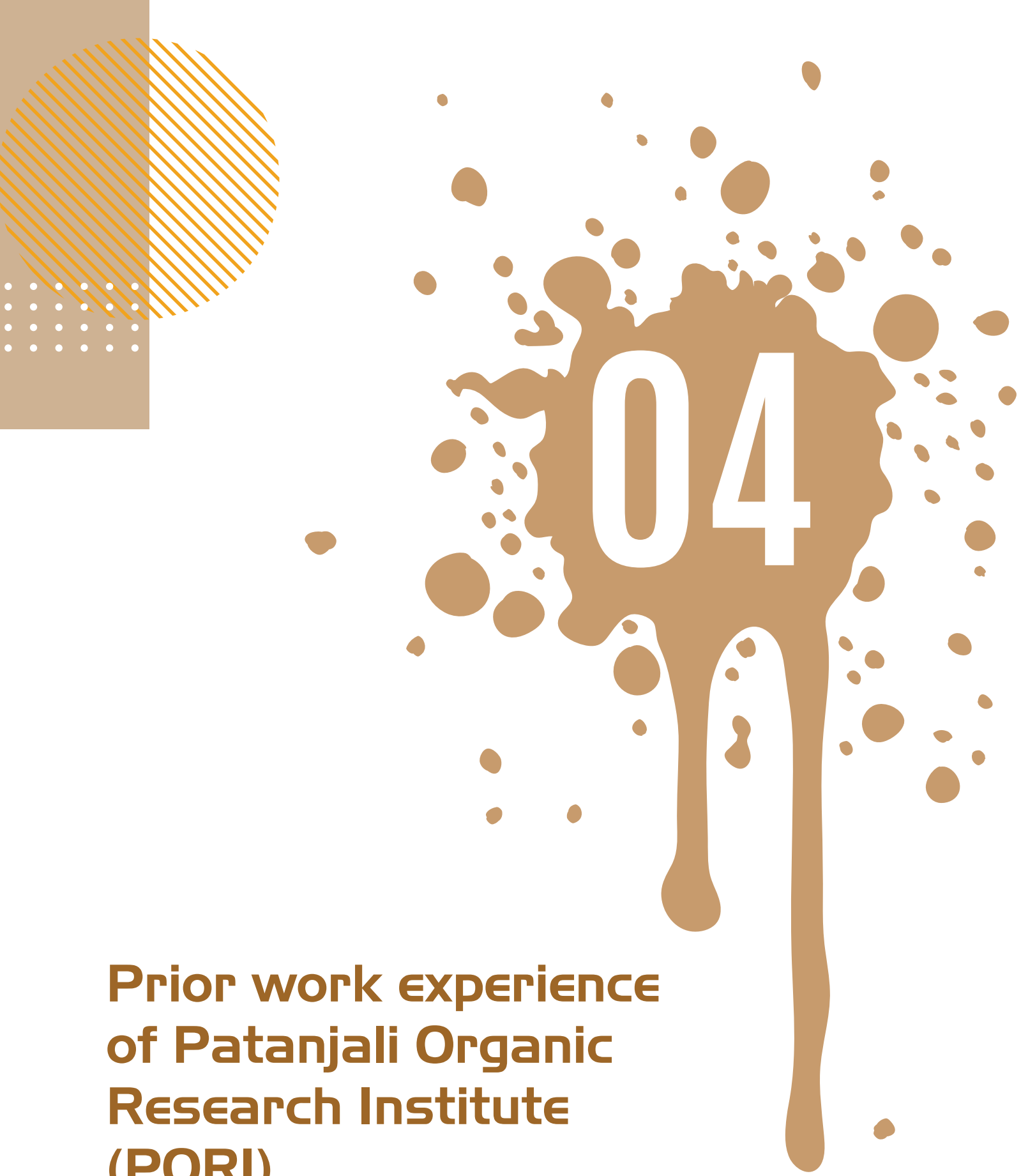
Figure 3.10. SWOT analysis of Biological Mechanism

3.1.4. Need for Standardization

As we have already discussed, the sludge generated is a global burden economically as well as for the environment. Management of the sludge with proper guidelines is of utmost importance to keep mankind safe and provide safe sanitation facilities. In the absence of proper guidelines, sludge generated could become a big threat to the world and could spread dreadful diseases that could cause future pandemics.

With growing concerns about sustainable waste management and resource recovery, the recycling of sludge into biosolids has emerged as a promising and eco-friendly solution. Bio solids, which can increase soil fertility, are essentially wastewater treated byproducts that include a high organic content, including microorganisms, phosphorus, potassium, and nitrogen. Scientifically proven and legally binding guidelines are necessary for the efficient handling of biosolids in order to protect people and the environment, encourage resource recovery, and support frameworks for the circular economy. India does not currently have a national standard for biosolids, and instead relies on fragmented provisions from municipal solid waste or compost regulations (Rajesh et al., 2015). It is important to have a standardized protocol to use biosoilids in agriculture to address the challenges regarding safety, economic viability and sustainability.

This project aims to explore the viable methods for converting sludge into safe, usable biosolids. It emphasizes the importance of adopting environmentally sound and cost-effective recycling techniques that can reduce landfill dependency, minimize greenhouse gas emissions, and support sustainable agriculture. By investigating the physico-chemical and microbiological characteristics of sludge, assessing various treatment methods, and evaluating the quality of the resulting biosolids through quality standards and field trials, this project seeks to contribute meaningful insights into sludge valorization. The rationale behind this study is to not only propose a scientifically sound waste management strategy but also to support policy recommendations and awareness about biosolid reuse in India and other developing regions.



Prior work experience of Patanjali Organic Research Institute (PORI)

4.1 Case study: Health Risk Assessment of Toxic Substances Ganga in Sludge Used as Fertilizer

To assess the toxicity of the sludge in the upper Indo-Gangetic area of Uttarakhand and Uttar Pradesh, a case study has been conducted. The goal was to evaluate the environmental and human health impact of sludge generated in the Indo-Gangetic region used as organic fertilizer and landfill disposal. The research conducts a comprehensive risk assessment, including physicochemical and heavy metals analysis, on samples obtained from 26 treatment plants. Critical insights into the advantages and environmental constraints of recycling treated sludge in farming systems are provided (Balkrishna et al., 2024).

Study area

The study focused on the management of sludge in the upper Indo-Gangetic basin states of **Uttarakhand** (17 STPs) and **Uttar Pradesh** (13 STPs), where industrial and urban activities greatly increase the pollution of the Ganga River (Figure 4.1). Sludge samples were taken in triplicate from each STP in accordance with USEPA-standardized procedures (Telliard, 1988; USEPA, 2009). To guarantee representativeness, samples were collected from various settling tank levels, composited, kept in sterile polyethylene containers, and chilled at 4 °C before analysis. Table 4.1 and figure 4.1, display the sampling locations' geographic distribution of STPs of Uttarakhand and Uttar Pradesh. The appropriate authorities in both states granted permission for the sampling.

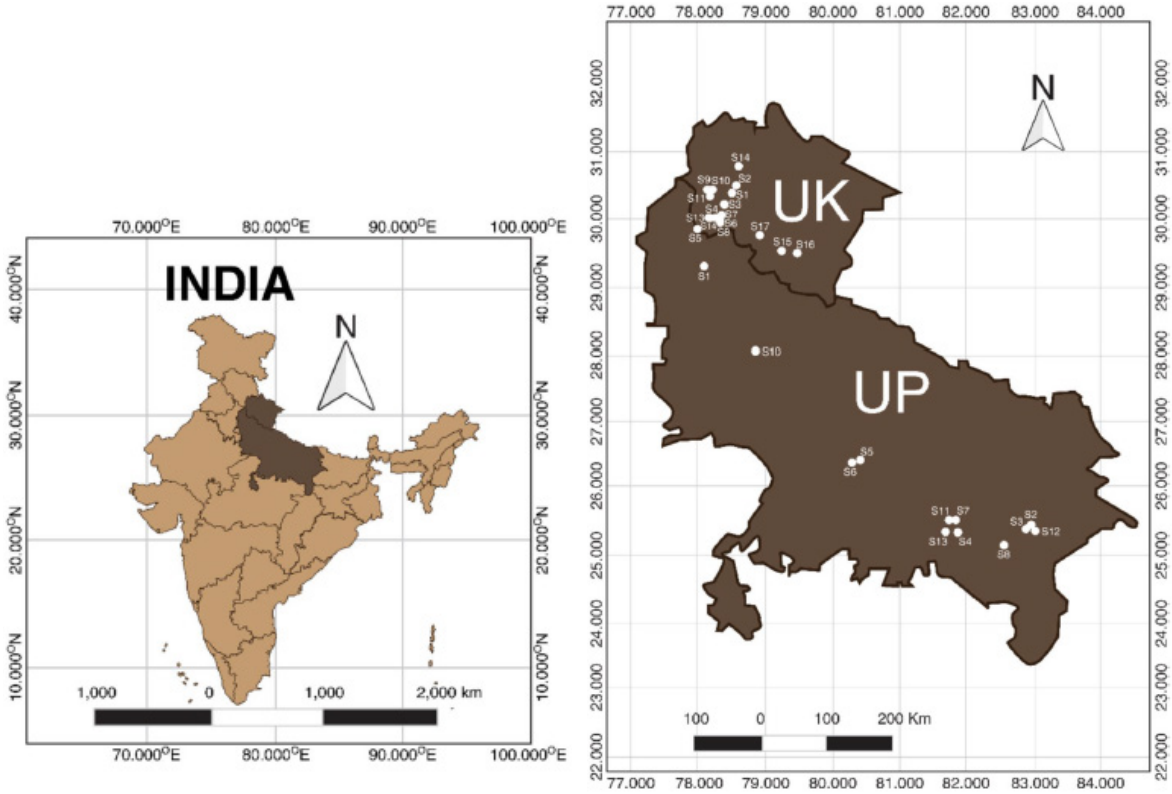


Figure 4.1. Sludge Collection Location

Table 4.1. The locations of the sewage sludge collection sites.

Sample codes	Collection site Name	Latitude	Longitude
UK-SP1	Chandreshwar Nagar, Rishikesh	30.107° N	78.307° E
UK-SP2	Tapovon, Rishikesh	30.132° N	78.33° E
UK-SP3	Labour Colony, Rishikesh	30.057° N	78.261° E
UK-SP4	BHEL, Township, Haridwar	29.932° N	78.082° E
UK-SP5	Roorkee, Haridwar	29.901° N	77.865° E
UK-SP6	Noorpur, Haridwar	29.898° N	78.138° E
UK-SP7	Missarpur, Mustakam, Haridwar	29.899° N	78.14° E
UK-SP8	Noorpur Panjanhaedi, Haridwar	29.899° N	78.14° E
UK-SP9	Indranagar Colony, Dehradun	30.309° N	77.997° E
UK-SP10	Neelkanth Arcade, 43-Rajput Road, Dehradun	30.304° N	78.052° E
UK-SP11	Mothrowala, Brahmanwala, Dehradun	30.284° N	78.015° E
UK-SP13	Ramnagar, Nainital	29.378° N	79.131° E
UK-SP15	Chokhla Tehri Garhwal (inlet)	30.377° N	78.465° E
UK-SP17	Sarai, Haridwar	29.895° N	78.089° E
UK-SP18	Sarai, Haridwar	29.904° N	78.108° E
UK-SP19	Ramnagar, Nainital	29.202° N	78.949° E
UK-SP21	Nainital	29.39° N	97.132° E
UK-SP22	Chorpani, Rishikesh	30.124° N	78.275° E
UP-SP1	Near Hemraj Colony, Bijnor	29.373° N	78.104° E
UP-SP2	Goithaha	25.387° N	82.997° E
UP-SP3	Dinapur	25.354° N	83.047° E
UP-SP4	Naini, Prayagraj	25.417° N	81.856° E
UP-SP5	Jajmau, Kanpur	26.415° N	80.419° E
UP-SP6	Bingawan, Kanpur	26.37° N	80.313° E
UP-SP7	Rajapur, Prayagraj	25.491° N	81.843° E
UP-SP8	Mirzapur	25.145° N	82.589° E
UP-SP9	Jajmau, Kanpur	26.415° N	80.419° E
UP-SP10	Narora Town	28.203° N	78.38° E
UP-SP11	Kodra, Prayagraj	25.464° N	81.777° E
UP-SP12	Dinapur	25.345° N	83.047° E
UP-SP13	Numaya Dahi, Prayagraj	25.383° N	81.781° E

Physicochemical Analysis

Key sludge parameters were determined using modified APHA standard procedures, including pH, electrical conductivity (EC), total organic carbon (TOC), total nitrogen (TN), total phosphorus (TP), total potassium (TK), and total moisture content (TMC).

Heavy Metal Analysis

With the use of Inductively Coupled Plasma Mass Spectrometry (ICP-MS), the concentrations of Cr, Zn, Cd, Cu, Pb, As, Ni, Hg, and Se were detected. Samples underwent homogenization, oven drying, and microwave-assisted acid digestion using hydrogen peroxide and Suprapur® nitric acid before analysis. Dry weight measurements of metal concentrations (mg/kg) were used for reporting.

Pollution Indices

Several metrics were used to assess pollution levels:

- Composite metal pollution is measured using the **Metal Pollution Index** (MPI).
- Sludge metal levels can be compared to background soil values using the **Geo-accumulation Index** (Igeo).
- To calculate the risk that heavy metals bring to ecosystems, use the Potential Ecological **Risk Index** (RI).

Human Health Risk Assessment

Three exposure pathways were taken into account in the risk assessment: ingestion, inhalation, and skin contact. Using the Hazard Quotient (HQ) and Hazard Index (HI), average daily intake (ADI) values for adults handling sludge were calculated and compared with reference doses (RfD) for non-carcinogenic effects. Target Cancer Risk (TCR) values for Cr, Cd, and As were used to evaluate carcinogenic risks.

Findings

Levels of Contaminants in Sludge vs Permissible Limits (Metal Pollution Index)

Significant differences between the sludge samples from Uttarakhand (UK) and Uttar Pradesh (UP) were found by the physicochemical evaluation (Fig. 4.2). The mean pH values (UK: 6.47; UP: 6.88) were within acceptable bounds, although there were notable regional variations ($p < 0.05$). The majority of the time, total organic carbon (TOC) and nitrogen (TN) demonstrated compliance, highlighting the sludge's potential as an organic amendment in agriculture. However, direct application without treatment was limited because total potassium (TK) and electrical conductivity (EC) frequently exceeded reference limits.

Mercury (Hg) exceedances were consistently found in both regions by heavy metal analysis. With the exception of mercury, which was a common environmental concern, most metals stayed below the FCO (2023) allowable criteria, even though quantities of chromium (Cr), zinc (Zn), cadmium (Cd), and lead (Pb) were generally greater in UP than in the UK. About 70% of UP samples had significant contamination (MPI > 6), while the majority of UK samples were in the light-to-serious range (1 < MPI < 6). This pattern was supported by geo-accumulation index (Igeo) values, which showed that 69% of UP samples were in "severe to extreme contamination" classes, whereas UK levels were mainly uncontaminated (Igeo < 0), Fig 4.3.

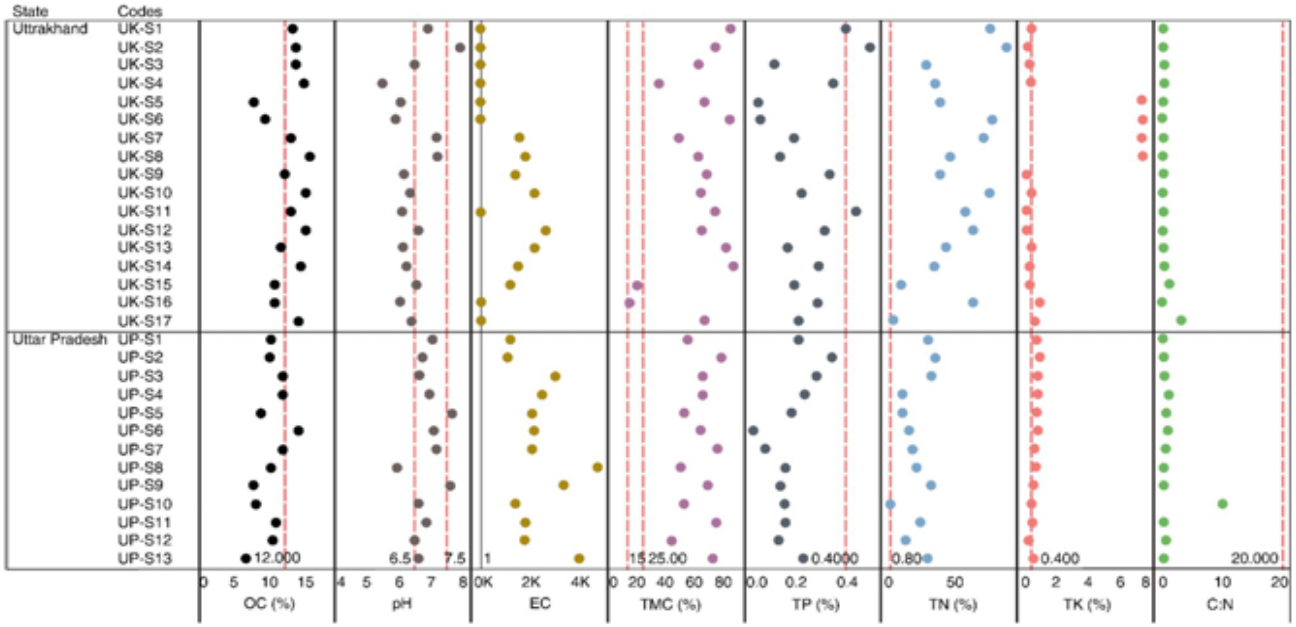
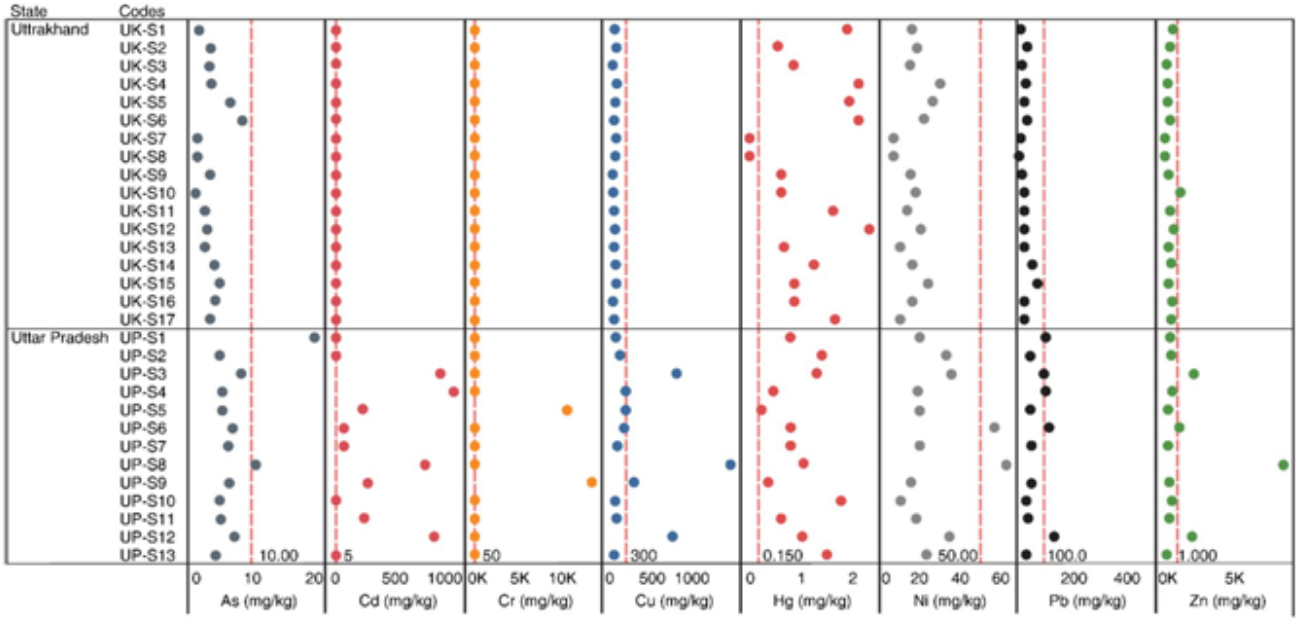


Figure 4.2 Spatial distribution of different physicochemical parameters around the sampling sites. The dotted lines in each parameter pointed out the safety reference value obtained from FCO 1985 (2023).



The dotted line in each parameter pointed out the safety reference value obtained from FCO 2023

Figure 4.3. Spatial distribution of different heavy metal concentration around the sampling sites.

Contaminant Transfer to Soil and Crops (Ecological risk index)

The application of sludge presents a real risk of heavy metal buildup in Indo-Gangetic soils. Cadmium (Cd), mercury (Hg), chromium (Cr), copper (Cu), and zinc (Zn) were ranked as the most dangerous metals by the ecological risk index (RI) (Figure 2). While most UK samples stayed at moderate levels, 84% of UP samples showed high ecological risk (RI > 600). In addition to decreasing fertility and enhancing the uptake of hazardous elements by food crops, these accumulation patterns have the potential to disrupt soil microbial activities and introduce these elements into the food chain.

Estimated Daily Intake (EDI) by Population Groups

Ingestion, cutaneous, and inhalation routes were modeled for both adults and children in order to evaluate exposure. The most common route was always ingestion, particularly for chromium (Cr), cadmium (Cd), and arsenic (As). Arsenic consumption at UP-S1, for instance, contributed 3.576×10^{-4} mg/kg/day, which is much higher than the risks of inhalation (4.09×10^{-5}) and cutaneous (5.08×10^{-5}) exposure. Children were at sensitive category for health risk assessments because of their smaller body weight and higher rates of soil intake, which put them at increased relative risk.

Human Health Risk Indices (HQ, HI, CR)

Both states' average values for the non-carcinogenic risk indices (Hazard Quotient, HQ; Hazard Index, HI) stayed below the risk threshold (HI < 1), Figure 4.4. Site-specific exceedances were noted, though: in Uttar Pradesh, 15.38% of STPs (UP-S4, UP-S10) above safe limits, whereas

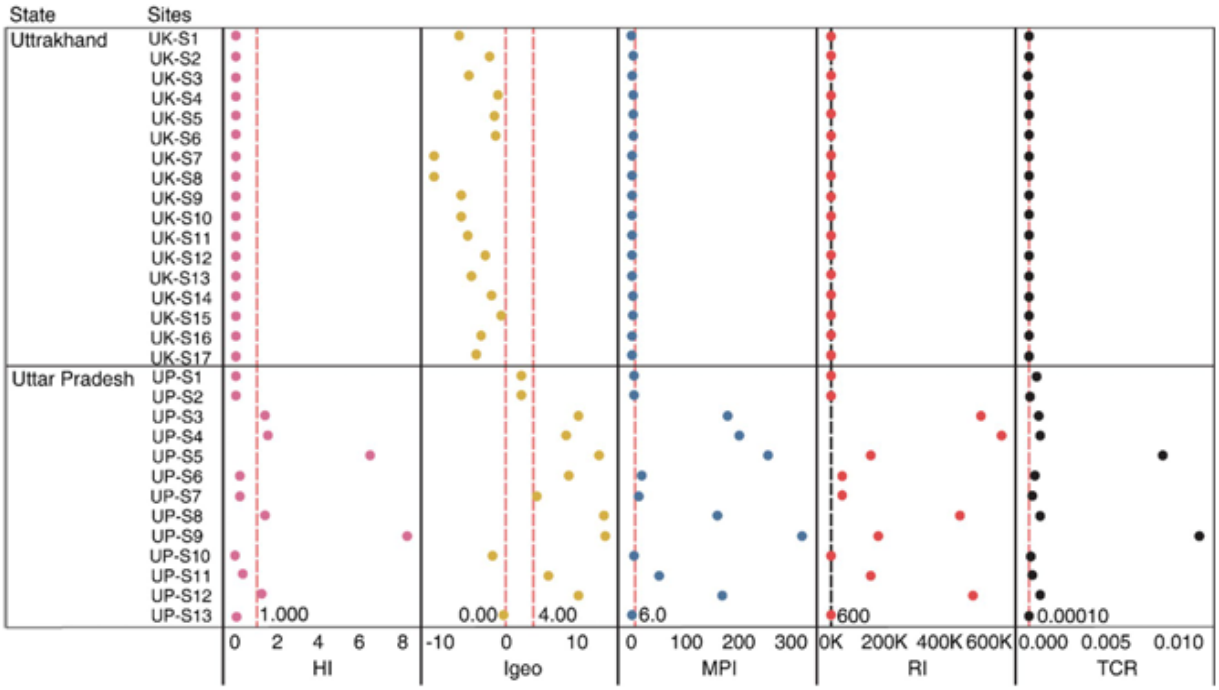


Figure 4.4. Spatial distribution of different pollution index (Igeo; MPI; RI) and health risk assessment (HI; TCR) values around the sampling sites.

10% of STPs (UK-S3, UK-S11, and UK-S24) in Uttarakhand displayed HI > 1. In comparison to the UK (HI = 0.0159), UP (HI = 0.0384) presented almost twice as much of a health risk.

In a number of locations, carcinogenic risks (Target Cancer Risk, or TCR) showed concerning exceedances (TCR > 1×10^{-4}). In Uttar Pradesh, UP-S9 (1.16×10^{-2}) and UP-S5 (9.11×10^{-3}) were recognized as important hotspots, whereas UK-S3, UK-S11, and UK-S24 reported TCR values > 2.5×10^{-4} in Uttarakhand. Most of the cancer risk burden was caused by cadmium and arsenic ingestion.

The study reveals concerns about the potential health risks associated with reusing sludge samples as fertilizer for crops or in landfills in Uttarakhand and Uttar Pradesh. The presence of heavy metals like Cd and Cr in sludge poses a significant risk to adult humans, ranging from 21.4 to 62.86%. Despite the hazard index and target cancer risk values indicating a borderline risk zone, it is necessary to burn or augment sludge with natural materials before any suggested use. The study's exclusivity and the integration of AI-based monitoring systems underscore its forward-looking perspective. It suggests setting strict guidelines for pre-application testing and sludge treatment, funding research for alternative waste management strategies, promoting public awareness, and creating and enforcing thorough legislation to guarantee the safe processing and application of municipal sludge. This comprehensive evaluation underscores the urgent need for a thorough evaluation of municipal sludge management in these regions.

4.2 Efficacy and Evaluation of Ganga Sludge-based Patanjali Organic Fertilizers in Different Crops

The field trials assessing the utilization of finished goods derived from sewage sludge in agriculture constitute a critical phase in validating their applicability and effectiveness. The products, applied at recommended doses, underwent rigorous testing across a spectrum of eight diverse crops encompassing food grains, vegetables, root crops. This approach is pivotal as it seeks to gauge the tangible impact of organic fertilizers derived from Ganga Sludge on crop yield enhancement. Such comprehensive field trials serve as an indispensable validation tool. If successful, these trials will provide empirical evidence demonstrating the potential of sewage sludge-based biofertilizers in significantly enhancing crop yields across various crop types. The rationale behind conducting these extensive trials rests upon the transformative implications they hold. Yield enhancements resulting from the application of these finished goods hold promise in charting a sustainable pathway for the management and constructive reuse of sewage sludge.

A comprehensive experimentation on the effects of Ganga sludge-based organic fertilizers on the growth and yield of six different food grain and vegetable crops, namely, tomato, capsicum, pea, wheat, spinach and fenugreek, was carried out by Patanjali Organic Research Institute (PORI). Five types of granulated organic fertilizers (Jaivik Prom, Natural Pori Potash, Dharti ka Chowkidar, Poshak and Jaivik Khad) prepared

from the stabilized Ganga sludge were used in field experimentation in various treatment compositions. The application of organic fertilizers significantly improved the performance of all experimental crops in terms of growth and other yield parameters. In the present field trials, the performance of Poshak in terms of increase in yield was found best in Capsicum (14.04%), Wheat (15.05%) and Fenugreek (16.77%). Similarly, Dharti ka Chowkidar, Jaivik Khad and Jaivik Prom were found effective in increasing the yield of Spinach (23.66%), Tomato (16.21%) and Pea (14.63%), respectively. In addition, Poshak was also found effective in increasing yield in mixed cropping (wheat & pea), while Dharti ka Chowkidar in Spinach and fenugreek. However, all other fertilizers also performed well in increasing the growth and yield of all crops. From these results, it was summarized that producing organic fertilizers from sludge and their utilization in agricultural farming is perhaps the most sustainable and eco-friendly way to manage Ganga sludge and enhance agricultural productivity. These fertilizers will also help lowering in burden of synthetic fertilizers on the environment.

Based on the observations recorded for the efficacy and evaluation of Ganga Sludge-based Patanjali Organic Fertilizers (Jaivik Prom, Natural Pori Potash, Dharti ka Chowkidar, Poshak, Jaivik Khad) in crops (Wheat, Capsicum, Pea, Tomato, Spinach, Fenugreek) during 2022-23, it may be summarized as:

Wheat crop:

The grain yield with application of Poshak (7 kg/ ac) on Wheat crop increased 15.05% followed by 12.65%, 12.54%, 11.95% and 9.75% in treatments Jaivik khad (80 kg /ac), Jaivik Prom (100 kg/ ac), Natural Pori Potash (100 kg/ac) and Dharti ka Chowkidar (10 kg/ac) respectively as compared to control (7.78%). Simillarly the grain yield with application of Jaivik Prom (100 kg/ac) + Jaivik Khad (80 kg/ac) on wheat crop is increased by 17.39% followed by12.89% Natural Pori Potash (100 kg/ac) + Poshak (7 kg/ac) in the mixed fertilizers dose trial.

Pea crop:

A considerable increase in the yield of Pea crop observed with the application of organic amendments. The application of Jaivik Prom (100 kg/ac), Poshak (7 kg/ac), Dharti ka Chowkidar (10 kg/ ac), Jaivik khad (80 kg /ac) and Natural Pori Potash (100 kg/ac) on pea crop increased 14.63% and 13.97%, 12.50%, 11.60% and 11.20% respectively as compared to control (11.79%). In the mixed fertilizers dose trial, the yield with the application of Natural Pori Potash (100 kg/ac) + Poshak (7 kg/ ac) on Pea crop found increased 12.34% whereas, it was 11.98% Jaivik in Prom (100 kg/ac) + Jaivik Khad (80 kg/ac).

Tomato crop:

The fruit yield with the application of Jaivik Khad (80 kg/ac) on tomato crop increased upto 16.21%, followed by 14.01%, 13.40%, 13.07% and 12.30% in Jaivik Prom (100 kg/ac), Poshak (7 kg/ac), Dharti ka Chowkidar (10 kg/ac), and Natural Pori Potash (100 kg/ac) as compared to control (7.58%). The application of mixed fertilizer dose also showed that fruit yield with the application of Jaivik Prom (100 kg/ac) + Jaivik Khad (80 kg/ac) on the tomato crop increased by 15.87% followed by 7.85% Natural Pori Potash (100 kg/ac) + Poshak (7 kg/ac) in comparison to control (7.58%).

Capsicum crop:

The fruit yield with application of Poshak (7 kg/ac) on Capsicum crop increased by 14.04% followed by 13.62%, 12.78%, 12.28% and 9.89% each Natural Pori Potash (100 kg/ac), Dharti ka Chowkidar (10 kg/ac), Jaivik Prom (100 kg/ ac), and Jaivik Khad (80 kg/ac) in comparison to control (9.22%). In the mixed fertilizer dose trial, the yield increased by 14.68% with the application of Natural Pori Potash (100 kg/ac) + Poshak (7 kg/ ac), followed by 13.49% Jaivik Prom (100 kg/ac) + Jaivik Khad (80 kg/ac).

Spinach crop:

The crop yield with application of Dharti ka Chowkidar (10 kg/ac) increased 23.66%, followed by 15.77%, 12.76%, 11.26% and 6.26% in Natural Pori Potash (100 kg/ac), Jaivik Prom (100 kg/ ac), Jaivik Khad (80 kg/ac), and Poshak (7 kg/ ac) respectively in comparison to control (6.27%). The crop yield increased upto 13.99% followed by 10.03% after application of Potash (100 kg/ ac) + Poshak (7 kg/ac) and Jaivik Prom (100 kg/ ac) + Jaivik Khad (80 kg/ac) in mixed fertilizers dose trials.

Fenugreek crop:

The application of Poshak (7 kg/ac) increased crop yield by 16.77% followed by 13.58%, 13.01%, 8.68%, and 8.25% in Dharti ka Chowkidar (10 kg/ac), Jaivik Prom (100 kg/ac), Jaivik Khad (80 kg/ac), and Natural Pori Potash (100 kg/ ac) respectively as compared to control (9.98%). Likewise, the crop yield increased by 17.78% with the application of Jaivik Prom (100 kg/ac) + Jaivik Khad (80 kg/ac) and 11.94% of Natural Pori Potash (100 kg/ac) + Poshak (7 kg/ac) in the mixed fertilizers dose trial as compared to the control (9.98%).

Mixed cropping system (Wheat and Pea):

The application of organic fertilizers aided the yield of both the crops however, grain yield of wheat was found greater than pea. Here the grain yield with application of Poshak (7 kg/ ac) was found 14.83% followed by 12.61%, 11.71%, 11.13%, 11.02% in Dharti ka Chowkidar (10 kg/ ac), Jaivik Khad (80 kg/ac), Jaivik Prom (100 kg/ac) and Natural Pori Potash (100 kg/ac) respectively as compared to control (8.88%). In the mixed fertilizers dose trial, the grain yield of wheat with the application of Jaivik Prom (100 kg/ac) + Jaivik Khad (80 kg/ac) increased by 17.90% followed by 11.91% of Natural Pori Potash (100 kg/ac) + Poshak (7 kg/ac) in compared to control (8.88%). Besides, applying organic fertilizers, mixed cropping with pea also supports the growth and yield of wheat.

Mixed cropping system (Spinach and Fenugreek):

The application of organic fertilizers aided the yield of both the crops; however, the leaf yield of spinach was found to be greater than fenugreek. Here the leaf yield with application of Dharti ka Chowkidar (10 kg/ac) was found 25.94% followed by 14.58%, 12.15%, 8.11%, 7.07% in Jaivik Khad (80 kg/ac), Jaivik Prom (100 kg/ac), Poshak (7 kg/ac) and Natural Pori Potash (100 kg/ac) respectively as compared to control (16.79%). In the mixed fertilizers dose trial, the leaf yield of spinach with the application of Jaivik Prom (100 kg/ac) + Jaivik Khad (80 kg/ac) increased by 8.93% followed by 11.91% of Natural Pori Potash (100 kg/ac) + Poshak (7 kg/ac) in compared to control (6.46%). Besides, applying organic fertilizers, mixed cropping with fenugreek also supports the growth and yield of spinach.

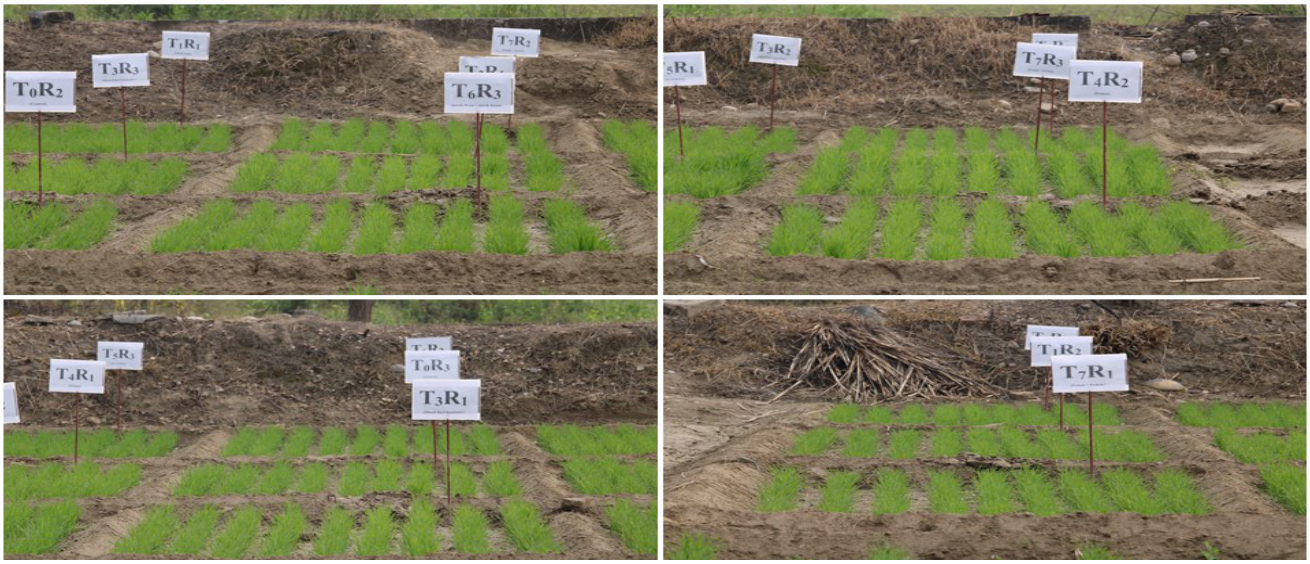
Moreover, the significance lies not only in yield enhancement but also in the broader context of sustainable waste management. Demonstrating increased yields across diverse crops not only validates the efficacy of these biofertilizers but also offers a viable solution to repurpose sewage sludge, addressing environmental challenges while contributing positively to agricultural productivity.

These trials essentially represent a critical bridge between scientific experimentation and practical application. By evaluating the impact of sewage sludge-based biofertilizers on different crops, this approach endeavours to substantiate the viability of these products, fostering a sustainable paradigm for sewage sludge management. Ultimately, the success of these field trials holds the potential to revolutionize agricultural practices, promoting environmental sustainability through the utilization of sewage sludge in a productive and beneficial manner.

Photo-plates of the experimental field Involved in the Project



Pea Crop





Wheat Crop



Tomato Crop



Capsicum Crop



Spinach Crop



Fenugreek Crop



Wheat and Pea in mixed cropping system



Spinach and Fenugreek in mixed cropping system



General overview of steps used during evaluation of plant parameters with reference to pea

SECTION II

EXPERIMENTAL DESIGN AND FINDINGS



Conversion of Raw Sludge into Economically Valuable Products

5.1 Introduction

Sludge, the semi-solid byproduct generated during the treatment of Ganga wastewater, poses significant environmental and public health concerns if not managed properly. Recycling this sludge into bio-solids treated organic materials that meet defined standards for land application offers a sustainable and resource-efficient solution. Bio-solids are rich in essential plant nutrients and organic matter, making them suitable for use as soil conditioners or fertilizers in agriculture, forestry, and land reclamation.

This Standard Operating Procedure (SOP) outlines the systematic steps involved in converting raw sludge into value-added products from biosolids in compliance with national and international regulatory standards, such as those outlined by the United States Environmental Protection Agency (EPA), World Health Organization (WHO), and applicable local environmental authorities. The goal is to ensure safe, efficient, and environmentally sound practices that promote circular resource use, reduce the environmental footprint of wastewater treatment, and contribute to soil health and productivity.

This SOP is intended for all operational, technical, and laboratory personnel involved in the sludge treatment and biosolid production process. It establishes uniform guidelines to ensure safety, quality control, environmental compliance, and the beneficial reuse of biosolids.

5.2 Sludge Collection and Initial Screening

a. Collection: Raw Ganga sludge was collected in bulk from the 68 million liters per day (MLD) Sewage Treatment Plant (STP) in Jagjeetpur (Latitude 29.89 and Longitude 78.13), which has been commissioned under the Namami Gange Program (Figure 5.1). All the samples were collected using aseptic technique, transferred to sealed packets and transported to the laboratory for further analysis and processing.

Procedure:

- Collect sludge sample using the 8-grab method to ensure representative sampling across the entire area.
- Measure and record the moisture content of the sample using the provided moisture meter before proceeding with further steps.
- Divide the sludge-holding area into a Z-shaped pattern to determine the sampling points evenly across the site.
- Using a surface-sterilized trowel, collect the first grab sample at the designated point and record the time of collection.
- Collect the remaining seven grab samples following the Z-pattern. Place each grab into a sterile, pre-marked container. Record the time when the final grab sample is taken.
- Immediately after collecting all grab samples, seal the container securely and reinforce the seal using Parafilm.
- If the interval between individual grab samples exceeds five minutes, store the container on ice or in refrigeration.
- Ensure that the sample is transported to the laboratory as soon as possible to preserve its integrity.

Safety Measures

- Use nitrile gloves while sampling. Discard the gloves after sampling with proper precautions at a designated disposal site as per the guidelines set by the concerned authority. Use a fresh pair of nitrile gloves for sampling at each STP.
- Wear a mask, head cap, and shoe covers during the sampling process. Discard all protective gear—including gloves, mask, head cap, and shoe covers—after sampling, following proper precautions and at the specified disposal location as directed by the authority.
- Use appropriate handling equipment while collecting the sludge. Do not use bare hands under any circumstances.

b. Screening: Large debris such as plastics, stones, and rags was removed using coarse and fine screens. This mechanical process eliminated coarse solids, debris, and large objects from the sludge before further treatment. It helped prevent damage to downstream equipment, pipes, and pumps, and improved the efficiency of subsequent wastewater treatment processes.





(A) (B)

Figure 5.1. Sample collection site, Jagjeetpur, Haridwar (A) Overview of STP (B) Processing Unit.

5.3 Analysing the major parameters

To determine the parameters of raw sludge, physicochemical, microbiological and heavy metal analysis was done. All the procedures for the measurement of the different parameters were obtained from the protocols given in the Fertiliser Control Order (FCO), 1985.

1. Physicochemical Analysis

The physicochemical properties of raw sludge were analyzed to assess their composition, behavior, and the impact of treatment on these properties. The analytical methods used for evaluating these physicochemical parameters are presented in Table 5.1.

Determination of moisture content

Apparatus: Clean dry Petri plate with lid, Digital weighing balance (precision ± 0.01 g), Hot air oven (105 ± 5°C), Desiccator.

Procedure:

- The petriplate was cleaned and dried thoroughly before use.
- The empty petri plate with lid was weighed using a digital balance, and the weight was recorded. *This was noted as* W_1 *(empty weight).*
- A known quantity of the moist sample was placed into the Petri plate and spread evenly for uniform drying.
- The petriplate with the wet sample and lid was weighed, and recorded. *This was noted as* W_2 *(wet weight).*
- The lid was removed, and the petriplate was placed in a hot air oven set at 105 ± 5°C**.**
- The sample was dried for 12–24 hours, or until a constant weight was achieved.
- After drying, the petri plate was carefully removed from the oven using heat-resistant gloves or tongs.

- The plate was then placed in a desiccator with the lid on and allowed to cool for 20–30 minutes to prevent moisture reabsorption.
- The Petri plate with the dry sample and lid was weighed again, and the weight was recorded. *This was noted as* W_3 *(dry weight).*
- Moisture content was calculated by using the formulae:
- Moisture Content (%) = $W_2 - W_3 \times 100 / W_2 - W_1$

Where:

- W_1 = Weight of empty Petri plate with lid
- W_2 = Weight of Petri plate + wet sample + lid
- W_3 = Weight of Petri plate + dry sample + lid

Determination of sludge pH

Reagents: Buffer solution (pH 4.0, 7.0 and 9.2)

Apparatus: A balance, 100mL beaker, measuring cylinder, glass rod, pH meter and tissue paper.

Procedure:

- 20 g of sludge from each sample was weighed into a 100 mL beaker, and 40 mL of distilled water was added.
- The mixture was stirred at least four times over a 30-minute period to allow equilibrium between the sludge and water.
- Meanwhile, the pH meter was switched on.
- The instrument was calibrated using buffer solutions of known pH.
- The electrodes were washed with distilled water and wiped with dry tissue paper.
- The pH of the sample was measured using the pH meter.
- After measurement, the electrodes were rinsed with distilled water and placed back into a beaker containing distilled water.

Interpretation

pH	Interpretation
Below 6.5	Acidic
6.5-8.7	Normal
8.7-9.3	Alkaline
Above 9.3	Highly Alkaline

Determination of electrical conductivity in soil

Apparatus: Weighing balance, 100mL beaker, a measuring cylinder, a glass rod, a conductivity meter.

Procedure:

- 20 g of sludge from each sample was weighed into a 50 mL beaker, and 40 mL of distilled water was added.
- The mixture was stirred intermittently with a glass rod for about 30 minutes, and then it was left undisturbed overnight to obtain a clear supernatant.
- The electrical conductivity of the supernatant liquid was determined using a conductivity meter.

Interpretation

EC (1:2 Soil Water) (dS/m)	Salt Concentration (%)	Category
Below 0.8	Below 0.05	Normal
0.8-1.6	0.05-0.15	Critical for salt sensitive crops
1.6-2.5	0.15-0.20	Critical for salt tolerant crops
Above 2.5	0.20-0.25	Injurious to all crops

Determination of available Nitrogen in soil

Reagents:

- $KMN0_4$ —Dissolve 3.2g of potassium permanganate in distilled water and make up the volume to one litre with distilled water.
- NaOH — Dissolve 25g of sodium hydroxide pellets in distilled water and make up the volume to one litre. 0.02 N H_2SO_4
- Mixed Indicator — Dissolve 0.066g of methyl red and 0.099g of bromocresol green in 100m1 of ethanol.
- Boric acid — Dissolve 25g of boric acid in one litre of distilled water and add 40m1 mixed indicator. Then adjust the pH to 4.5-5.0 by adding 2.5% NaOH.

Apparatus: Kjeldahl distillation assembly, measuring cylinder, pipettes and a 100ml conical flask.

Procedure:

- The Kjeldahl assembly was prepared, with one inlet tube dipped in 0.32% $KMnO_4$ and the second in 2.5% NaOH reagent tanks.
- 5 g of sludge from each sample was weighed and transferred into a distillation tube, ensuring the sample did not stick to the sides.
- Any soil particles adhering to the tube walls were washed down with distilled water.
- The distillation tube was fixed in the distillation unit, and the sample was moistened with distilled water by pressing the dilution key.
- 25 mL of 2.5% boric acid was pipetted into a conical flask, and the receiving end of the distillation tube was dipped into it.
- 25 mL of $KMnO_4$ and 25 mL of NaOH were added to the sample by pressing the respective keys.
- The heating unit was switched on, and the process was run for 6 minutes.
- Ammonia gas was distilled from the sample and captured in the boric acid receiver.
- After approximately 6 minutes, the receiver flask was removed upon completion of distillation.
- The ammonium borate in the receiver flask was titrated against 0.02 N H_2SO_4, and the volume of acid used was noted.
- The endpoint of titration was observed by a color change from bluish green to wine red.

Interpretation

Kg/ha	Kg/acre	Rating
Below 272	Below 110	Low
272-544	110-220	Medium
Above 544	Above 220	High

Determination of available Potassium in soil

Reagents: 1N Ammonium Acetate (NH_4OAc), pH 7.0**,** Standard Potassium Solution**,** Distilled Water

Apparatus: Weighing machine, Sample bottles, Shaker, Filter paper, Flame photometer.

Procedure:

- 5 g of sludge from each sample was weighed into a clean 100 mL shaking bottle.
- 25 mL of 1N ammonium acetate solution (pH 7.0) was added to the bottle.
- The mixture was shaken for 30 minutes using a mechanical shaker.
- The suspension was filtered through Whatman No. 42 filter paper.
- The clear filtrate was collected for potassium analysis.
- The filtrate was aspirated into a flame photometer, and the potassium reading was recorded.

Interpretation

Kg/acre	Kg/ha	Category
Below 55	Below 137	Low
55-135	137-337	Medium
Above 135	Above 337	High

Determination of Available Organic Carbon in soil

Reagents: 1N Potassium dichromate ($K_2Cr_2O_7$) solution**,** Concentrated sulfuric acid (H_2SO_4)**,** 0.5N Ferrous ammonium sulfate ($Fe(NH_4)^2(SO_4)^2$)**,** Diphenylamine indicator**,** Distilled water.

Apparatus: Weighing machine, 250ml conical flask, measuring cylinder, weighing machine and titration stand**.**

Procedure:

- 2 g of sludge from each sample was weighed into a 250 mL conical flask.
- 10 mL of 1N $K_2Cr_2O_7$ (potassium dichromate) solution was added to the sludge.
- 20 mL of concentrated H_2SO_4 (sulfuric acid) was added, and the flask was swirled gently for about 1 minute to mix thoroughly.
- The mixture was allowed to stand for 30 minutes to let oxidation take place.
- 0.5 g of NaF (sodium fluoride) was added to the flask.

- 100 mL of distilled water was then added to the mixture.
- 10 drops of diphenylamine indicator were added, and the solution turned violet.
- The mixture was titrated with 0.5N ferrous ammonium sulfate until the color changed from violet to bright green.

Interpretation

Organic Carbon (%)	Soil rating
Below 0.40	Low
0.40-0.75	Medium
Above 0.75	High

Determination of Available Phosphorus in Sludge Sample

Reagents: Sodium bicarbonate, H_2SO_4 (5%), Darco G-60, Molybdate reagent, Distilled water

Apparatus: Weighing machine, sample bottles, filter paper, 25 ml volumetric flask, Bulb pipette, UV-spectrophotometer.

Procedure:

- 1 g of sludge from each sample was weighed into a sample bottle.
- 1 g of Darco G-60 was added to each sample.
- 20 mL of 0.5 N $NaHCO_3$ (pH 8.5) was added to the sludge sample to extract available phosphorus.
- The mixture was shaken vigorously for 30 minutes on a mechanical shaker.
- The suspension was filtered through Whatman No. 42 filter paper into a clean sample bottle.
- 5 mL of the filtered extract was taken with a bulb pipette into a 25 mL volumetric flask.
- 0.5 mL of H_2SO_4 was added, followed by 10 mL of distilled water.
- 4 mL of freshly prepared indicator reagent was added, and the volume was made up to 25 mL.
- The volumetric flask was left undisturbed for 30 minutes for turbidity to develop.
- The blue color developed after 30 minutes was measured using a UV-Spectrophotometer at 660 millimicrons, after setting the instrument to zero with a blank prepared without standard or soil extract.

Interpretation

Kg/ha	Kg/acre	Category
Below 12.4	Below 5	Low
12.4-22.4	5-9	Medium
22.4-50	9-20	High
Above 50	Above 20	Very High

Determination of Available Micronutrients in sludge sample

Reagents: DTPA (Diethylenetriaminepentaacetic acid), Distilled water

Apparatus: Weighing machine, sample bottles, filter paper, mechanical shaker and Atomic Absorption Spectrophotometer (AAS).

Procedure:

- 15 g of air-dried, sieved sludge was weighed into a clean sample bottle.
- 30 mL of DTPA extracting solution was added to the sludge sample.
- The mixture was shaken on a mechanical shaker for 2 hours.
- The suspension was filtered through Whatman No. 42 filter paper.
- The clear filtrate was collected for further analysis.
- The filtrate was analyzed for Fe and Mn concentrations using an Atomic Absorption Spectrophotometer (AAS).

Interpretation

Micronutrient	Low	Medium	High
Iron (Fe)	<4.5 ppm	4.5 – 10 ppm	> 10 ppm
Manganese (Mn)	< 2.0 ppm	2 – 5 ppm	> 5 ppm

Table 5.1. Physicochemical analysis methods and mandate followed

S. No.	Parameter	Methods Followed	Mandate Followed
1.	pH	Determination through pH Meter	APHA, 2017
2.	Electrical Conductivity	Determination through Conductivity Meter	APHA, 2017
3.	Total Moisture Content	Gravimetric Analysis	APHA, 2017
4.	Total Nitrogen	Kjeldahl's Method	APHA, 2017
5.	Total Phosphorus	Vanado-Molybdo Phosphoric yellow colour method in nitric acid system	APHA, 2017
6.	Total Potassium	Determination through Flame Photometer	APHA, 2017

2. Heavy Metal Analysis

Heavy metals, including lead (Pb), cadmium (Cd), mercury (Hg), arsenic (As), zinc (Zn), copper (Cu), and nickel (Ni), of raw sludge were analyzed to ensure the safety of biosolids for agricultural applications. The analysis was conducted using the APHA method with Inductively Coupled Plasma-Mass Spectrometry (ICP-MS).

Reagents: Sludge sample, 0.005 M Diethylenetriaminepentaacetic acid (DTPA) solution

Apparatus: Orbital Shaker, Remi CIS-24 Plus

Procedure:

- 12.5 g of the sludge sample was weighed accurately.
- The sample was mixed thoroughly with 25 ml of DTPA reagent in a clean container.

- The mixture was placed on a shaker set at 89 rpm and was allowed to shake for 2 hours to ensure complete extraction.
- After shaking, the mixture was removed and immediately filtered through acid-washed and distilled water-washed Whatman No. 1 filter paper.
- The clear filtrate obtained was carefully collected in a clean container.
- The filtrate was then used for further metal analysis.

Interpretation

Metal	LOD (mg/kg)	FCO Limit (mg/kg)
Cadmium (Cd)	0.01	<5
Lead (Pb)	0.05	<100
Arsenic (As)	0.01	<10
Mercury (Hg)	0.005	<0.15
Zinc (Zn)	0.05	<1000
Copper (Cu)	0.05	<300
Nickel (Ni)	0.02	<50

3. **Microbial Analysis**

Microbial analysis of raw sludge was also performed to understand potential pathogenic risks, and its suitability for land application. To determine the level of fecal coliform and other *enterobacteriacae* species, MPN method and other selective media were used. The methods employed for microbial analysis of sludge samples are presented in Table 5.2.

Determination of Microbial Load in Sludge Samples through Aerobic Microbial Count

Reagents and media: Sludge sample, Sodium chloride (analytical grade), Distilled water (autoclaved), 70% ethanol, Plate Count Agar (PCA).

Apparatus: Analytical balance (±0.01 g precision), Orbital shaker (150 rpm),Autoclave (121°C, 15 psi), Laminar airflow cabinet, Bunsen burner or spirit lamp, Refrigerator (4 ± 2°C).

Procedure:

Preparation of Saline Diluent (0.85% NaCl)

1. Weigh 0.85 g of NaCl and dissolve in 100 mL of distilled water.
2. Transfer into a sterile conical flask, seal with a cotton plug, and cover with foil.
3. Autoclave at 121°C, 15 psi for 15 minutes.
4. Cool to room temperature and store at 4°C.

Preparation of Sludge Suspension (Mother Stock)

1. Weigh 10 g of sludge sample and add to 90 mL sterile saline in a 250 mL conical flask.

2. Seal with sterile cotton and foil.
3. Homogenize on an orbital shaker at 150 rpm for 2 hours.
4. Allow settling for 30 minutes at room temperature.
5. Label the supernatant as "Mother Stock" and store at 4°C.

Serial Dilution

1. Label four sterile test tubes from 10^{-1} to 10^{-4}.
2. Add 9 mL sterile saline to each tube.
3. Under laminar flow, transfer 1 mL of mother stock into the first tube (10^{-1}); mix well.
4. Sequentially transfer 1 mL from each dilution to the next tube, mixing thoroughly at each step.
5. Maintain all tubes under refrigeration or proceed directly to plating.

Plating

- From each selected dilution, 1 mL of the sample was transferred into a sterile Petri plate.
- About 15–20 mL of sterile molten Plate Count Agar (PCA) (cooled to about 45°C) was poured into each plate.
- The contents were gently swirled to mix the inoculum evenly with the medium.
- The plates were allowed to solidify at room temperature.
- The inoculated plates were incubated at 35–37°C for 48 hours in an inverted position.
- After incubation, colonies were counted using a colony counter or manually.
- Plates with 30–300 colonies were considered for calculation.
- The aerobic microbial count was expressed as CFU/g (colony-forming units per gram) of the sludge sample.

Determination of Most Probable Number (MPN) for Total Coliforms

Presumptive Test

The MPN technique is a statistical method used to estimate viable bacterial counts based on dilution-to-extinction principles. Tubes of selective growth media are inoculated with varying volumes of sample and incubated to observe gas and acid production from lactose fermentation, indicating coliform presence. Positive tubes are then compared against a standard probability table to obtain the MPN index per 100 mL.

Reagents: MacConkey Broth (Double and Single Strength)

Procedure

- Five test tubes containing double-strength MacConkey broth and ten test tubes containing single-strength MacConkey broth were prepared**.**
- A Durham tube was inserted into each test tube before sterilization to trap any gas produced during incubation.
- Each set of tubes was labeled for three sample volumes:
- Five tubes were labeled for 10 mL sample (double-strength)
- Five tubes were labeled for 1 mL sample (single-strength)

- Five tubes were labeled for 0.1 mL sample (single-strength)
- The sample was aseptically inoculated as follows:
- 10 mL of sample was added to 10 mL of double-strength broth
- 1 mL of sample was added to 10 mL of single-strength broth
- 0.1 mL of sample was added to 10 mL of single-strength broth
- All the tubes were incubated at 37 ± 1°C for 24 hours.
- If no gas or color change was observed, the incubation was extended up to 48 hours.
- After incubation, each tube was observed for gas in the Durham tube
- Color change (yellowing of broth) indicating a positive presumptive test
- The number of positive tubes at each dilution was recorded (e.g., 3-2-1 combination).
- The MPN value was determined using the standard MPN index table as per APHA or BIS IS:1622**,** and the result was reported as MPN per 100 mL of sample.

Confirmatory Test: Detection of *E. coli* and Coliform via EMB Count

Confirmatory test was done to confirm the presence of *Escherichia coli* and total coliform bacteria from presumptive positive MPN samples using selective enrichment and biochemical differentiation. Broth culture sample is streaked onto Eosin Methylene Blue (EMB) agar, which selectively differentiates lactose fermenters. Coliforms appear pink to red. *E. coli* exhibits characteristic green metallic sheen due to acid and dye precipitation.

Reagents: Brilliant Green Lactose Bile (BGLB) Broth – for confirmatory testing

Procedure:

- The external surface of the tubes were disinfected using 70% ethanol.
- The sample was mixed thoroughly by inverting or shaking.
- 100 µL of the positive MPN culture was transferred onto pre-poured, solidified EMB agar plates using a sterile pipette.
- The inoculum was spread evenly using a sterile spreader under aseptic conditions.
- The plates were incubated at 36 ± 2°C for 18–24 hours.
- Pink to red colonies were counted as presumptive coliforms.
- Colonies with dark blue to violet centers or metallic green sheen were recorded as presumptive *E. coli*.
- The MPN result was expressed as MPN/100 mL based on the 3-level tube combination (e.g., 3–2–1 = 17 MPN).
- **CFU Count**: Select plates with 30–300 colonies and calculate:

CFU/mL = Colony Count × Dilution Factor/Volume of sample (mL)

Table 5.2. Details of Microbial Analysis Methods

Experiment Name	Culture media Name	Composition of media	Company	Purpose of Using the Media	Cultural response (Incubation Temp. and Duration)	Expected outcome
Most Probable Number Test	MacConkey Broth	Gelatin peptone, Lactose monohydrate, Dehydrated bile, Bromo cresol purple	Himedia MH083	For the selective enrichment of total coliform and *E. coli*	30-35°C for 18-48 hours	Gas and Acid formation
Detection of *E. coli* and fecal Coliform	Eosin Methylene Blue (EMB) Agar	Peptone, Dipotassium hydrogen phosphate, Lactose, Saccharose (Sucrose), Eosin – Y-Methylene blue, Agar	Himedia-M317	For the isolation of Gram-negative enteric bacteria	35-37°C for 18-24 hours	Lactose-fermenting bacteria produce dark colonies with a metallic sheen, while non-lactose-fermenting bacteria produce colorless colonies
Aerobic Microbial count	Plate Count Agar	Tryptone, Yeast extract, Dextrose (Glucose), Agar	Himedia-M091A	For determining plate counts of microorganisms	35-37°C for 18-24 hours	Total number of live, aerobic bacteria in the sample

5.4 Implementation Plan for Sludge Treatment

5.4.1. Excess Moisture and Pathogen Removal

Solar Drying: Drying beds are used to remove moisture in the summer season. Solar drying uses solar radiation and natural airflow to evaporate water from sludge. It is energy-efficient and environmentally friendly. For the operation, Sun and wind dry the sludge; percolation helps remove water and drying time is required for approximately 15–30 days, depending on the weather.

Thermal Drying: High temperatures can destroy microbial proteins and nucleic acids. Here, the sludge was optimized at >600°C, and it is anticipated that all pathogens will be killed/ destroyed. In addition, sludge volume has been also reduces drastically. To validate this process, raw sludge sample was divided primarily and treated at different temperatures (300-600°C) (Table 5.3) and analyzed for the presence of bacteria. For confirmation, dry sludge samples were tested in various specific growth media of major pathogens like *Salmonella, Shigella, Vibrio,* and *Escherichia coli* under aseptic conditions (Refer to 5.3).

Table 5.3. Codes for raw sludge and sludge treated at different temperatures

Sample code	Description
A	Raw wet sludge
B	Sample A treated at 300°C
C	Sample A treated at 500°C
D	Sample A treated at 600°C

5.4.2. Heavy Metal and Organic Pollutant Elimination

The removal or stabilization of heavy metals from sludge is critical for environmental safety and regulatory compliance. To stabilize heavy metals, bioleaching was employed. Where specific microorganisms (e.g., *Thiobacillus ferrooxidans*, *Aspergillus niger*) are utilized to oxidize, solubilize, or bioaccumulate heavy metals from the sludge. This eco-friendly approach is especially effective at treating metals present in low concentrations.

Procedure:

- Inoculate sludge with selected microbial cultures *Thiobacillus ferrooxidans, Aspergillus niger* in suitable bioreactors (5–20% (v/v) of the total sludge volume, with a cell density of ~10^6 to 10^8 CFU/mL
- Maintain conditions ideal for microbial growth (e.g., 28–30°C, pH 2.5–3.5 for acidophilic bacteria).
- Stir periodically and incubate for 5–10 days depending on sludge type and metal load.
- Monitor metal solubilization through regular sampling and analysis.

5.5 Nutrient Enrichment

The dried and treated sludge powder serves as a critical raw material in the production of organic fertilizers at dedicated granulation plants (two facilities, each with a capacity of 200 MT/day). The production process involves the following key steps:

Nutrient Analysis:

- A comprehensive nutrient analysis is performed on the treated dried sludge powder to determine its essential composition. Typical values include:
- Total Organic Carbon: ≥14%
- Total Nitrogen: 0.2–0.8%
- Total Phosphorus: 0.2–1.0%
- Total Potash: 0.4–0.7%
- pH: ≥7

Formulation: Based on the nutrient profile, the sludge powder is meticulously blended with other raw materials to formulate a fertilizer that meets specific agricultural requirements, in full compliance with FCO 1985 standards.

Nutrient Enrichment: To enhance the nutrient profile of sludge, specific organic and mineral amendments are added. Neem cake is added to increase the nitrogen (N) content; it not only enriches nitrogen levels but also acts as a natural pesticide and improves soil health. For enhancing phosphorus (P), rock phosphate is added. To boost potassium (K) levels, fly ash from sugarcane is added, providing an economical and sustainable source of potash.

Palletisation: The homogeneous blend is converted into granules or pellets, ensuring ease of application and uniform nutrient distribution for farmers.

5.6 Development of Value Added Products

1. Jaivik - PROM



Phosphate Rich Organic Manure (PROM) is an advanced organic phosphate-based fertilizer formulated through the controlled composting of dry sludge (34%), rock phosphate, press mud, poultry manure, neem cake, amino acids, and bentonite using a thermal treatment process. Engineered as a granulated fertilizer in compliance with FCO specifications, it ensures an optimal balance of essential nutrients. Its composition includes:

- Total Organic Carbon: ≥8–10%
- Total Nitrogen: ≥0.5–1%
- Total Phosphorus: ≥8–9%
- Carbon-to-Nitrogen (C:N) Ratio: <20
- pH: up to 8
- Bulk Density: ≤1.6 g/cm³

Post-granulation, the fertilizer is further enhanced with a coating of phosphate-solubilizing bacteria at a concentration of 1×10^9 CFU/ml, which augments its phosphorus bioavailability. Patanjali Jaivik PROM is a highly efficient nutrient source, significantly contributing to soil fertility and sustainable organic farming practices.



2. Jaivik Khad

Jaivik Khad is a premium organic manure produced through an entirely organic process, utilizing a carefully screened blend of dry sludge (68%), rock phosphate, press mud, poultry manure, and biodegradable residues from medicinal plants, flowers, vegetables, and cattle dung. The production process is further enhanced by beneficial microbial consortia—such as *Azotobacter* spp., phosphate-solubilizing bacteria (PSB), potassium-mobilizing bacteria

(KMB), and *Pseudomonas* spp.—to promote nutrient bioavailability and soil enrichment.

Key attributes of the final product include:

- Total Organic Carbon: 14–16%
- Total Nitrogen: 0.5–1%
- Total Phosphorus: 1–2%
- Total Potash: 0.5–1.5%
- C:N Ratio: <20
- pH: ≤8.5
- Bulk Density: <1 g/cm³
- Total NPK: <3%

Engineered for superior soil conditioning and nutrient replenishment, Patanjali Jaivik Khad serves as an effective, eco-friendly alternative for sustainable agriculture, promoting enhanced microbial activity, improved soil structure, and long-term fertility.

3. Jaivik Poshak

Jaivik Poshak is an advanced mycorrhiza-based granular biofertilizer formulated to enhance soil fertility and plant nutrient uptake. It is enriched with a balanced composition of essential micronutrients and macronutrients, meticulously processed through a controlled heating method. The formulation comprises:



- Dry sludge (50%)
- Humic acid
- Amino acids
- Sea grass
- Natural minerals
- Biodegradable herbal and medicinal residues

A key feature of this biofertilizer is the incorporation of mycorrhizal fungi, which are synergistically blended with the nutrient-rich sludge to promote superior root colonization and enhanced phosphorus solubilization. The final product is optimized to maintain a minimum spore count of 46, with a pH not exceeding 7.5, ensuring optimal microbial viability and soil compatibility. Designed for sustainable agriculture, Patanjali Jaivik Poshak significantly improves nutrient absorption, enhances soil structure, and supports plant resilience against abiotic stress, making it an essential component for organic and regenerative farming systems.

4. Natural PORI Potash

Natural PORI Potash is an eco-friendly; value-added potassium (K_2O) fertilizer developed through green chemistry principles.

It is formulated using:

- Potash derived from molasses,
- Fly ash,
- Bentonite, and
- 5% dry sludge.



The potassium content is readily available in its free form, ensuring efficient uptake by plants. This specialized fertilizer plays a crucial role in enhancing chlorophyll synthesis, promoting robust plant growth, and improving overall soil fertility. Following the granulation process, the product is further enriched with a coating of potassium-solubilizing bacteria (KMB) to enhance potassium bioavailability.

The final product is optimized with a minimum moisture content of 5% and a total potash concentration ranging from 14.5% to 16.2%, ensuring consistent nutrient delivery for sustainable agricultural applications.

5. Dharti Ka Chowkidar (DKC)

Patanjali Dharti Ka Chowkidar is a scientifically formulated granular biofertilizer developed using PROM Technology. It incorporates a nutrient-rich blend of dry sludge (24%), natural micronutrients, rock phosphate, press mud, poultry manure, and medicinal herbs through a controlled heating process.

Following granulation, the product is coated with:

- Neem oil (1500 ppm)
- *Trichoderma* spp. (2×10^6 CFU minimum)
- *Pseudomonas fluorescens* (2×10^8 CFU minimum)

This coating enhances the fertilizer's biocontrol and soil-conditioning properties. The final product delivers a balanced nutrient composition, including:

- Total Organic Carbon: ≥10%
- Total Nitrogen: ≥1%
- Total Phosphorus: 8–9%
- C:N Ratio: <20
- pH: up to 8
- Bulk Density: <1.6 g/cm³

Engineered to enhance soil fertility, promote plant growth and yield, and minimize reliance on chemical fertilizers and pesticides, Dharti Ka Chowkidar offers an advanced solution for both organic and conventional farming, ensuring sustainable and eco-friendly agricultural practices.



5.7 Packaging and Distribution

The final products are packaged in compliance with FCO 1985, Government of India regulations. They are then efficiently distributed to farmers, agricultural cooperatives, and government institutions to maximize accessibility and impact.

5.8 Quality Control and Compliance

Testing Parameters: The physical and chemical parameters, including the presence of heavy metals, were tested in accordance with the standards prescribed under the Fertilizer Control Order (FCO), 1985 and verified in compliance with the limits specified under Schedule II of the Environment (Protection) Act (EPA) and Schedule IV of the FCO (Refer to 5.3).

Labelling: The packaging and labelling of the final product strictly adhere to the labelling guidelines outlined in the Fertilizer Control Order (FCO)**.** Each package is appropriately labelled with mandatory information including the product name, nutrient content (N-P-K), net weight, batch number, date of manufacture, expiry date, and the name and address of the manufacturer. Additionally, precautionary statements, usage instructions, and certification marks (if applicable) are clearly displayed to ensure transparency and proper usage by end-users.

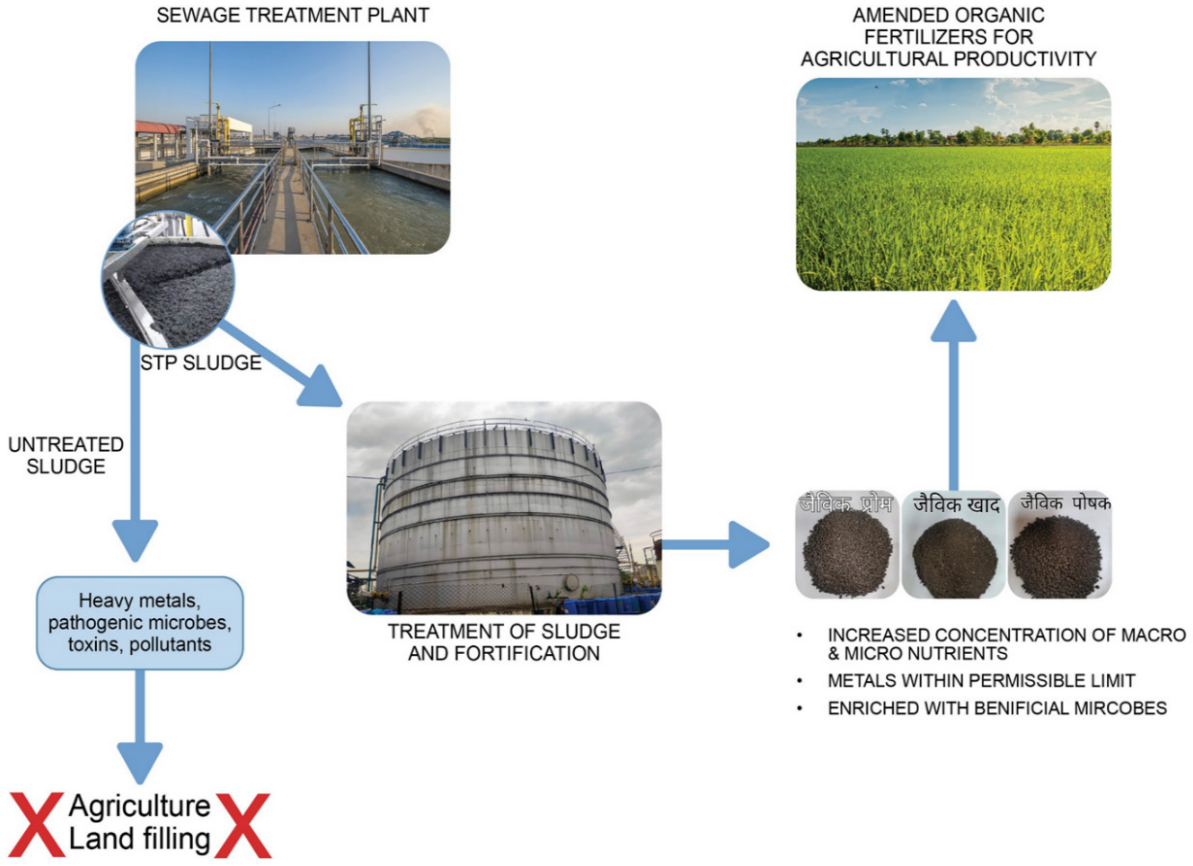


Figure 5.2. Sludge Treatment Plan

5.9 Understanding Raw Sludge Parameters

5.9.1. Physicochemical Parameters

The raw sludge sample exhibits several distinctive physico-chemical properties. The pH of the sludge was measured at 5.6, which is well below the FCO safety guideline of 7.5, indicating that the sample is acidic in nature. The electrical conductivity (EC) was recorded at 11.35 mS/cm, significantly exceeding the permissible limit of 4 mS/cm. This suggests a high concentration of soluble salts and potential salinity issues. The organic carbon content was measured at 14%, aligning precisely with the FCO safety requirement, indicating a substantial presence of organic matter. However, the nitrogen concentration was found to be exceptionally high at 25.55%, far exceeding the recommended limit of 0.5%. Such elevated nitrogen levels may suggest contamination or enrichment from sewage or industrial effluents. Similarly, the concentrations of potassium and phosphorus were also notably high, recorded at 3.9% and 1.6% respectively. Both values surpass the FCO benchmark of 0.5%, indicating excessive nutrient loading beyond typical agronomic requirements. Finally, the moisture content of the raw sludge was determined to be 66%, which is considerably higher than the FCO safety guideline of 25%. Table 5.4 and Figure 5.3 presents the physicochemical parameters of collected raw sludge.

Table 5.4. Physiochemical parameters of raw sludge

Physico-chemical parameters	Raw	FCO safety value
pH	5.6	7.5
EC (mS/cm)	11.35	4
Organic Carbon (%)	14	14
Nitrogen (%)	25.55	0.5
Phosphorus (%)	1.6	0.5
Potassium (%)	3.9	0.5
Moisture content (%)	66	25

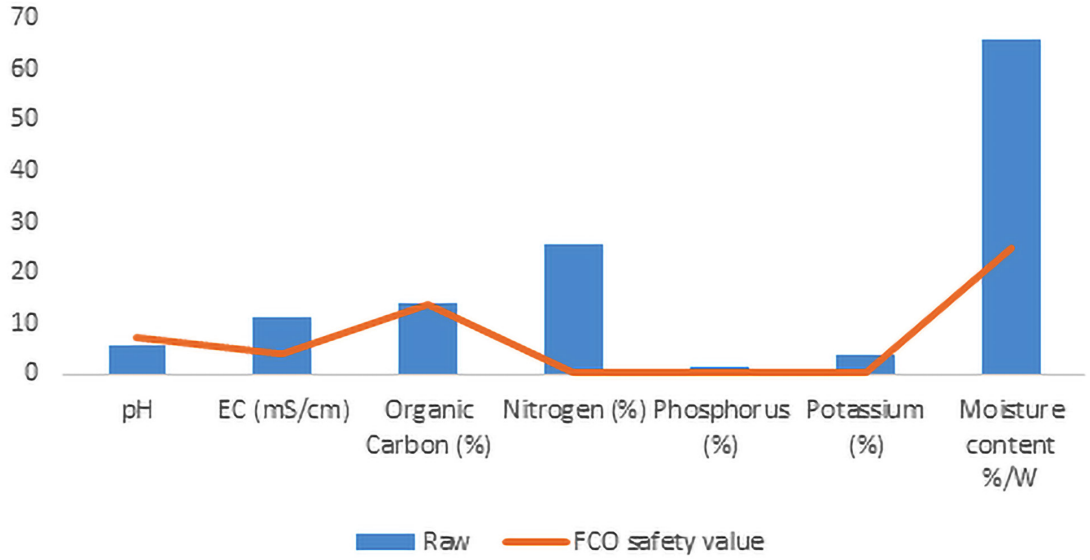


Figure 5.3. Physicochemical analysis of raw sludge

5.9.2. Heavy Metal Concentration

The heavy metal analysis of the raw sludge revealed that the concentrations of certain elements exceeded the permissible safety limits prescribed under the Fertilizer Control Order (FCO). Specifically, the concentrations of chromium (Cr) and cadmium (Cd) were found to be 77.8 mg/kg and 6.34 mg/kg, respectively, surpassing their respective FCO limits of 50 mg/kg and 5 mg/kg. Furthermore, the concentration of zinc (Zn) was notably high at 2134.42 mg/kg, more than twice the permissible limit of 1000 mg/kg.

In contrast, the concentrations of other heavy metals, including copper (Cu) at 206.67 mg/kg, nickel (Ni) at 17.46 mg/kg, mercury (Hg) at 0.06 mg/kg, lead (Pb) at 23.44 mg/kg, and arsenic (As) at 7.51 mg/kg, were all within the recommended FCO safety limits (refer to Table 5.5 and Figure 5.4).

Table 5.5. Concentration of heavy metals in raw sludge

Heavy metal parameters	Raw Sludge (mg/kg)	FCO safety limit (mg/kg)
Cd	6.34	5
Cr	77.8	50
Cu	206.67	300
Hg	0.06	0.15
Ni	17.46	50
Pb	23.44	100
Zn	2134.42	1000
As	7.51	10

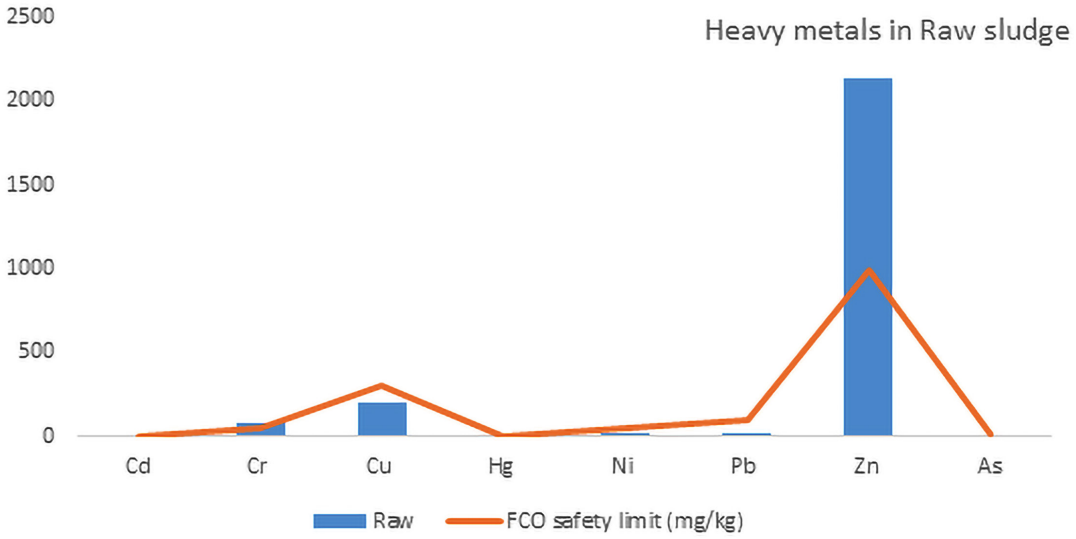


Figure 5.4. Heavy Metals presence in raw sludge

5.9.3. Microbial Analysis

A high microbiological load in the raw wet sludge (Sample A) suggested serious hygienic issues. With a Most Probable Number (MPN) of 11,000/ 100 mL, there was a significant amount of coliform bacteria present. The total bacterial count (TBC) was 7.6 $\log_{10}$ CFU/mL, but the fecal coliform count was 8.1 $\log_{10}$ CFU/mL (Table 5.6).

Table 5.6. Microbial Count of Raw Sludge

Sample code	MPN/ 100mL	Fecal count (CFU/ mL Log 10)	TBC (CFU/ mL Log 10)
A	11000	8.1	7.6

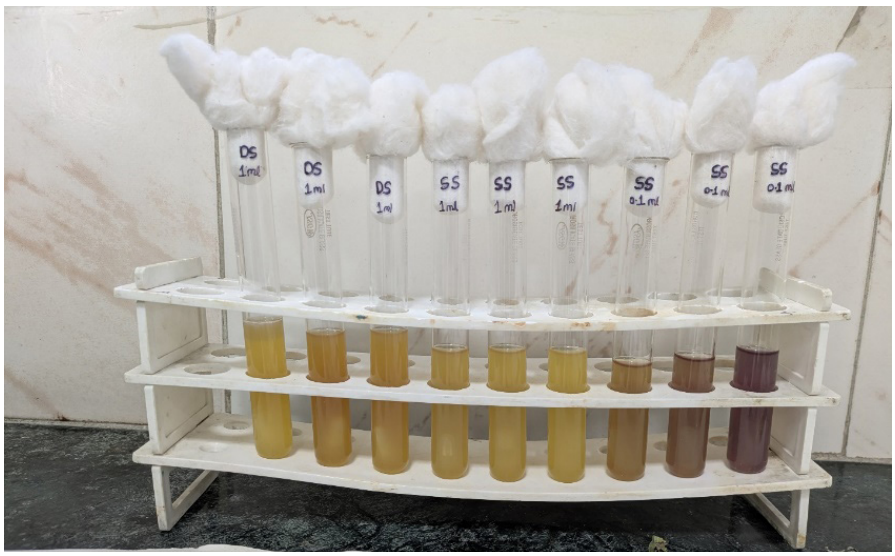


Figure 5.5. Tubes showing the MPN load of raw sludge

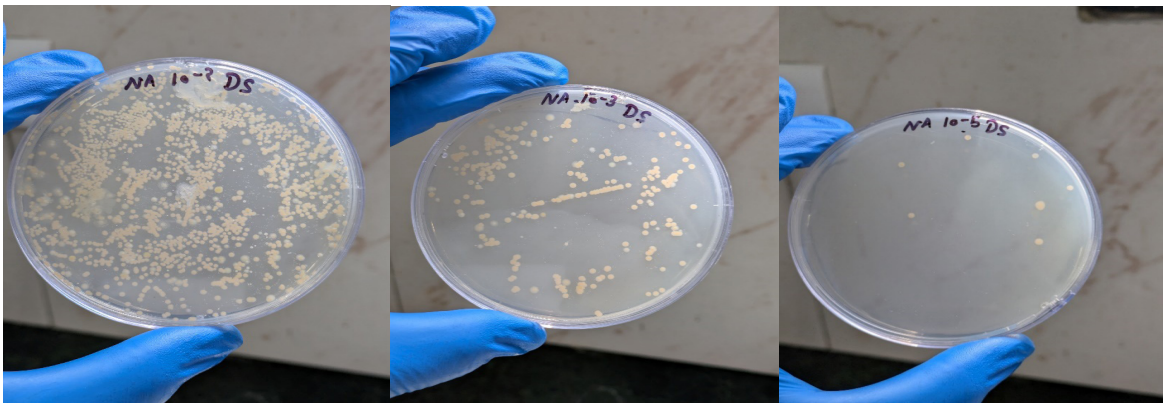


Figure 5.6. Plates showing the CFU count of raw sludge

5.10 Analysing Treated Sludge Parameters

5.10.1. Physicochemical Parameters

When compared to the raw sludge, the physico-chemical characteristics of the treated sludge showed significant improvement, with most parameters aligning closely with the safety standards prescribed by the Fertilizer Control Order (FCO). The electrical conductivity (EC) was notably reduced to 1.46 mS/cm, well below the permissible limit of 4 mS/cm, indicating a substantial decrease in salinity. Additionally, the pH increased to 6.38, approaching neutrality and nearing the allowable value of 7.5.

The moisture content dropped to 15.7%, significantly lower than the FCO limit of 25%, suggesting improved handling properties. The organic carbon content was measured at 12%, slightly below the recommended 14%, yet still indicative of a good presence of organic matter. The concentrations of phosphorus and nitrogen were recorded at 0.9% and 3%, respectively, both exceeding the minimum requirement of 0.5%, reflecting enhanced nutrient value. However, the potassium content was measured at 0.21%, slightly below the desired benchmark of 0.5%. Table 5.7 and Figure 5.7 represent the parameters of treated sludge.

Table 5.7. Physicochemical Parameters of Treated Sludge

Physico-chemical parameters	Treated Sludge	FCO safety value
pH	**6.38**	7.5
EC (mS/cm)	1.46	4
Organic Carbon (%)	12	14
Nitrogen (%)	**3**	0.5
Phosphorus (%)	**0.9**	0.5
Potassium (%)	0.21	0.5
Moisture content %/W	15.7	25

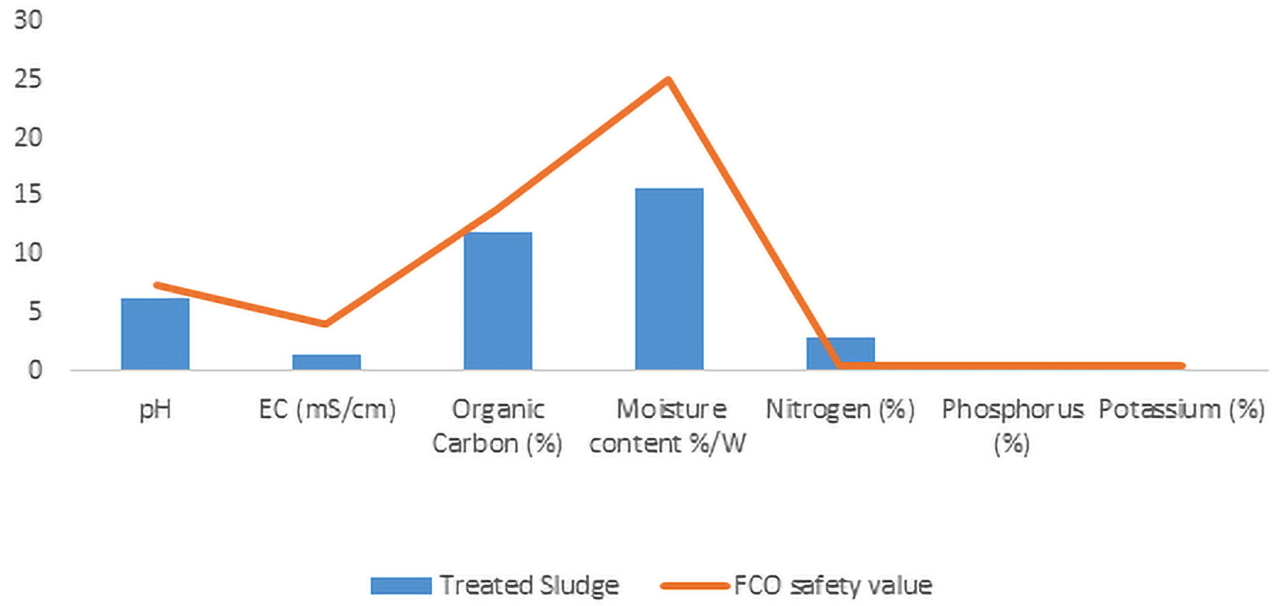


Figure. 5.7. Physicochemical parameters of Treated sludge

5.10.2. Heavy Metals Analysis

All of the examined heavy metal concentrations were considerably lower in the treated sludge, with values falling well below the Fertilizer Control Order's (FCO) permissible limits. All three elements were brought well below their respective thresholds: copper (Cu) to 55.73 mg/kg, chromium (Cr) to 23.1 mg/kg, and cadmium (Cd) to 0.65 mg/kg. While lead (Pb) and nickel (Ni) were identified at 8.28 mg/kg and 19.73 mg/kg, respectively—well below the limits of 50 mg/kg and 100 mg/kg—mercury (Hg) was determined to be absolutely absent (0 mg/kg). Arsenic (As) was found at just 0.15 mg/kg, compared to the limit of 10 mg/kg, while zinc (Zn) was decreased to 120.9 mg/kg, well below the maximum permitted 1000 mg/kg.

Table 5.8. Heavy Metal parameters of treated sludge

Heavy metal parameters	Treated sludge (mg/kg)	FCO safety limit (mg/kg)
Cd	0.65	5
Cr	23.1	50
Cu	55.73	300
Hg	0	0.15
Ni	8.28	50
Pb	19.73	100
Zn	120.9	1000
As	0.15	10

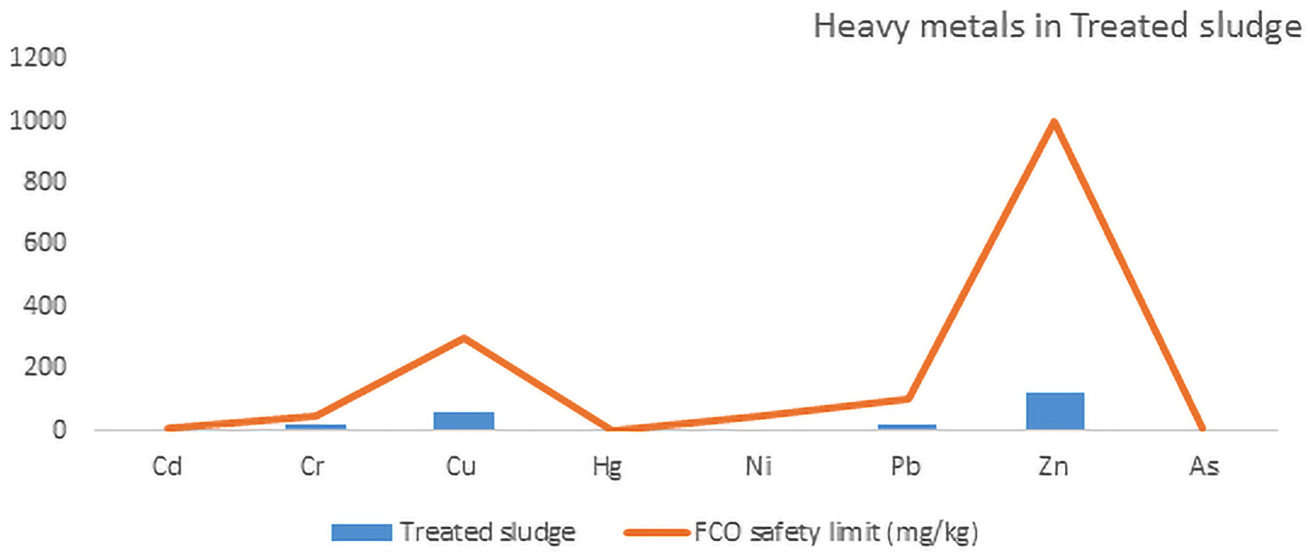


Figure. 5.8. Graph showing variations in heavy metals of treated sludge

5.10.3. Microbial Analysis

Microbial growth was greatly decreased by thermally treated raw sludge at increasingly higher temperatures. To validate the process, the raw sludge was divided into three parts and treated at different temperatures viz - 300, 500 and 600^0 C. The microbial load stayed comparatively high at 300°C, with only a modest decrease in the total bacterial count and no decrease in MPN. Both the coliform and total bacterial populations significantly decreased after treatment at 500°C. Effective sanitization was demonstrated by the complete removal of MPN at 600°C and the low levels of total and fecal bacteria. Therefore, for all the analyses regarding treated sludge, sample D has been taken. Table 5.9 displays the microbiological findings for the treated sludge samples.

Table 5.9. Microbial Load of Treated Sludge Samples

Sample Code	Treatment Temperature	MPN (/100 mL)	Fecal Count (log_{10} CFU/mL)	TBC (log_{10} CFU/mL)
B	300°C	11,000	9.34	5.2
C	500°C	4,600	5.23	3.7
D	600°C	0	1.1	1.5

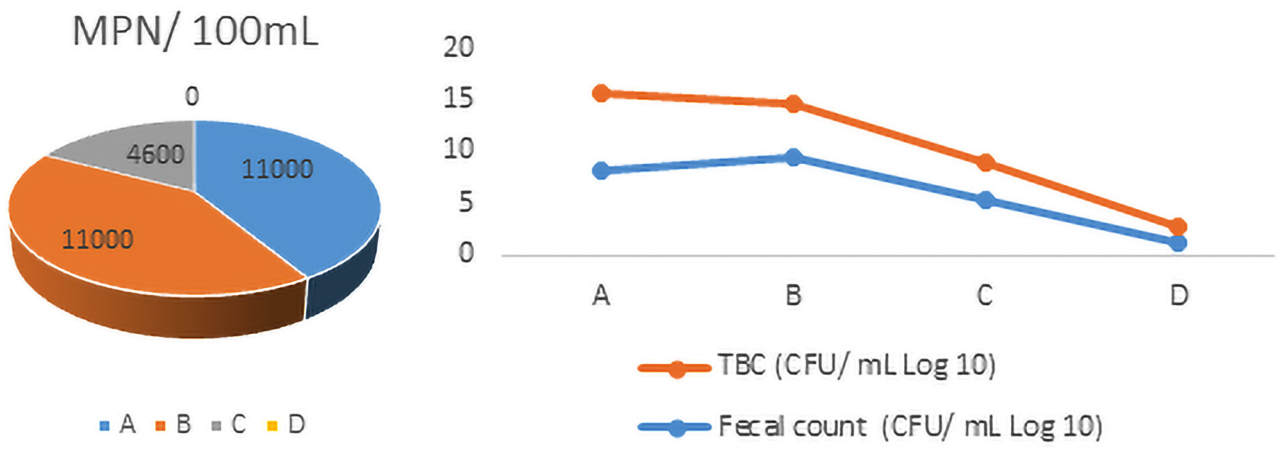


Figure 5.9. Comparison of MPN and bacterial count of Raw and treated sludge at different temperature.



Figure 5.10. MPN results of treated sludge sample.

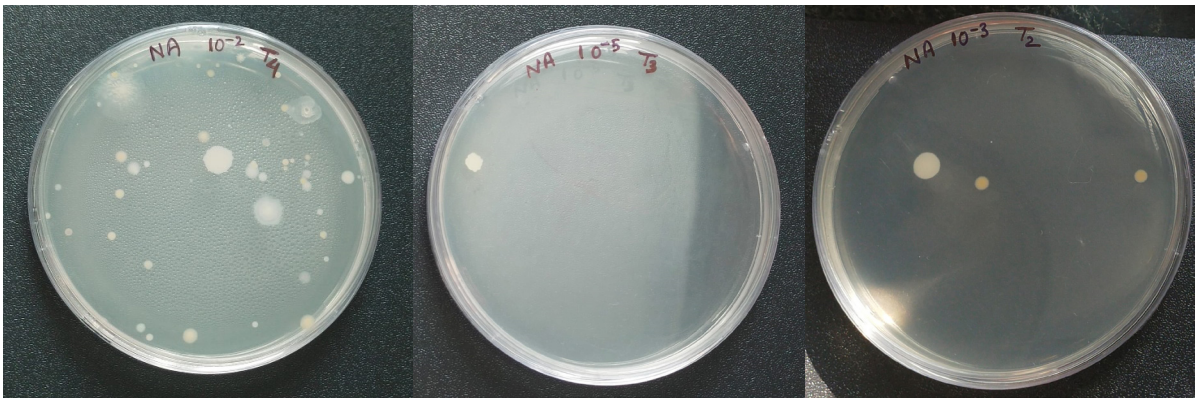


Figure 5.11. CFU count of treated sludge.

5.11 Quality Compliance of Value-added Products

5.11.1. Physicochemical Parameters

The majority of parameters in the physico-chemical analysis of the organic manure products such as Jaivik Prom, Jaivik Khad, DKC, Poshak, and PDM, which are prepared with treated sludge fulfilled the requirements of the Fertilizer Control Order (FCO) for organic manures. Although all of the products were within or around the permitted range of 7.5, the pH values of the products ranged from 6.67 to 8.5, with Poshak being the most acidic (6.67) and Jaivik Khad having the highest alkalinity (8.5) due to the variation in compostion. Low saline levels were indicated by the electrical conductivity (EC) of all products, which was significantly below the 4 mS/cm safety limit.

The highest levels of organic carbon content, a crucial measure of soil fertility potential, were found in PDM (16.77%) and Jaivik Khad (15.09%), both of which were above the 14% minimum needed. The nitrogen concentration of each product varied; DKC (0.01%) was much below the FCO requirement of 0.5%, whereas Poshak (2.04%) and PDM (1.24%) displayed noticeably higher amounts.

With the exception of DKC, which had a somewhat lower potassium value (0.4%), the phosphorus and potassium concentrations of other products were typically above the necessary 0.5% level. All varieties of manure had moisture contents that ranged from 16.39% (Jaivik Prom) to 23.65% (PDM), staying well within the allowed 25%.

Table 5.10. Physicochemical and heavy metal parameters of value added products

Physico-Chemical Parameters	Safety Values in Organic manure according to FCO	Jaivik prom	Jaivik Khad	DKC	Poshak	PDM
pH	7.5	8	8.5	8	6.67	7.4
EC (mS/cm)	4	1.32	1.07	1.05	1.22	1.65
Organic Carbon (%)	14	10.01	15.09	12	13.16	16.77
Nitrogen (%)	0.5	0.5	1.01	0.01	2.04	1.24
Phosphorus (%)	0.5	0.73	0.41	0.68	0.65	0.64
Potassium (%)	0.5	2.15	1.87	0.4	1.35	2.34
Moisture content %	25	16.39	21.05	16.45	20.07	23.65

Physico-Chemical Parameters	Safety Values in Organic manure according to FCO	Jaivik prom	Jaivik Khad	DKC	Poshak	PDM
Heavy metal parameters						
Cd	5	0.51	0.53	0.26	0.31	0.13
Cr	50	16.31	17.52	6.44	6.84	7.84
As	10	0.13	0.1	0.12	0.12	0.13
Hg	0.15	0	0	0	0	0
Ni	50	7.23	8.01	7.26	6.08	7.09
Pb	100	11.81	19.41	7.08	8.03	5.17
Cu	300	39.87	64.61	16.61	21.83	22.78
Zn	1000	89.2	187.02	83.95	129.88	122.71
Micro-nutrients						
Fe		2186.3	2509.9	2137.6	2525.99	2091.7
Mn		335.1	559.8	298.3	330.9	368.9

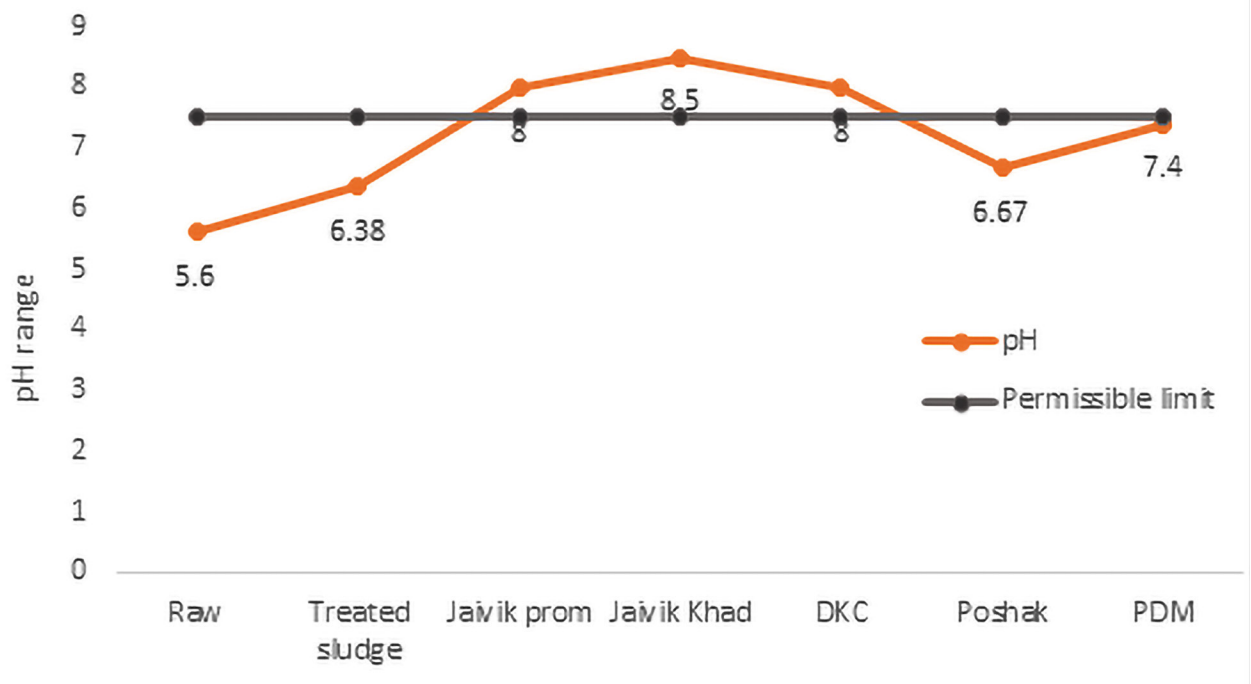


Figure 5.12. pH values of final products

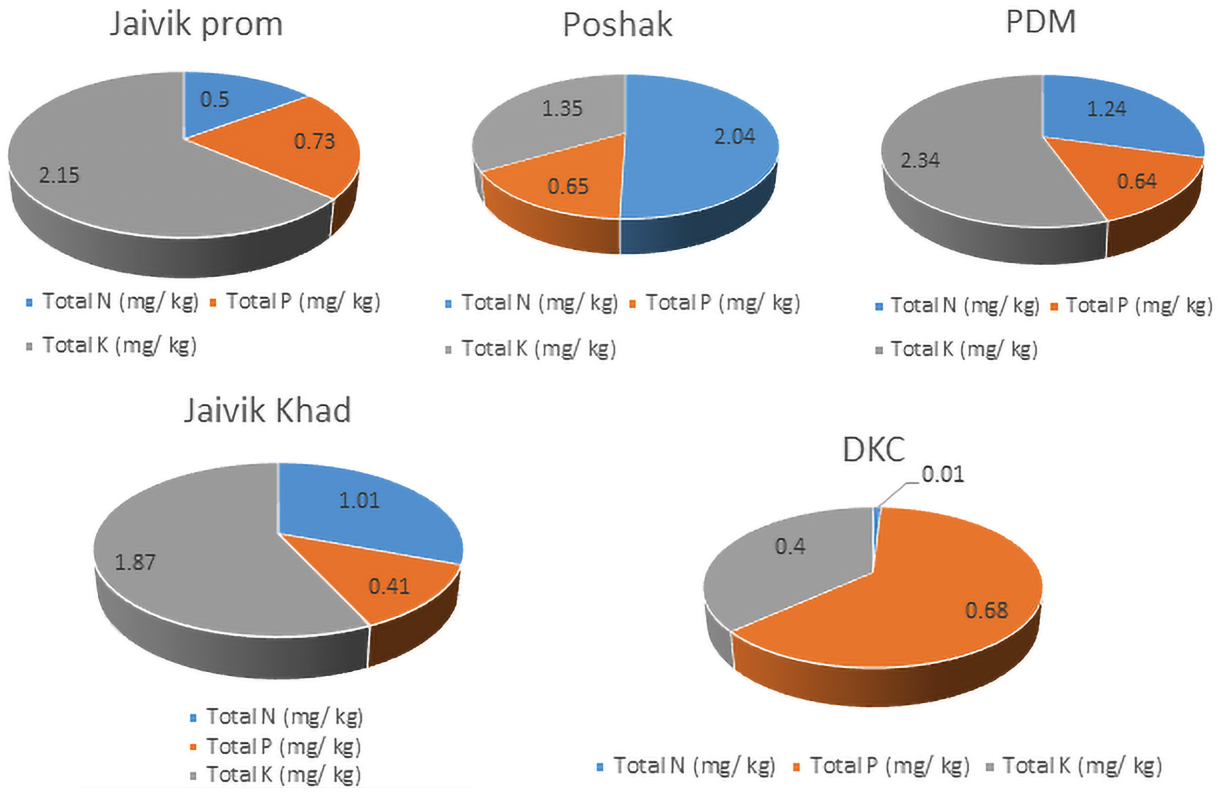


Figure 5.13. Total NPK of all value-added products (A) Jaivik PROM (B) Poshak (C) PDM (D) Jaivik Khad (E) DKC

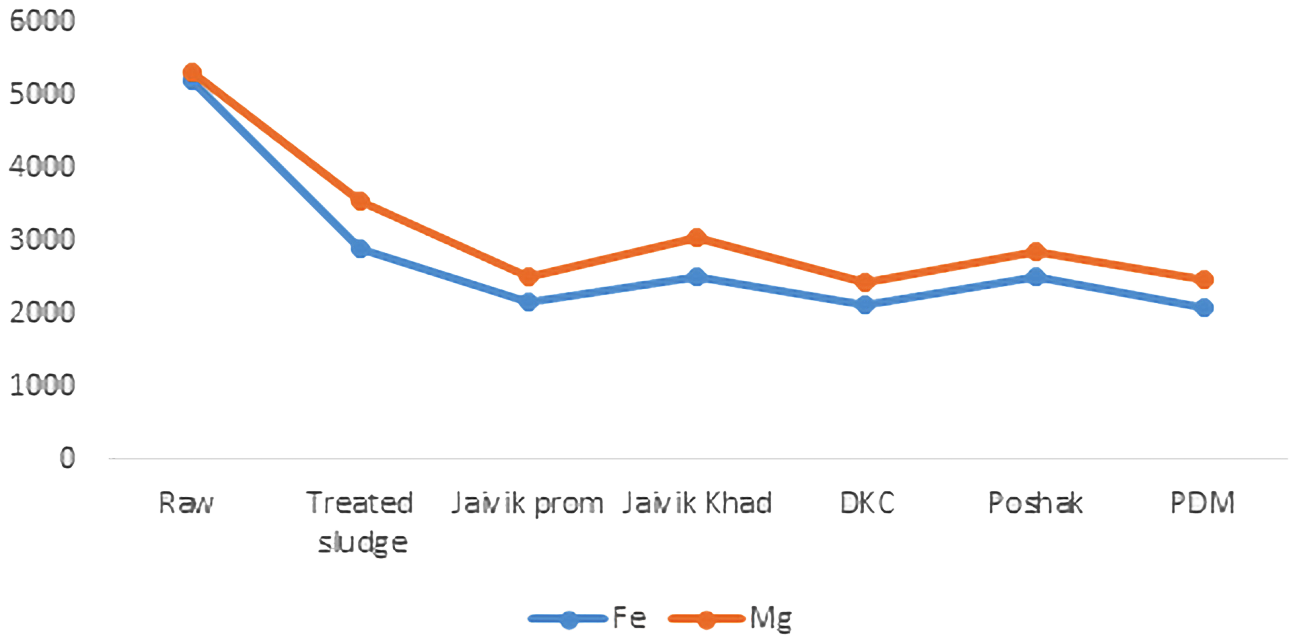
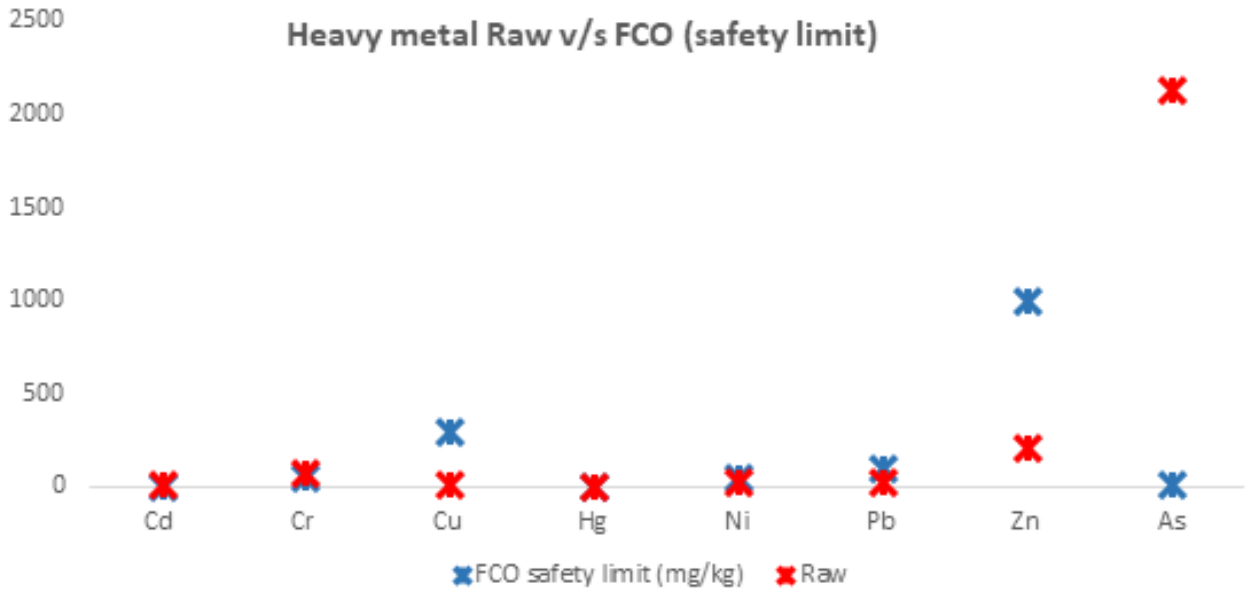


Figure 5.14. Micro-nutrients in products

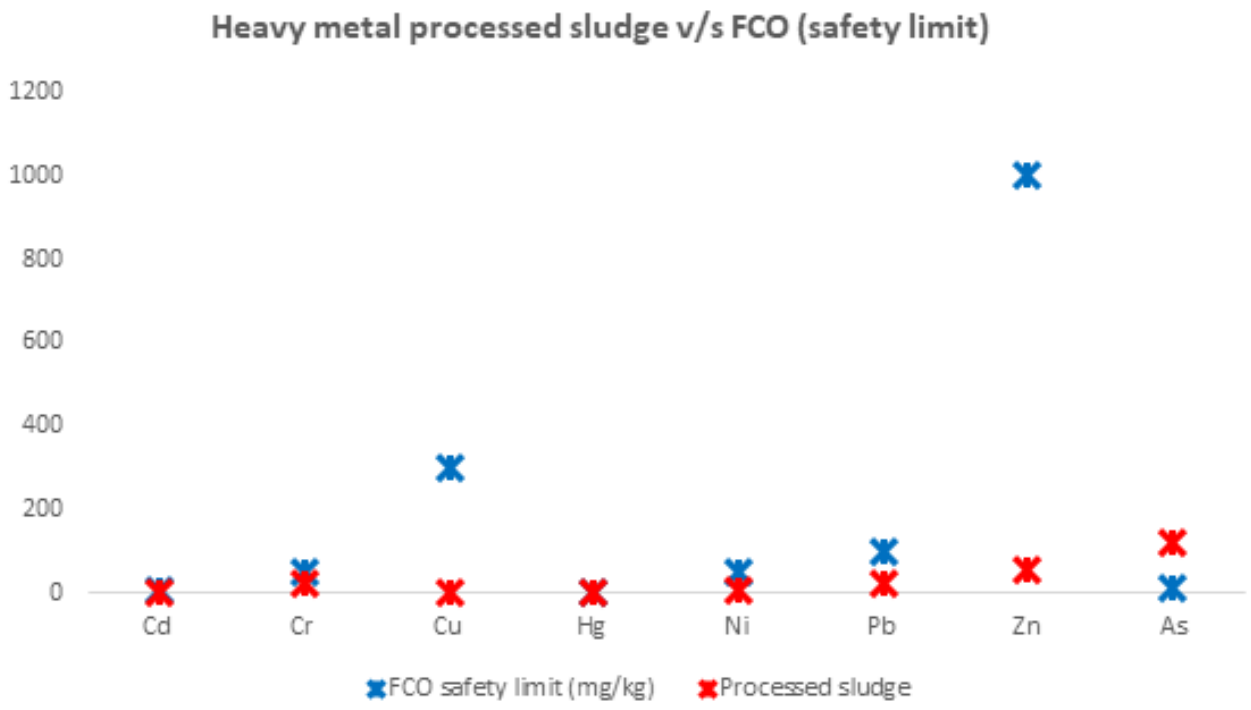
5.11.2. Heavy Metal Analysis

When compared to raw sludge, the quantities of heavy metals in all processed sludge-based products were considerably lower, demonstrating how well formulation and heat treatment may mitigate metal contamination. All products were far below the FCO safety standard of 5 mg/kg for cadmium (Cd), which dropped from 6.34 mg/kg in raw sludge to as low as 0.13 mg/kg in PDM. Additionally, there was a significant decrease in chromium (Cr), which ranged from 77.8 mg/kg in raw sludge to 6.44–23.1 mg/kg in all products, with DKC showing the lowest Cr level. Initially present at 7.51 mg/kg in raw sludge, arsenic (As) was lowered to ≤0.13 mg/kg in all manure products. In every treated sample, mercury (Hg) was totally removed (0 mg/kg). In raw sludge, nickel (Ni) decreased from 17.46 mg/kg to levels between 6.08 to 8.28 mg/kg, which were once more within acceptable bounds.

The amount of lead (Pb) decreased from 23.44 mg/kg in raw sludge to at least 5.17 mg/kg in PDM, and all formulations stayed below the 100 mg/kg FCO maximum. Copper (Cu) also experienced a dramatic drop, going from 206.67 mg/kg to values between 16.61 mg/kg (DKC) to 64.61 mg/kg (Jaivik Khad). All manure products had a considerable decrease in zinc (Zn), which was initially quite high at 2134.42 mg/kg. Levels ranged from 83.95 mg/kg to 187.02 mg/kg, which is again considerably below the FCO safety standard of 1000 mg/kg. Figure 5.15 (A & B) and 6.16 show the amount of heavy metal in raw, treated and processed value added fertilizers.



(A)



(B)

Figure 5.15. (A & B). Heavy metal levels in raw and treated sludge in relation to FCO permissible limits

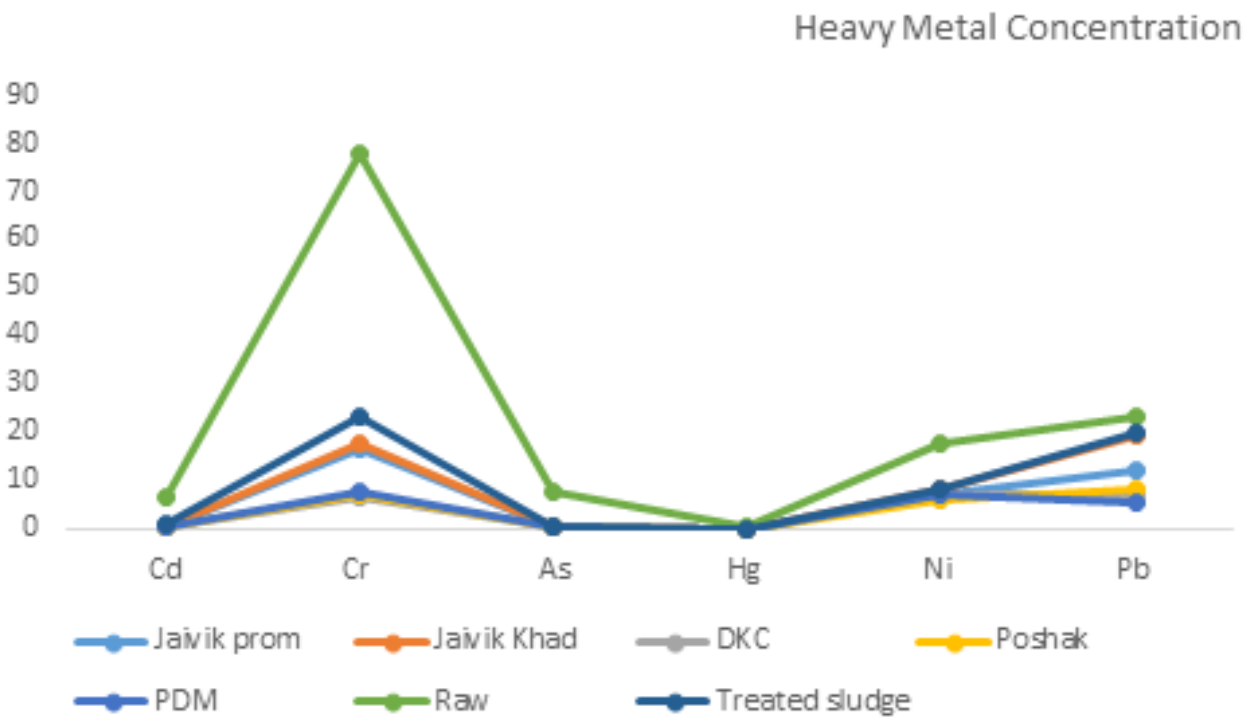


Figure 5.16. Comparison of heavy metal levels across raw sludge, treated sludge, and value-added products

5.11.3. Determination of Microbiological parameters

To assess the sanitation status of the raw sludge, thermally treated sludge, and the final manure products, a comprehensive microbiological evaluation was conducted. The raw sludge (Sample A) exhibited the highest level of contamination, with a fecal coliform count of 8.1 log_{10} CFU/mL, a total bacterial count (TBC) of 7.6 log_{10} CFU/mL, and an MPN of 11,000 per 100 mL. These results indicate a substantial pathogenic load. Following thermal treatment, a progressive reduction in bacterial presence was observed. At 300°C (Sample B), the total bacterial count decreased to 5.2 log_{10} CFU/mL. However, fecal coliform levels remained high at 9.34 log_{10} CFU/mL, and the MPN remained unchanged at 11,000 per 100 mL. Further treatment at 500°C (Sample C) led to a decrease in MPN to 4,600 per 100 mL, with fecal coliforms and total bacterial counts reducing to 5.23 and 3.7 log_{10} CFU/mL, respectively. Complete microbial deactivation was achieved at 600°C (Sample D), as evidenced by an MPN of 0, a fecal coliform count of 1.1 log_{10} CFU/mL, and a TBC of 1.5 log_{10} CFU/mL. This confirmed the successful eradication of coliform bacteria.

Additionally, all organic manure products (Jaivik Prom, Jaivik Khad, DKC, Poshak, and PDM) exhibited zero MPN and zero fecal coliforms, confirming the absence of harmful coliform bacteria. However, total bacterial counts varied among these products. Poshak recorded the highest TBC at 7.37 log_{10} CFU/mL, while PDM had the lowest at 1.70 log_{10} CFU/mL. These variations suggest the presence of potentially beneficial, non-pathogenic microbial communities typical of organic soil amendments.

Table 5.11. Microbiological parameters of products made from treated sludge

Sample code	MPN/100mL	Fecal count (Log_{10} CFU/mL)	TBC (Log_{10} CFU/mL)
A	11000	8.1	7.6
B	11000	9.34	5.2
C	4600	5.23	3.7
D	0	1.1	1.5
Jaivik prom	0	0	5.72
Jaivik Khad	0	0	6.45
DKC	0	0	5.69
Poshak	0	0	7.37
PDM	0	0	1.70

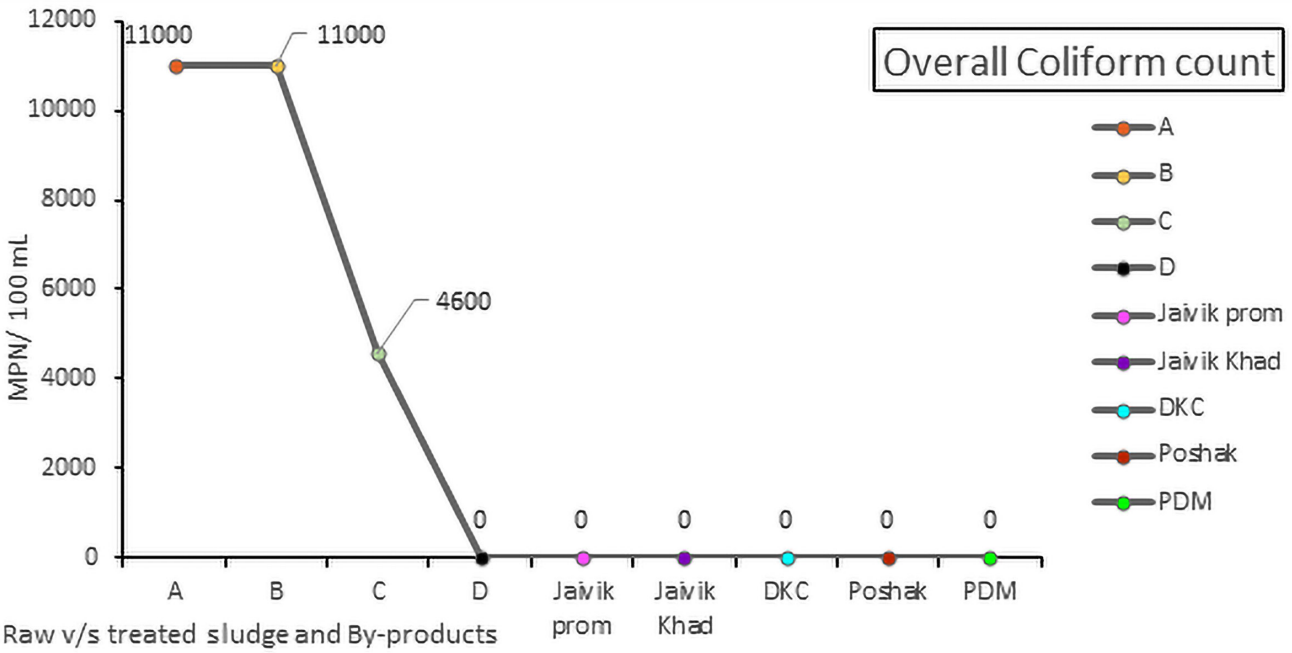


Figure 5.17. Graphical representation showing drastic reduction in MPN of coliform from raw sludge to value added products.

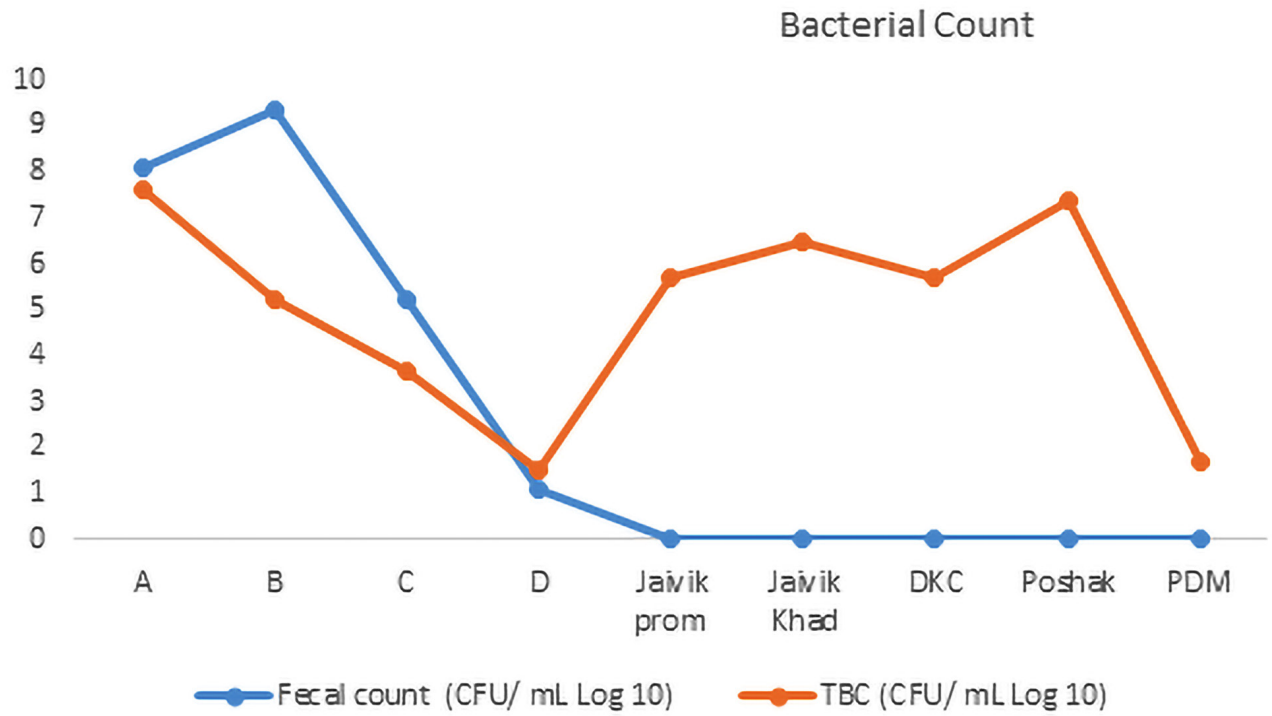
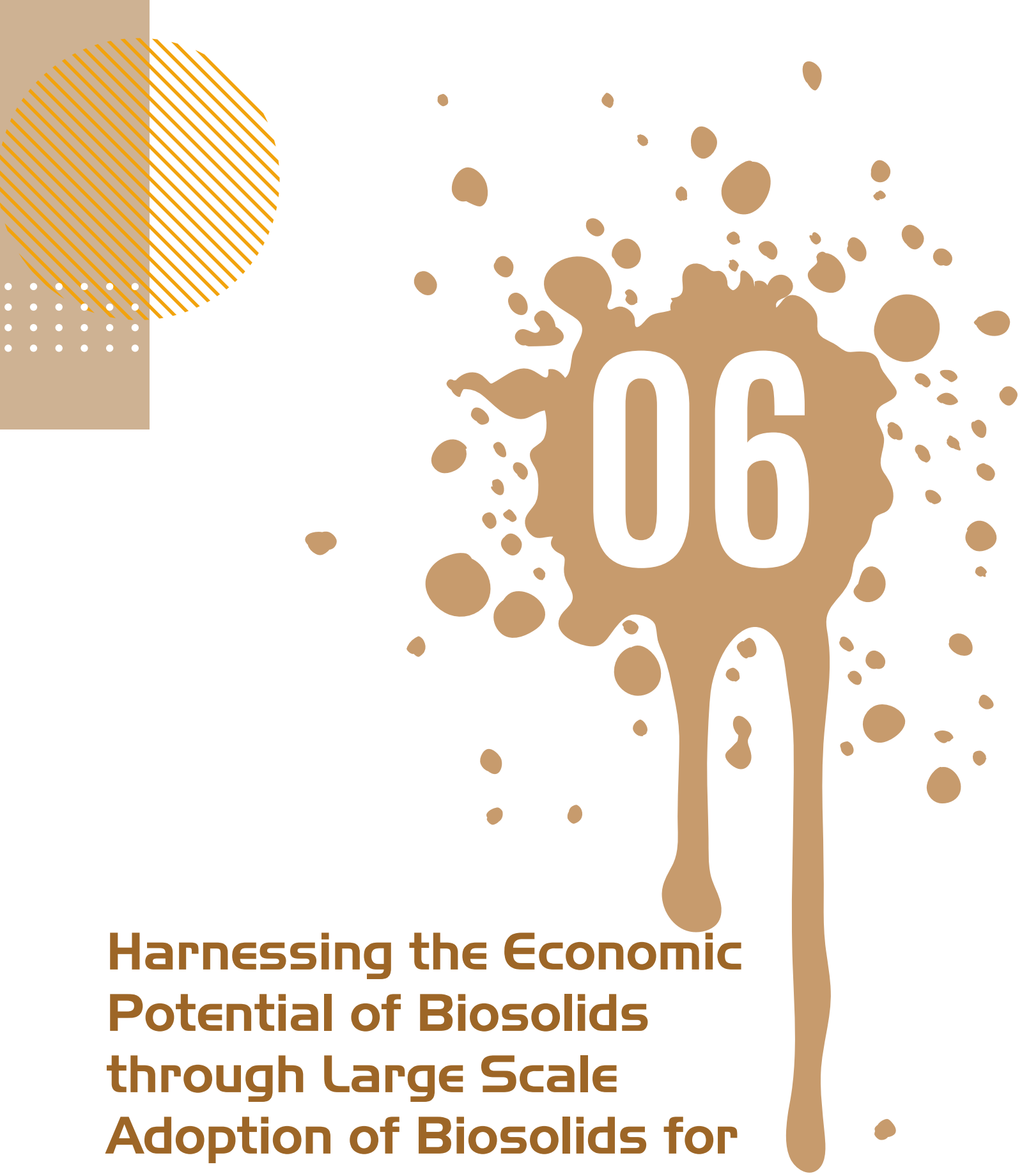


Figure 5.18. Graphical representation of overall bacterial count in raw, treated and value added products.



Harnessing the Economic Potential of Biosolids through Large Scale Adoption of Biosolids for Natural Farming

6.1 Objective

Feasibility study of biosolids for natural farming in five districts of Uttarakhand (including Haridwar), factoring in aspects of crop productivity, transition period, cost-benefit analysis, logistics, and operations.

Locations: Five districts, namely, Haridwar, Dehradun, Uttarkashi, Tehri-Garhwal and Pauri-Garhwal

Season and year: Kharif season, 2025

Total number of farmers included in this Study: 52

Total number of crops included in this Study: 16

Treatments: Ganga Sludge-Based Organic Manures + Control (No manure)

Name of organic manures used: 04

- Jaivik Khad
- Jaivik Prom
- Natural Pori Potash (Pori Potash)
- Dharti Ka Chowkidar (DKC)

Table 6.1. District-wise coverage of farmers

Sr. No.	Name of District	Number of Farmers
1.	Haridwar	17
2.	Dehradun	17
3.	Uttarkashi	7
4.	Tehri-Garhwal	5
5.	Pauri-Garhwal	6
Total Farmers		**52**

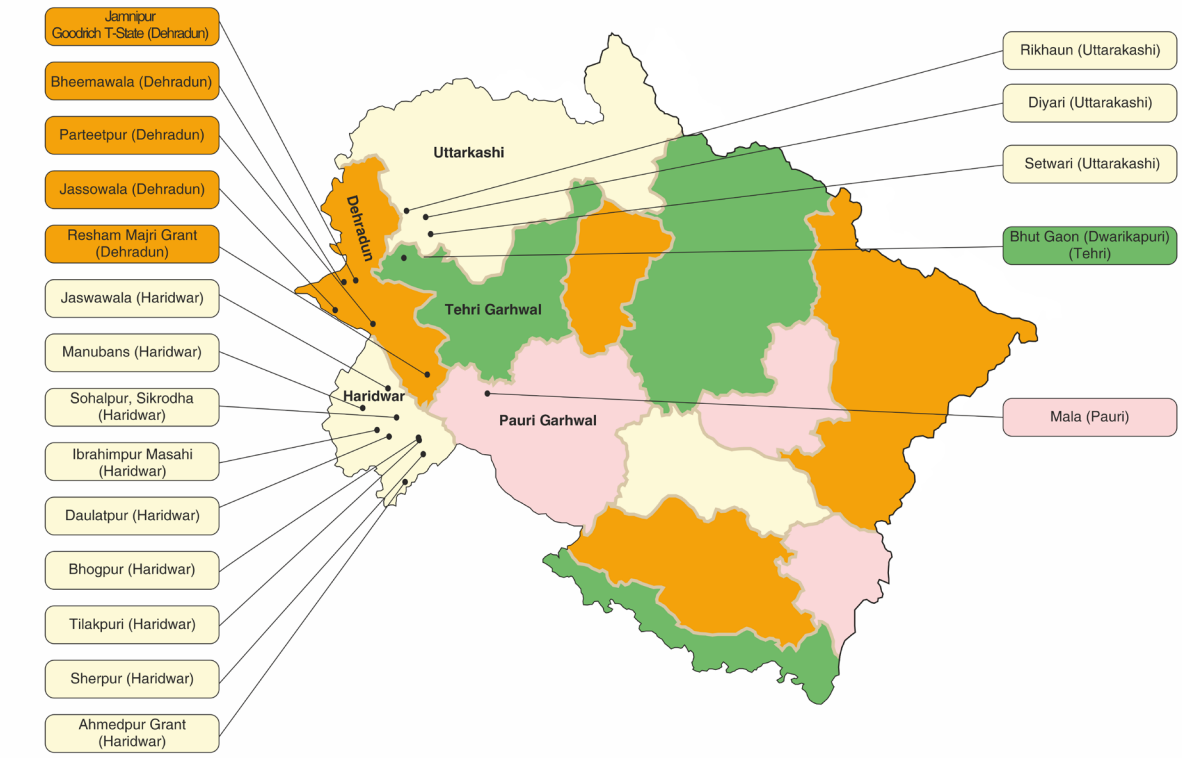


Figure 6.1. Map of Uttarakhand showing five districts with villages covered for field trials under the NMCG project

6.2 Detailed Methodology

The detailed methodology used to conduct the experimental study under the NMCG Project is given in Figure 6.2:

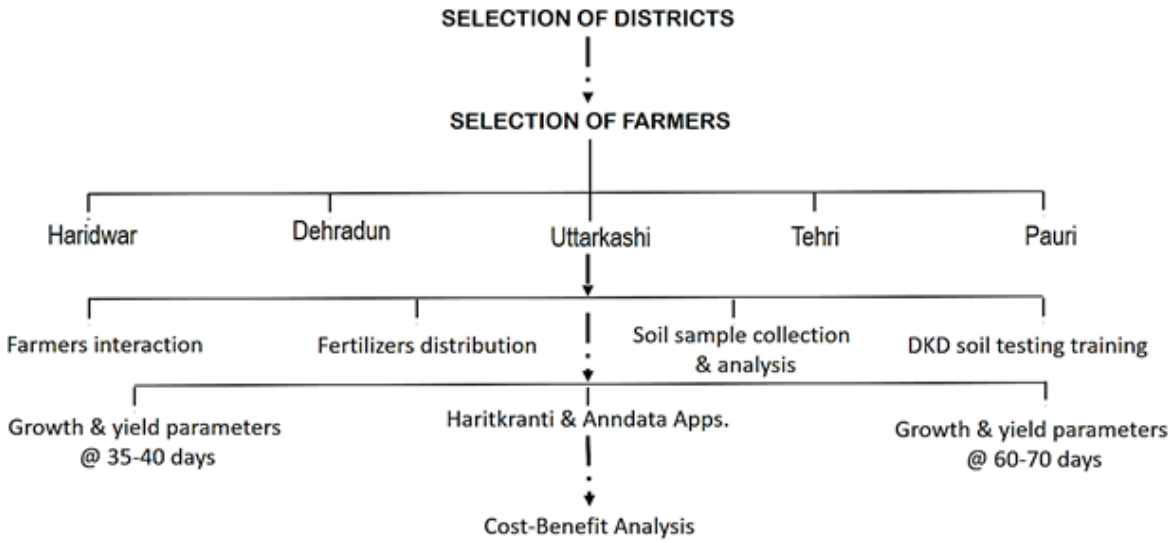


Figure 6.2. Flow chart showing detailed methodology used for the implementation of the NMCG project

The detailed information on each step used in the present project is given below:

1. Selection of districts and farmers

Five districts adjoining to the main district Haridwar, namely Dehradun, Uttarkashi, Tehri and Pauri were selected to carry out field trial studies during the present study. The farmers were selected based on the following information:

- Active participation in agriculture as a progressive farmer.
- Available land for agricultural use.
- Availability of resources required for agricultural practices.
- Awareness about agriculture.

The farmer's information was filled in a proforma during the interaction to take their consent for this study. The consent for all farmers, their general information along with a list of farmers agreed to participate in this NMCG project is attached as annexures (see annexures IV & V).

2. Distribution of organic manures and general awareness

Based on the information gathered during farmer's interaction, about 0.5-1 bigha of land area from the agricultural land of each farmer was selected for experimentation. Different aspects of do's and don'ts during the field trial experimentation were discussed in detail with all selected farmers and their family members. All the farmers were also made aware of the precautions that they will not use any inorganic agricultural product (chemical fertilizers and pesticides, etc.) in the field crop/crops during the experimentation under NMCG project.

Based on the interest of farmers to cultivate any crop under this project, their general awareness about nutritional requirement soil and soil testing recommendations, the organic manures were finally selected and distributed.

Each organic manure finally selected for distribution was provided to all the selected farmers with 75% subsidy on their original cost. In addition, a specific kit named as **Bio-Agent Kit** developed by **Patanjali Organic Research Institute (PORI)** was also distributed among Farmers. This kit contains biological manure & pesticides, and growth promoters recommended for use in one bigha of agricultural land.

3. Physico-chemical properties of the Soil

To analyze physico-chemical properties, soil samples from the fields selected for experimentation were taken in triplicate using a **geotagging method** in a specialized collection bag called **"Mrida Sangrah Thalley (Patent Application Number: 202111056212)"**. The soil sampling (0-15 cm depth) was carried out before cropping as per the standard methods (Jackson 1973) (Table 6.2). The collected soil samples were analyzed in the laboratory for available soil nutrients. The soil health cards based on laboratory results were distributed to all farmers.

4. Soil sampling and training on soil testing

Through the Dharti Ka Doctor (DKD) soil testing kit, training on soil testing has been provided to all (52) selected farmers and other farmers too. Training on soil testing was imparted to all 52 selected farmers, as well as additional farmers, through the utilization of the Dharti Ka Doctor (DKD) soil testing kit (refer Annexure VI & VII). The training of preparation of soil health cards and fertilizer recommendations was also provided, which were developed using the DKD soil testing kit results in conjunction with the DKD mobile application. Additionally the collected soil samples were also analyzed for all important macro and micronutrients in the soil science laboratory and soil health cards were also distributed to the farmers (see Annexure VIII).

Based on specific crop types and soil testing recommendations, the first and subsequent doses of organic manure have been applied in the selected fields of all chosen farmers across five districts.

Table 6.2. Analysis of physico-chemical properties of the experimental field soil

Particulars	Analytical Method Used for Analysis
Physical characteristics of soil	By physical examination
Potential of Hydrogen (pH)	pH Meter in 1:2.5 soil water suspension
Electrical Conductivity (EC)	Conductivity Meter
Organic Carbon (%)	Volumetric Redox Titration (Walkley and Black) Method
Available Nitrogen [kg ha-1]	Alkaline Potassium permanganate method
Available Phosphorus (P2 O5) [kg ha-1]	Olsen Method
Available Potash (K2 O) [kg ha-1]	Flame Photometer Method

5. Agronomical practices

- **Selection of Site:** The experiment was conducted on medium land with good irrigation facilities.
- **Land preparation:** The land was prepared and planked and after that, the clods and all stubble of previous crops were removed. After leveling, the fields were laid out properly by making a bund in each channel for irrigation and drainage.
- **Application of organic manures:** The organic manures were applied considering per recommended dose. The sources of manure were Ganga sludge-based organic manures, applied during the land preparation and top dressed two times, first initially and then every 30 days after sowing or transplanting.
- **Growth and yield:** The growth and yield were recorded as per the detailed parameters given in the next point.

6. Assessment of organic manures for their effects on growth and yield

To assess the effects of organic manure on different crops, various growth and yield parameters were analyzed. Different growth and yield parameters evaluated in this project are given below:

Growth parameters:

- Plant height (in cm) (all crops)
- Leaf area (in cm^2) (all crops)
- Chlorophyll (All Crops)
- Total number of branches (all crops except Sugarcane)
- Number of fruits/plant (all crops except Sugarcane, Tulsi and Menthol)
- Number of bunches/plant (Tomato)
- Number of fruits/bunch (Tomato)
- Number of leaves per plant (Tulsi and Menthol)
- Plant weight (in g) (Tulsi and Menthol)
- Number of tillers (Sugarcane)
- Stem length (in cm) (Sugarcane)
- Diameter of stem (Sugarcane)
- Internode length (in cm) (Sugarcane)
- Number of pods/plant (Lobiya, Black gram)

Yield parameters:

- Yield/plant (in g) (All Crops except Sugarcane)
- Yield/plot (in kg) (All Crops)

7. Cost- Benefit Analysis and Marketing Strategies

After compiling data on yield parameters, the cost-benefit analysis was performed to evaluate and compare the total expected costs versus the anticipated benefits of a project.

To provide market platforms and other government schemes going on for farmers of India and Uttarakhand, training on the following mobile applications was also provided to all selected farmers:

- **Harit Kranti mobile application:** Harit Kranti mobile application provides users/farmers with agronomic advisory, soil health analysis, input availability, weather information, financial services and various other services.
- **Annadata mobile application:** Annadata App. is a mobile application especially designed to serve the needs of the farmers and empower them to be equal partners in the supply chain. It brings in various buyers and sellers of different commodities from across India under one platform to create an inclusive and vibrant market.

8. Feedback from the participant farmers

The feedback of participant farmers under the National Mission for Clean Ganga (NMCG) project was systematically recorded to evaluate their experience with field crops grown using Ganga sludge-based organic manures. QR codes for the testimonials of the farmers recorded are presented in observation section.

6.3 Experimental Outputs of the Study

1. Selection of districts, farmers, crops and organic manures

- **Total number of districts included in this project:** 05

  (Haridwar, Dehradun, Uttarkashi, Tehri-Garhwal and Pauri-Garhwal).

- **Total Villages covered in this Study:** 19
- **Total number of farmers selected:** 52

Haridwar	:	17
Dehradun	:	17
Uttarkashi	:	07
Tehri-Garhwal	:	05
Pauri-Garhwal	:	06

- **Total crops included in this Study:** 16

2. Name of organic manures used: 04

- Jaivik Prom @ 100 kg/ac.
- Natural Pori Potash @ 100 kg/ac.
- Dharti ka Chowkidar @ 10 kg/ac.
- Jaivik Khad @ 80 kg/ac.



Figure 6.3. Ganga sludge-based organic manure used in the feild trial experimentation



Figure 6.4. Promotional material used during the implementation of NMCG project

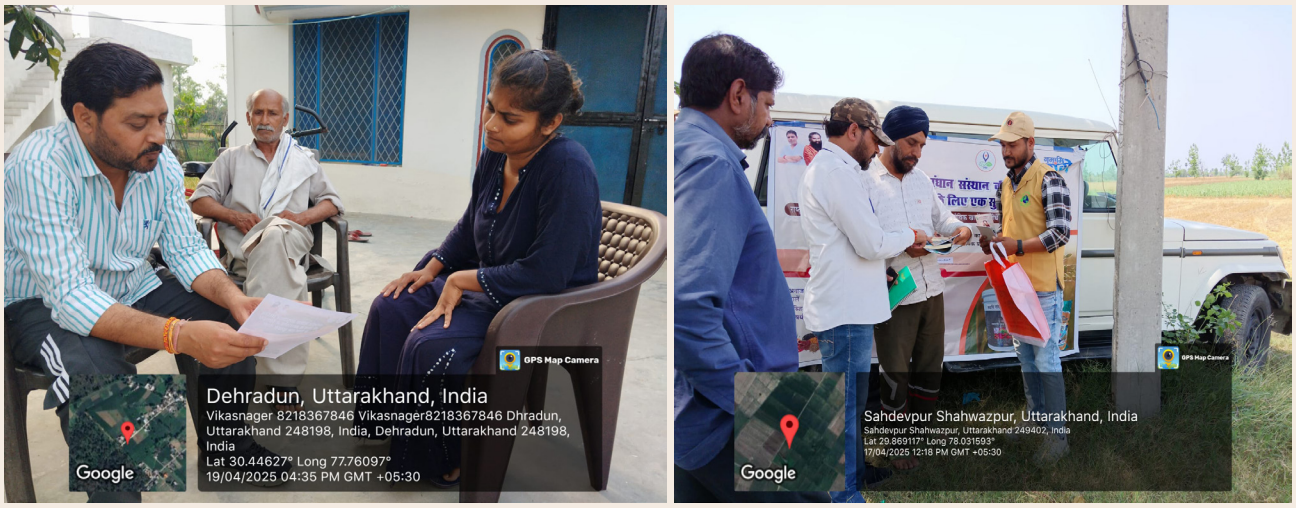


Figure 6.5. Interaction with farmers and their selection to the NMCG project



Figure 6.6. Soil testing training through Dharti Ka Doctor (DKD) kit



Figure 6.7. Organic manure distribution among farmers



Figure 6.8. Field trials under Ganga sludge-based organic manure



Figure 6.9. Distribution of bio-agent kit among farmers



Figure 6.10. Display boards used during field trials of Ganga sludge-based organic manures

Table 6.3. Total Crops (District-wise) selected and cultivated for this study:

Sr. No.	Name of crop	Haridwar	Dehradun	Uttarkashi	Tehri	Pauri
1.	*Zea mays* (Sweet corn)	--	☑	☑	--	--
2.	*Momordica charantia* (Bitter Gourd)	--	☑	--	--	--
3.	*Vigna mungo* (Black Gram/Urad)	☑	--	--	--	--
4.	*Solanum melongena* (Brinjal)	☑	--	--	--	--
5.	*Capsicum annuum* (Capsicum)	--	--	☑	☑	☑
6.	*Amaranthus* sp. (Cholai)	--	☑	--	--	☑
7.	*Cucumis sativus* (Cucumber)	--	☑	--	--	--
8.	*Abelmoschus esculentus* (Bhindi/Okra)	☑	☑	--	--	☑
9.	*Vigna unguiculata* (Cowpea/Lobiya)	☑	--	--	--	--
10.	*Mentha spicate* (Menthol)	☑	--	--	--	--
11	*M.arvensis* (Mint)	--	☑	--	--	--
12.	*Allium cepa* (Onion)	--	--	--	--	☑
13.	*Oryza sativa* (Paddy/Rice)	☑	--	--	--	--
14.	*Saccharum officinarum* (Sugarcane)	☑	☑	--	--	--
15.	*Solanum lycopersicum* (Tomato)	--	--	☑	☑	--
16.	*Ocimum basilicum* (Tulsi)	--	☑	--	--	--
Total = 16		**07**	**08**	**03**	**02**	**04**

3. Detailed information on trainings conducted on DKD soil testing and digital market platforms during the project

A total of 52 farmers were trained, with all types of training conducted during the project's implementation. The district-wise number of farmers trained is presented in Table 6.4.

Table 6.4. The district-wise number of farmers trained on DKD soil testing and digital market platforms

Sr. No.	Districts	No. of farmers trained
1.	Haridwar	17
2.	Dehradun	17
3.	Uttarkashi	7
4.	Tehri-Garhwal	5
5.	Pauri-Garhwal	6
Total		**52**

In the DKD Soil Testing Training, the farmers were demonstrated six soil testing parameters using the Dharti ka Doctor (DKD) soil testing kit.

- Potential of hydrogen (pH),
- Electrical conductivity (EC),
- Organic carbon (OC),
- Available Nitrogen (N),
- Available Phosphorus (P)
- Available Potassium (K)

After completing the soil analysis, the demonstration was also given to use Dharti ka Doctor (DKD) mobile application to generate a soil health card along with fertilizer recommendations.



Figure 6.11. Dharti ka Doctor (DKD) soil testing kit

6.4 District-Wise Outcome of Field Experimentation

HARIDWAR

In Haridwar district, a total of 17 farmers belonging to nine villages (Ahmedpur Grant / Jaswawala / Sohalpur Sikrodha / Daulatpur / Ibrahimpur Masahi, Sherpur, Bhogpur, Tilakpuri, Manubans) were included in the present study. Total seven (7) crops were evaluated to study the effects of four (04) organic Ganga sludge-based organic manures (Table 6.5).

Table 6.5. Detailed information about the number of farmers included, crops and manure used in Haridwar district

Sample code	Name	Village	Crop	Manure used
NMCGH001	Sachin Saini	Ahmedpur Grant	Rice	Jaivik Khad
NMCGH002	Aakash Saini	Jaswawala	Bhindi/Okra	Dharti ka Chowkidar
NMCGH003	Mangeram Saini	Sherpur	Sugarcane	Jaivik Prom
NMCGH004	Yugveer Singh	Bhogpur	Sugar cane	Jaivik Prom
NMCGH005	Yasveer Singh	Bhogpur	Sugarcane	Jaivik Khad
NMCGH006	Dhani Ram	Bhogpur	Sugarcane	Jaivik Khad
NMCGH007	Sonu Kumar	Bhogpur	Sugar Cane	Jaivik Prom
NMCGH008	Tilak Raj	Tilakpuri	Sugarcane	Natural Pori Potash
NMCGH009	Suresh Kumar	Bhogpur	Sugarcane	Dharti ka Chowkidar
NMCGH0010	Harsh Kumar	Manubans	Sugarcane	Natural Pori Potash
NMCGH0011	Mahepal	Sohalpur Sikrodha	Brinjal	Jaivik Khad
NMCGH0012	Munna Lal	Ibrahimpur Masahi	Menthol	Jaivik Prom
NMCGH0013	Ram Kumar	Sohalpur Sikrodha	Brinjal	Jaivik Khad
NMCGH0014	Madan Pal	Bhogpur	Sugarcane	Natural Pori Potash
NMCGH0015	Ram Singh	Daulatpur	Black Gram/Urad	Jaivik Khad
NMCGH0016	Dhyan Singh	Daulatpur	Bhindi/Okra	Natural Pori Potash
NMCGH0017	Balram	Daulatpur	Cowpea/Lobiya	Dharti ka Chowkidar

The agro-meteorological data for Haridwar district revealed that, temperature (minimum) was observed in the range of 18.0 -25.3 °C, while it was observed 28.5 - 37.4 °C (maximum) during the study period. Besides, the rainfall (in inches) during the study period was found minimum of one (1) inch, while a maximum of 14 inches. The detailed agro-meteorological data for the district Haridwar is given in Table 6.6.

Table 6.6. Agro-meteorological data of district Haridwar of Uttarakhand, India

Duration	Temperature		Rainfall (In Inch)
	Minimum (in °C)	Maximum (in °C)	
March -2025	12.6	28.5	1
April -2025	18.0	35.0	1
May -2025	22.3	37.4	1
June -2025	25.1	35.8	5
July -2025	25.3	31.5	14
August -2025	24.7	30.7	13

(**Source:** Agro-meteorology section weather Spark)

The analysis of soil samples collected from fields in Haridwar district selected for the current project study revealed variations in physical properties and nutrient compositions. The physical properties of the soil of the study area are generally observed as deep sandy loam to loam. The organic carbon is found in medium range, whereas pH was observed as slightly acidic to alkaline. The electrical conductivity was also found to be normal. A variation in available Nitrogen, Phosphorus and Potassium was also observed after the analysis of different soil samples. A detailed report of soil parameters is presented in Table 6.7.

Table 6.7. Soil properties of different soil samples collected in district of Haridwar

Sample Code	pH	Organic Carbon (%)	Electrical Conductivity (dS/m)	Available Nitrogen (Kg/ha)	Available Phosphorus (Kg/ha)	Available Potassium (Kg/ha)
NMCGH001	8.17	0.61	0.52	165.58	35.88	69.96
NMCGH002	8.70	0.69	0.40	186.07	93.89	69.63
NMCGH003	7.57	0.79	0.34	176.87	86.94	49.39
NMCGH004	6.90	0.70	0.48	185.23	121.45	61.90
NMCGH005	7.37	0.82	0.61	202.38	41.43	49.62
NMCGH006	6.03	0.67	0.45	196.94	76.44	71.27

Sample Code	pH	Organic Carbon (%)	Electrical Conductivity (dS/m)	Available Nitrogen (Kg/ha)	Available Phosphorus (Kg/ha)	Available Potassium (Kg/ha)
NMCGH007	7.97	0.63	0.48	214.08	72.99	47.41
NMCGH008	7.30	0.78	0.44	181.89	133.00	64.10
NMCGH009	5.97	0.81	0.44	209.90	63.32	72.17
NMCGH0010	5.50	0.46	0.27	153.04	158.48	85.38
NMCGH0011	7.73	0.62	0.44	186.07	210.25	76.46
NMCGH0012	7.23	0.78	0.46	204.47	64.71	226.35
NMCGH0013	7.37	0.28	0.16	153.87	121.56	29.75
NMCGH0014	7.47	0.93	0.43	165.16	32.38	39.46
NMCGH0015	8.67	0.10	0.88	110.39	48.57	19.94
NMCGH0016	8.60	0.07	0.80	133.38	46.77	28.71
NMCGH0017	8.67	0.07	0.93	122.09	17.13	53.42

Effects of Ganga sludge-based organic manures on growth parameters

Based on the observations recorded for the evaluation of Ganga sludge-based organic manures in crops (black gram, brinjal, bhindi/ okra, lobiya, menthol, rice and sugarcane) during the field experimentation, it may be concluded that growth in terms of increase in plant height (in cm), leaf area (in (cm^2), chlorophyll, total number of leaves, branches and number of fruits or bunch/plant was observed in treatments plots in comparison to control. A comparative account of the effects on growth parameters of different crops treated with Ganga sludge-based organic manures and their control (no manure) is given below (Table 6.8 & 6.9):

Table 6.8. Effects of Ganga sludge-based organic manures on growth parameters

Farmers detail and crop	Plant Height (cm)		Leaf area (cm^2)		Chlorophyll		Total No. of Branches		No. of Fruits/ Plant		No. of Leaves/ Plant		No. of Pods / plant	
	C	T	C	T	C	T	C	T	C	T	C	T	C	T
Sachin Saini NMCGH001 (Rice-60 Days)	116.2 ± 9.68	123.6 ± 11.84	61.56 ± 7.11	72.85 ± 6.59	45.16 ± 3.61	53.88 ± 6.47	NA	NA	NA	NA	28.71 ± 1.85 (Spike length in cm)	30.76 ± 1.71 (Spike length in cm)	110.20 ± 10.56 (Seed no./ spike)	135.67 ± 13.48 (Seed no./ spike)
Aakash Saini NMCGH002 (Bhindi/Okra)	120.20 ± 15.56	158.20 ± 4.71	351.22 ± 33.28	483.74 ± 28.48	56.10 ± 2.26	59.74 ± 1.07	2.80 ± 1.30	3.20 ± 0.84	2.80 ± 0.84	3.40 ± 0.89	NA	NA	NA	NA
Mahepal NMCGH0011 (Brinjal)	86.75 ± 12.34	118.4 ± 13.52	234.84 ± 34.43	275.75 ± 36.56	41.65 ± 1.27	43.54 ± 3.05	5.75 ± 0.50	9.0 ± 1.87	2.5 ± 1.00	2.2 ± 0.84	NA	NA	NA	NA
Munna Lal NMCGH0012 (Menthol)	25.94 ± 2.87	37.14 ± 2.28	19.082 ± 3.622	33.67 ± 6.89	30.5 ± 0.721	41.240 ± 5.58	5.4 ± 0.548	11.80 ± 5.89	NA	NA	47.6 ± 9.290	107.60 ± 39.04	NA	NA
Ram Kumar NMCGH0013 (Brinjal)	79.4 ± 12.99	103.8 ± 7.60	203.288 ± 52.54	276.832 ± 60.12	44.84 ± 2.92	50.32 ± 3.46	7.6 ± 1.14	11 ± 1.22	6.8 ± 0.84	11.6 ± 1.52	NA	NA	NA	NA
Ram Singh NMCGH0015 (Black Gram)	28 ± 3.08	31.4 ± 2.61	31.9 ± 7.08	36.85 ± 7.76	41.76 ± 3.36	44.5 ± 1.49	3.2 ± 0.84	4 ± 1.00	61.8 ± 8.70	68.4 ± 6.58	NA	NA	NA	NA
Dhyan Singh NMCGH0016 (Bhindi/Okra)	82.96 ± 7.54	95.01 ± 12.97	303.16 ± 29.76	361.03 ± 28.25	44.38 ± 7.41	52.54 ± 5.98	2.4 ± 0.80	3.4 ± 0.55	4.4 ± 1.20	7.6 ± 1.82	NA	NA	NA	NA
Balram NMCGH0017 (Cowpea/ Lobiya)	184.36 ± 14.16	247.26 ± 24.41	53.824 ± 9.92	66.488 ± 3.69	64.3 ± 4.41	70.86 ± 4.91	12.2 ± 1.92	16.4 ± 1.52	NA	NA	NA	NA	6.2 ± 0.84	7.8 ± 1.48

Table 6.9. Effects of Ganga sludge-based organic manures on growth parameters of Sugarcane

Farmers detail and crop	Number of Tillers		Number of Leaves		Leaf Area (in cm^2)		Chlorophyll		Stem Length/ Plant Height (in cm)		Stem Diameter (mm)		Internode Length (cm)	
	C	T	C	T	C	T	C	T	C	T	C	T	C	T
Mangeram Saini NMCGH003 (Sugarcane)	8.6 ± 1.34	11 ± 1.41	7.4 ± 0.55	1.8 ± 1.30	465.77 ± 56.70	678.63 ± 61.92	29.88 ± 3.86	41.62 ± 7.35	217.2 ± 17.31	256.3 ± 18.37	17.89 ± 1.46	24.6 ± 2.82	15.2 ± 1.50	20.74 ± 0.68
Yugveer Singh NMCGH004 (Sugarcane)	14.80 ± 3.56	16.20 ± 5.85	7.80 ± 0.84	8.60 ± 0.55	548.89 ± 41.72	616.17 ± 53.95	38.48 ± 4.42	37.58 ± 3.28	270.53 ± 27.06	309.43 ± 9.63	23.75 ± 1.41	28.70 ± 2.27	17.59 ± 1.43	20.93 ± 1.24
Yasveer Singh NMCGH005 (Sugarcane)	8.8 ± 0.84	10.4 ± 1.67	8.0 ± 0.71	9.6 ± 1.52	560.09 ± 60.35	783.74 ± 87.31	34.02 ± 3.15	35.24 ± 2.22	218.08 ± 17.90	301.78 ± 8.74	26.18 ± 2.06	32.11 ± 0.42	16.53 ± 3.41	20.57 ± 2.15
Dhani Ram NMCGH006 (Sugarcane)	10.20 ± 2.05	13.00 ± 2.00	9.20 ± 0.84	9.80 ± 1.48	440.77 ± 32.96	668.32 ± 35.25	41.80 ± 7.23	46.20 ± 8.38	243.97 ± 15.08	290.54 ± 28.48	23.11 ± 2.41	32.49 ± 3.18	14.75 ± 1.52	21.69 ± 1.55
Sonu Kumar NMCGH007 (Sugarcane)	8.80 ± 1.30	12.8 ± 3.42	8.2 ± 0.84	10.6 ± 1.34	507.66 ± 44.61	593.83 ± 53.92	36.32 ± 10.71	48.08 ± 5.65	301.79 ± 15.77	322.00 ± 9.99	21.31 ± 1.70	23.26 ± 1.37	16.99 ± 0.78	21.41 ± 3.10
Tilak Raj NMCGH008 (Sugarcane)	8.20 ± 1.64	10.40 ± 1.14	8.6 ± 0.89	10.00 ± 1.58	559.71 ± 46.61	618.12 ± 37.65	29.66 ± 2.85	35.58 ± 7.24	252.8 ± 28.99	301.9 ± 10.68	23.82 ± 0.91	31.29 ± 0.83	14.79 ± 0.89	20.21 ± 2.10
Suresh Kumar NMCGH009 (Sugarcane)	14.00 ± 2.45	16.20 ± 1.64	7.00 ± 1.58	9.80 ± 1.48	599.36 ± 41.69	756.52 ± 88.75	28.92 ± 2.76	38.20 ± 4.50	263.68 ± 29.29	296.63 ± 27.56	26.17 ± 2.31	30.58 ± 2.22	18.59 ± 0.80	20.64 ± 2.39
Harsh Kumar NMCGH0010 (Sugarcane)	7.80 ± 0.84	9.60 ± 1.14	7.60 ± 0.55	8.60 ± 1.14	633.35 ± 65.39	724.90 ± 40.10	33.34 ± 5.20	37.70 ± 2.31	239.47 ± 24.02	286.07 ± 13.39	22.63 ± 0.45	28.34 ± 1.22	17.64 ± 1.18	20.93 ± 0.70
Madan Pal NMCGH0014 (Sugarcane)	12.80 ± 2.17	16.00 ± 3.08	8.60 ± 0.55	9.60 ± 1.52	580.56 ± 63.29	695.29 ± 59.82	23.84 ± 5.73	35.28 ± 4.71	221.49 ± 15.21	262.33 ± 7.51	23.39 ± 1.45	29.27 ± 1.36	14.00 ± 0.68	16.80 ± 0.58

Effects of Ganga sludge-based organic manures on yield parameters

Similar to growth, a significant increase in the yield of all types of crops (black gram, brinjal, bhindi/okra, lobiya, mentha, rice and sugarcane) was observed during the present study. Based on the results, an increase in yield per plant, plot and total yield was found increased as compare to the control. However, the final yield of the crops, like sugarcane, still needs to be calculated as the crops are still at growing stage. A comparative account of the increase in yield parameters of crops treated with Ganga sludge-based organic manures and their control (no manure) is given below (Table 6.10 & Photo-plate 6.1):

Table 6.10. Effects of Ganga sludge-based organic manures on yield parameters

Farmers detail and crop	No. of Tillers		Yield/ Plant (g)		Yield/ Plot (kg)		Other Yield/ Plot (kg)		Total Yield/Plot (kg)	
	C	T	C	T	C	T	C	T	C	T
Sachin Saini NMCGH001 (Rice-60 Days)	15.2 ± 2.59	27.8 ± 4.97	NA	NA	NA	NA	NA	NA	352	412
Aakash Saini NMCGH002 Bhindi (Okra)	NA	NA	6.81 ± 1.19	8.97 ± 1.18	282.00	365.00	125.00	175.00	407.00	540.00
Mangeram Saini NMCGH003 (Sugarcane)	Crop is still growing									
Yugveer Singh NMCGH004 (Sugarcane)	Crop is still growing									
Yasveer Singh NMCGH005 (Sugarcane)	Crop is still growing									
Dhani Ram NMCGH006 (Sugarcane)	Crop is still growing									
Sonu Kumar NMCGH007 (Sugarcane)	Crop is still growing									
Tilak Raj NMCGH008 (Sugarcane)	Crop is still growing									
Suresh Kumar NMCGH009 (Sugarcane)	Crop is still growing									
Harsh Kumar NMCGH0010 (Sugarcane)	Crop is still growing									

Farmers detail and crop	No. of Tillers		Yield/ Plant (g)		Yield/ Plot (kg)		Other Yield/ Plot (kg)		Total Yield/Plot (kg)	
	C	T	C	T	C	T	C	T	C	T
Mahepal NMCGH0011 (Brinjal)	1.002 ± 0.29 (in kg)		1.35 ± 0.56 (in kg)		284	324	310	376	594	718
Munna Lal NMCGH0012 (Menthol)	238.8 ± 17.712		280.20 ± 18.59		NA	NA	NA	NA	350	465
Ram Kumar NMCGH0013 (Brinjal)	1.10 ± 0.28 (in kg)		1.31 ± 0.29 (in kg)		394	566	263	315	657	881
Madan Pal NMCGH0014 (Sugarcane)	Crop is still growing									
Ram Singh NMCGH0015 (Black Gram)	18.53 ± 4.88		24.70 ± 8.23		NA	NA	NA	NA	65.00	83.00
Dhyan Singh NMCGH0016 (Bhindi/Okra)	121.498 ± 69.73		279.104 ± 82.21		352	378	435	605	787	983
Balram NMCGH0017 (Cowpea/Lobiya)	60 ± 4.47		70.2 ± 3.83		135	207	355	414	490	621

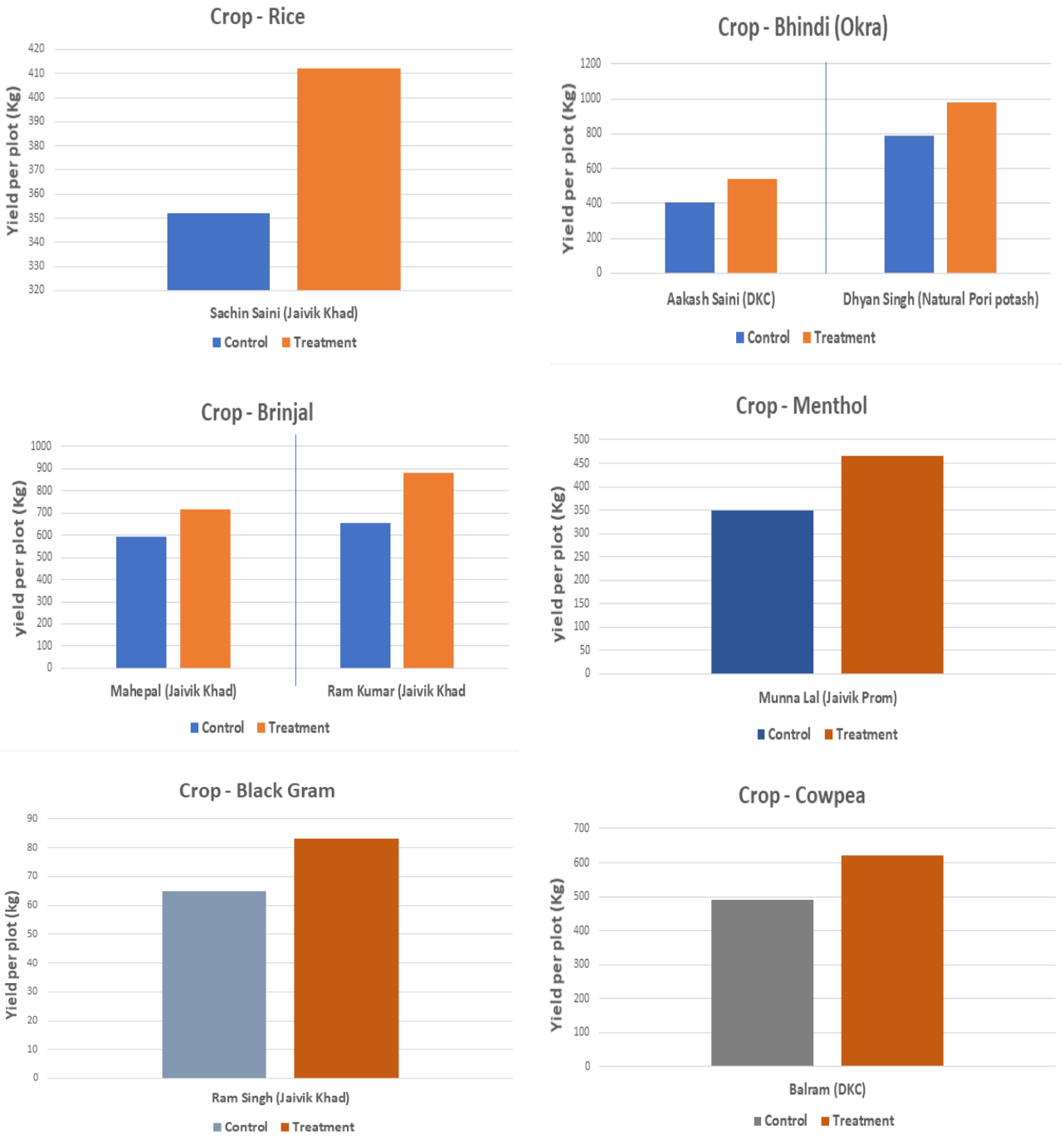


Photo-plate 6.1: Effects of Ganga sludge-based organic manures on yield potential of different crops growing in District Haridwar.



Figure 6.12. Pictorial glimpses of implementation of project in the farmer fields of Haridwar district (Uttarakhand)



Figure 6.13. Pictorial glimpses of the implementation of project in the farmer fields of Haridwar district (Uttarakhand)

DEHRADUN

In Dehradun district, 17 farmers belonging to five villages (Resham Majri Grant/Jassowala/ Jamnipur (Jamnipur Goodrich T-State)/ Bheemawala (Vikasnagar)/Parteetpur) were included in the present study. Eight (8) crops were evaluated to study the effects of four (04) organic Ganga sludge-based organic manures (Table 6.11).

Table 6.11. Detailed information about the number of farmers included, crops and manure used in Dehradun district

Sample code	Name	Village	Crop	Manure used
NMCGD001	Kunwar Singh	Resham Majri Grant	Basil (Tulsi)	Dharti ka Chowkidar
NMCGD002	Devender Singh	Resham Majri Grant	Bhindi/Okra	Jaivik Khad
NMCGD003	Yaspal Singh	Resham Majri Grant	Cholai (Amaranth)	Jaivik Khad
NMCGD004	Chaitan	Resham Majri Grant	Mint	Dharti ka Chowkidar
NMCGD005	Nikhil Kumar	Resham Majri Grant	Cholai (Amaranth)	Dharti ka Chowkidar
NMCGD006	Satypal Singh	Resham Majri Grant	Bhindi/Okra	Dharti ka Chowkidar
NMCGD007	Hritik Kumar	Resham Majri Grant	Karela	Jaivik Khad
NMCGD008	Kuldeep S. Saini	Bheemawala	Bhindi/Okra	Dharti ka Chowkidar
NMCGD009	Tara Chand Saini	Jassowala	Cucumber	Dharti ka Chowkidar
NMCGD0010	Sachin Kumar	Jassowala	Sugarcane	Natural Pori Potash
NMCGD0011	Ramesh Chand	Parteetpur	Sugarcane	Natural Pori Potash
NMCGD0012	Rajender Singh	Jamnipur Goodrich T-State	Bhindi/Okra	Jaivik Khad
NMCGD0013	Ashish Kumar	Jamnipur Goodrich T-State	Bhindi/Okra	Jaivik Prom
NMCGD0014	Shubham	Jamnipur Goodrich T-State	Bhindi/Okra	Jaivik Khad
NMCGD0015	Jitender Singh	Jassowala	Sugarcane	Natural Pori Potash
NMCGD0016	Aryan Saini	Jassowala	Cucumber	Natural Pori Potash
NMCGD0017	Rishipal	Jassowala	Sweet Corn	Jaivik Khad

The agro-meteorological data for Dehradun district revealed that, temperature (minimum) was observed in the range of 10.2 -22.8 °C, while it was observed 25.5 - 33.9 °C (maximum)during the study period. Besides, the rainfall (in inches) during the study period was found to be a minimum of one (1) inch, with a maximum of 17 inches. The detailed agro-meteorological data for the district Dehradun are given in Table 6.12.

Table 6.12. Agro-meteorological data of district Dehradun of Uttarakhand, India

Duration	Temperature		Rainfall (in Inches)
	Minimum (in °C)	Maximum (in °C)	
March -2025	10.2	25.5	1
April -2025	15.3	31.4	1
May -2025	19	33.9	1
June -2025	21.8	32.7	5
July -2025	22.8	28.9	17
August -2025	22.3	28.3	16

(**Source:** Agro-meteorology section weather Spark)

The analysis of soil samples collected from fields in Dehradun district for the current project study revealed variations in physical properties and nutrient compositions. The physical properties of the soil of the study area are generally observed as sandy clay loam to sandy clay. The organic carbon is found to be variable in the low to high range, whereas pH was observed as slightly acidic to normal. The electrical conductivity was also found to be normal. A variation in available Nitrogen, Phosphorus and Potassium was also observed after the analysis of different soil samples. A detailed report of soil parameters is presented in Table 6.13.

Table 6.13. Soil properties of different soil samples collected in district Dehradun

Sample Code	pH	Organic Carbon (%)	Electrical Conductivity (dS/m)	Available Nitrogen (Kg/ha)	Available Phosphorus (Kg/ha)	Available Potassium (Kg/ha)
NMCGD001	6.87	0.51	0.77	267.61	381.96	105.24
NMCGD002	7.0	0.26	0.66	277.22	179.30	126.37
NMCGD003	7.83	0.39	0.34	261.33	150.98	83.89
NMCGD004	7.60	0.28	0.51	360.01	396.59	169.72
NMCGD005	7.30	0.34	0.11	316.53	284.44	542.64
NMCGD006	7.00	0.31	0.32	212.83	55.17	79.18

Sample Code	pH	Organic Carbon (%)	Electrical Conductivity (dS/m)	Available Nitrogen (Kg/ha)	Available Phosphorus (Kg/ha)	Available Potassium (Kg/ha)
NMCGD007	6.88	0.41	0.39	231.65	55.00	65.63
NMCGD008	6.70	0.22	0.27	222.45	204.72	61.45
NMCGD009	6.50	1.41	0.38	215.76	183.78	55.40
NMCGD0010	6.10	0.67	0.22	288.09	80.54	88.44
NMCGD0011	6.83	0.85	0.23	230.39	64.77	94.45
NMCGD0012	6.17	0.27	0.20	235.83	122.15	56.78
NMCGD0013	6.30	0.36	0.22	191.51	148.15	67.31
NMCGD0014	6.63	0.68	0.12	224.54	73.14	49.62
NMCGD0015	5.47	0.43	0.26	225.79	72.49	47.15
NMCGD0016	5.29	1.32	0.15	158.89	78.77	32.14
NMCGD0017	5.50	1.87	0.23	194.43	96.92	58.73

Effects of Ganga sludge-based organic manures on growth parameters

Based on the observations made during the field experiment to evaluate Ganga sludge-based organic manures in crops (sweet corn, basil (tulsi), cholai (amaranth), cucumber, karela, bhindi/okra, menthol and sugarcane), it can be concluded that an increase in plant height (in cm), leaf area (in cm^2), chlorophyll, total number of branches, and number of fruits or bunches/ plant was observed in plants treated with organic manures when comparing to control. A comparative account of the effects on growth parameters of different crops treated with Ganga sludge-based organic manures and their control (no manure) is given below (Table 6.14 & 6.15):

Table 6.14. Effects of Ganga sludge-based organic manures on growth parameters of different crops

Farmer detail and crop	Plant Height (in cm)		Leaf area (cm^2)		Chlorophyll		No. of Leaves/Plant		Total number of Branches		No. of Fruits/ Plant		No. of Bunches/Plant	
	C	T	C	T	C	T	C	T	C	T	C	T	C	T
Kunwar Singh NMCGD001 (Tulsi)	48.80 ± 2.28	60.00 ± 2.55	57.77 ± 4.65	64.71 ± 5.99	49.76 ± 1.84	50.92 ± 4.63	58.60 ± 1.52	71.00 ± 2.74	23.80 ± 3.03	29.40 ± 3.78	NA	NA	NA	NA
Devender NMCGD002 (Bhindi/Okra)	81.8 ± 3.11	119.2 ± 3.70	169.26 ± 4.42	201.29 ± 6.73	49.6 ± 4.60	57.38 ± 6.33	NA	NA	3.0 ± 1.00	4.4 ± 1.52	9.2 ± 0.84	15.4 ± 0.89	NA	NA
Yaspal Singh NMCGD003 (Cholai/ Amaranth)	45.2 ± 2.77	62.8 ± 1.64	113.47 ± 3.33	149.32 ± 3.79	34.2 ± 2.14	39.52 ± 2.49	20.6 ± 2.41	29.8 ± 5.54	7.8 ± 1.48	11.00 ± 1.00	NA	NA	NA	NA
Chaitan NMCGD004 (Mentha/mint)	27.74 ± 2.08	36.26 ± 3.09	20.57 ± 2.87	33.84 ± 2.08	31.30 ± 1.83	43.92 ± 4.22	46.80 ± 3.70	81.60 ± 2.70	5.00 ± 1.00	11.80 ± 1.48	NA	NA	NA	NA
Nikhil Kumar NMCGD005 (Cholai/ Amaranth)	45.8 ± 3.11	58 ± 1.22	126.52 ± 6.81	150.82 ± 6.68	43.54 ± 3.01	59.7 ± 1.78	19.8 ± 1.79	26.00 ± 1.22	NA	NA	NA	NA	NA	NA
Satypal Singh NMCGD006 (Bhindi/Okra)	67.4 ± 3.91	78.4 ± 3.05	154.36 ± 6.23	169.83 ± 8.84	54.88 ± 7.05	61.9 ± 4.39	NA	NA	3.2 ± 0.84	4.8 ± 0.84	4.6 ± 0.89	7 ± 1.00	NA	NA
Hritik Kumar NMCGD007 (Karela/ Bittergourd)	215.4 ± 5.03	257.6 ± 6.35	17.748 ± 1.68	27.31 ± 1.89	45.96 ± 4.50	50.72 ± 3.51	NA	NA	5.2 ± 0.84	7.00 ± 0.71	7.4 ± 0.89	9.2 ± 0.84	NA	NA

Farmer detail and crop	Plant Height (in cm)		Leaf area (cm^2)		Chlorophyll		No. of Leaves/Plant		Total number of Branches		No. of Fruits/ Plant		No. of Bunches/Plant	
	C	T	C	T	C	T	C	T	C	T	C	T	C	T
Kuldeep S. Saini NMCGD008 (Bhindi/Okra)	89.6 ± 2.07	108.8 ± 2.77	226.06 ± 7.47	257.55 ± 7.75	51.74 ± 8.03	56.52 ± 2.13	NA	NA	2.4 ± 0.89	4.6 ± 0.55	5.8 ± 0.84	7.00 ± 0.71	NA	NA
Tara Chand Saini NMCGD009 (Cucumber)	263.4 ± 10.29	293.2 ± 14.13	226.856 ± 20.09	247.124 ± 15.57	75.48 ± 5.40	79.96 ± 5.99	NA	NA	3.6 ± 0.55	5 ± 0.71	4.8 ± 0.84	6.4 ± 1.14	NA	NA
Rajender Singh NMCGD0012 (Bhindi/Okra)	58.2 ± 2.39	68.8 ± 2.59	255.29 ± 7.28	279.85 ± 8.27	57.6 ± 5.60	60.19 ± 5.24	NA	NA	4.2 ± 0.71	5.60 ± 0.89	3 ± 0.71	5.20 ± 0.84	NA	NA
Ashish Kumar NMCGD0013 (Bhindi/Okra)	173.6 ± 9.86	197.8 ± 8.84	146.33 ± 6.52	172.25 ± 9.81	67.6 ± 2.70	74.32 ± 3.79	NA	NA	1.6 ± 0.55	2 ± 0.71	7.2 ± 0.84	11.40 ± 0.89	NA	NA
Shubham NMCGD0014 (Bhindi/Okra)	118.8 ± 9.20	158.2 ± 4.71	243.91 ± 7.76	276.97 ± 9.58	56 ± 1.91	58.82 ± 1.95	NA	NA	3 ± 1.00	4.6 ± 0.55	3.4 ± 0.55	6.2 ± 0.84	NA	NA
Aryan Saini NMCGD0016 (Cucumber)	257.2 ± 6.69	264.4 ± 4.16	202.468 ± 6.87	241.95 ± 9.75	72.82 ± 4.67	80.42 ± 3.87	NA	NA	5.8 ± 0.84	6.6 ± 0.89	5.6 ± 0.98	7 ± 1.00	NA	NA

Table 6.15. Effects of Ganga sludge-based organic manures on growth parameters of Sugarcane and Sweet-corn

Farmer detail and crop	Number of tillers		Number of Leaves		Leaf area in (cm^2)		Chlorophyll		Plant/Stem Length (cm)		Stem Diameter (mm)		Length of Internode (cm)	
	C	T	C	T	C	T	C	T	C	T	C	T	C	T
Sachin Kumar NMCGD0010 (Sugarcane)	9.6 ± 0.55	11.6 ± 1.14	10.2 ± 1.10	10.4 ± 1.67	490.09 ± 26.31	742.93 ± 36.25	35.02 ± 1.91	38.14 ± 2.37	247.69 ± 11.16	306.13 ± 8.43	27.01 ± 1.11	30.52 ± 1.19	18.27 ± 0.53	21.35 ± 1.14
Ramesh Chand NMCGD0011 (Sugarcane)	8.2 ± 1.64	11.2 ± 1.64	7.0 ± 1.22	10.2 ± 1.10	543.27 ± 80.00	783.94 ± 98.17	35.08 ± 1.44	39.04 ± 1.92	217.76 ± 13.81	241.18 ± 4.26	24.63 ± 1.34	32.89 ± 3.27	16.87 ± 3.32	20.75 ± 1.68
Jitender Singh NMCGD0015 (Sugarcane)	9.8 ± 1.79	12.4 ± 1.82	10.2 ± 1.10	11.8 ± 1.10	954.91 ± 99.47	1029.86 ± 105.42	40.28 ± 2.18	44.04 ± 4.10	221.40 ± 6.15	274.71 ± 14.13	23.47 ± 1.35	30.02 ± 0.99	15.26 ± 1.38	20.21 ± 1.21
Rishipal NMCGD0017 (Sweet Corn)	NA	NA	NA	NA	617.04 ± 41.71	766.68 ± 67.99	58.96 ± 6.32	62.16 ± 5.01	192.4 ± 13.15	212.6 ± 5.64	NA	NA	NA	NA

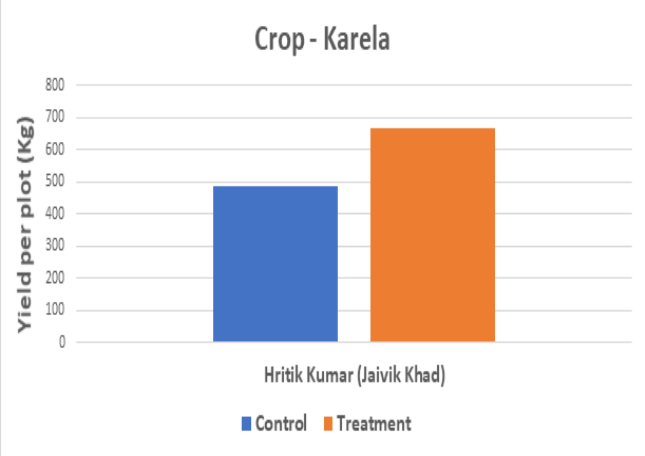
Effects of Ganga sludge-based organic manures on yield parameters

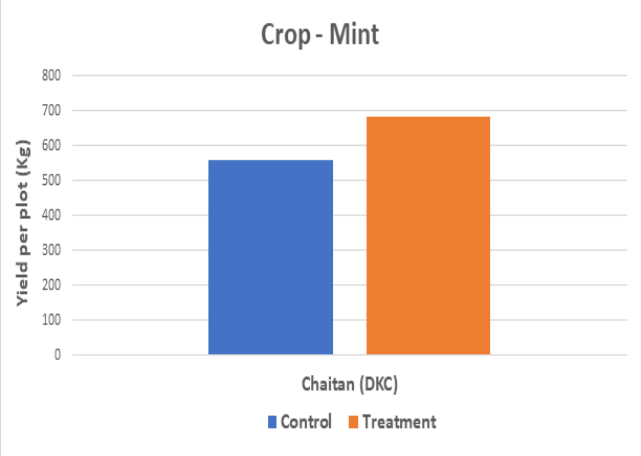
Similar to growth, a notable rise in the yield of all crop types (Sweet corn, basil (tulsi), cholai (amaranth), cucumber, karela, bhindi/okra, menthol and sugarcane) was noted. Based on these results, an increase in yield per plant, plot and total yield was found as compared to the control. However, the final yield of the crops, like sugarcane and sweet corn, still needs to be calculated as the crops are still at growing stage. The parameter-wise yield analysis of the effects of organic manures is presented in Table 6.16 & Photo-plate 6.2a-b.

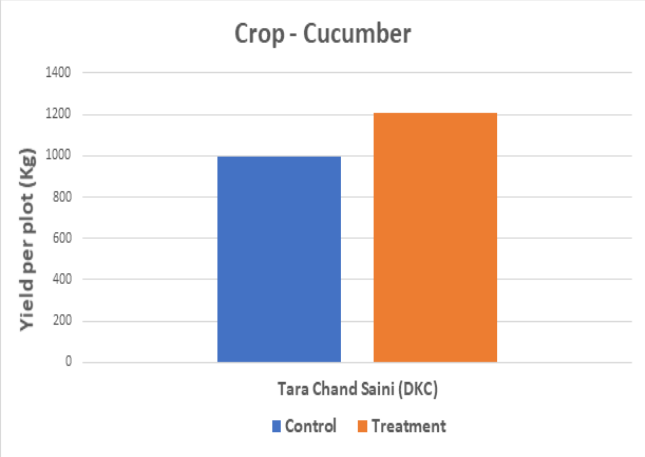
Table 6.16. Effects of Ganga sludge-based organic manures on yield parameters

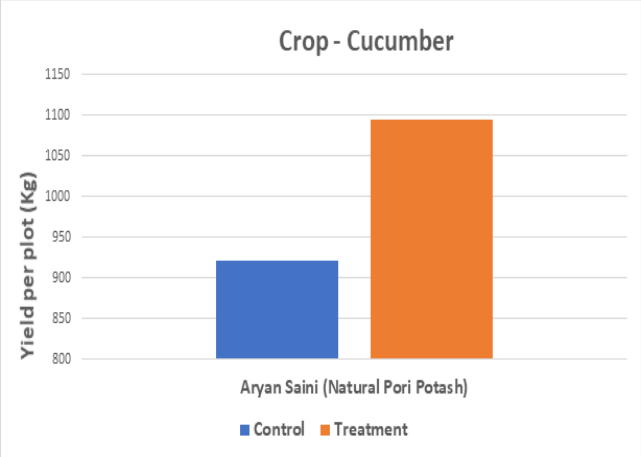
Farmer detail and crop	Yield/Plant (g)		Yield/Plot (kg)		Other Yield/Plot (kg)		Total Yield/Plot (kg)	
	C	T	C	T	C	T	C	T
Kunwar Singh NMCGD001 (Tulsi)	220.60 ± 9.71	260.80 ± 6.76	NA	NA	NA	NA	842	1084
Devender NMCGD002 (Bhindi/Okra)	45.93 ± 8.08	71.95 ± 6.14	165	188	282	369	447	557
Yaspal Singh NMCGD003 (Cholai/Amaranth)	36.2 ± 3.90	51.8 ± 3.03	85	136	236	268	321	404

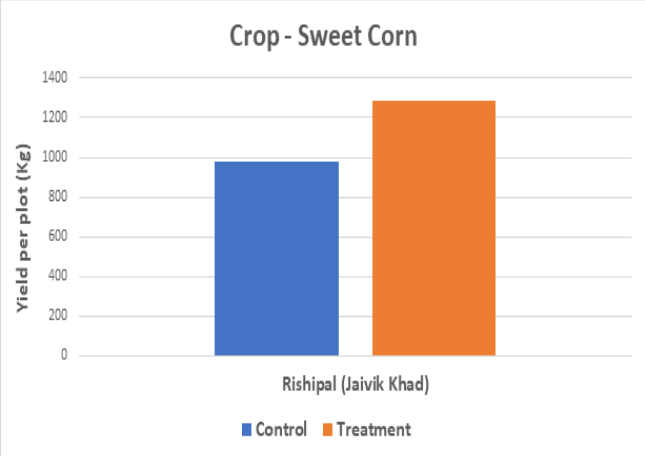
Farmer detail and crop	Yield/Plant (g)		Yield/Plot (kg)		Other Yield/Plot (kg)		Total Yield/Plot (kg)	
	C	T	C	T	C	T	C	T
Chaitan NMCGD004 (Mint)	240.40 ± 18.19	279.40 ± 17.60	NA	NA	NA	NA	558.16	683.00
Nikhil Kumar NMCGD005 (Cholai/Amaranth)	56.2 ± 3.70	70.8 ± 6.61	96	125	185	250	281	375
Satypal Singh NMCGD006 (Bhindi/Okra)	37.296 ± 5.30	56.252 ± 7.79	245	286	652	827	897	1113
Hritik Kumar NMCGD007 (Karela/ Bittergourd)	3.28 ± 0.33	3.76 ± 0.76	184	225	305	445	489	670
Kuldeep Saini NMCGD008 (Bhindi/Okra)	41.11 ± 7.34	84.90 ± 12.74	240	287	86	140	326	427
Tara Chand Saini NMCGD009 (Cucumber)	4.1 ± 0.48 (in kg)	5.12 ± 0.57 (in kg)	564	625	432	574	996	1209
Rajender Singh NMCGD0012 (Bhindi/Okra)	54.64 ± 9.03	91.63 ± 8.51	359	479	228	282	587	761
Ashish Kumar NMCGD0013 (Bhindi/Okra)	51.53 ± 9.00	78.10 ± 7.50	315	463	326	386	641	849
Shubham NMCGD0014 (Bhindi/Okra)	70.00 ± 8.49	80.4 ± 7.09	258	388	235	267	493	655
Aryan Saini NMCGD0016 (Cucumber)	4.5 ± 0.54 (in kg)	5.26 ± 0.63 (in kg)	435	510	487	585	922	1095
Sachin Kumar NMCGD0010 (Sugarcane)	Crop is still growing							
Ramesh Chand NMCGD0011 (Sugarcane)	Crop is still growing							
Jitender Singh NMCGD0015 (Sugarcane)	Crop is still growing							
Rishipal NMCGD0017 (Sweet Corn)	179.6 ± 3.36	214.8 ± 4.15					978	1287











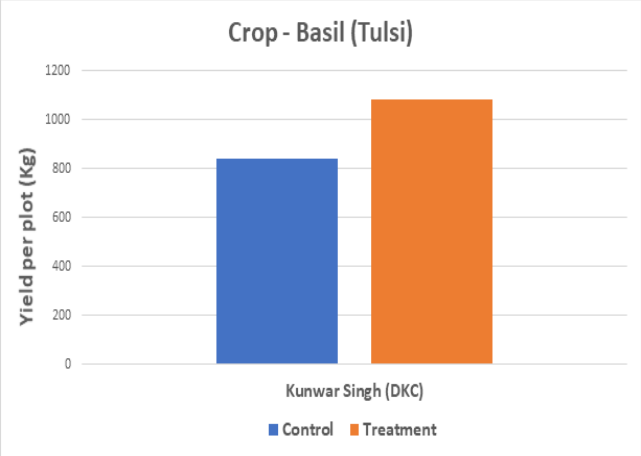
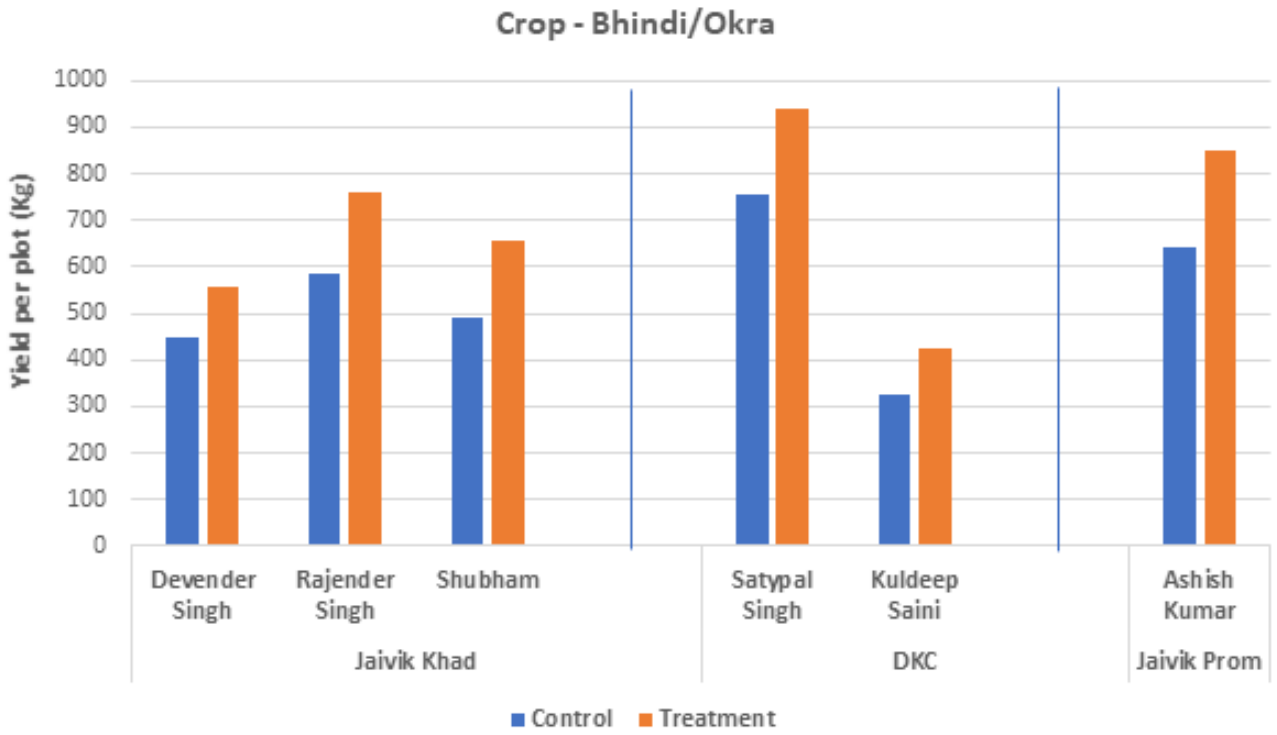


Photo-plate 6.2a: Effects of Ganga sludge-based organic manures on yield potential of different crops growing in District Dehradun.



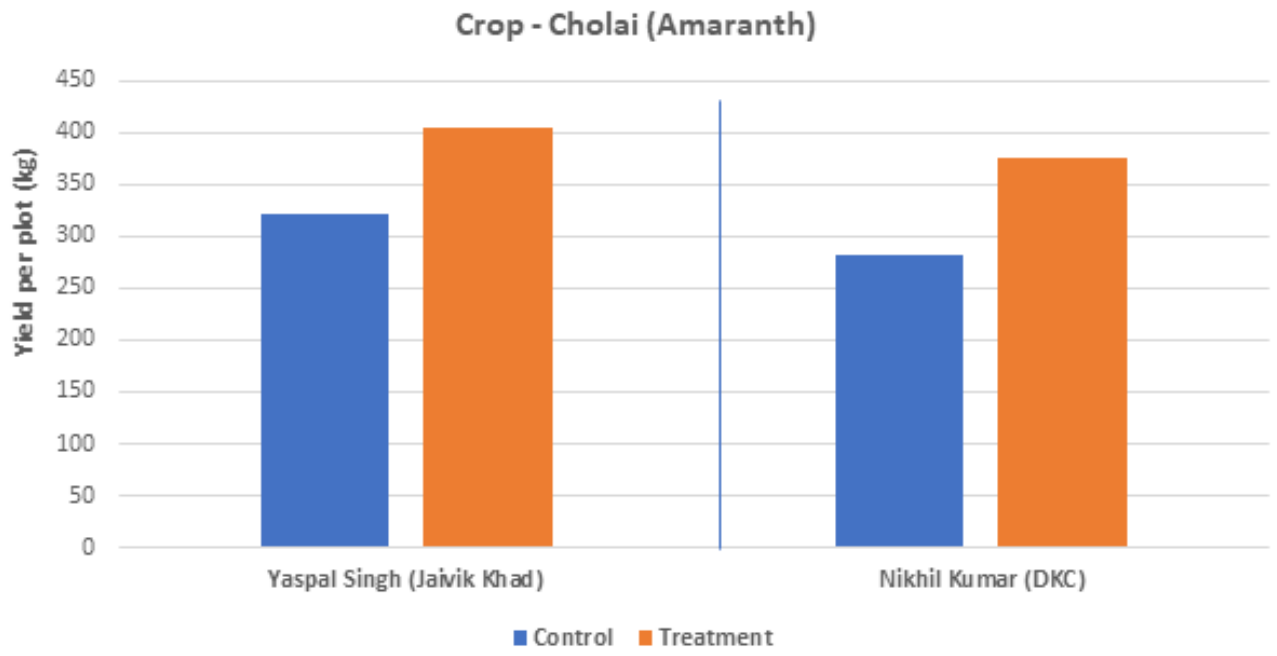


Photo-plate 6.2b: Effects of Ganga sludge-based organic manures on yield potential of different crops growing in District Dehradun.



Figure 6.14. Pictorial glimpses of interaction, selection, DKD training under NMCG project in Dehradun district of Uttarakhand



Figure 6.15. Pictorial glimpses of crops in the farmer fields of Dehradun district under field trials of NMCG project

UTTARKASHI

In Uttarkashi district, a total of seven (07) farmers belonging to three (03) villages (Setwari, Diyari and Rikhaun) were included in the present study. Total three (03) crops were evaluated to study the effects of Ganga sludge-based organic manures (Table 6.17).

Table 6.17. Detailed information about the number of farmers included, crops and manure used in Uttarkashi district

Sample code	Name	Village	Crop	Manure used
NMCGU001	Chatar Singh	Setwari	Tomato	Natural Pori Potash
NMCGU002	Inder Singh	Diyari	Tomato	Natural Pori Potash
NMCGU003	Bhagtu Lal	Setwari	Capsicum	Jaivik Prom
NMCGU004	Gulabu Singh	Setwari	Tomato	Jaivik Prom
NMCGU005	Dinesh Panwar	Rikhaun	Tomato	Jaivik Khad
NMCGU006	Pyar Singh	Rikhaun	Tomato	Dharti ka Chowkidar
NMCGU007	Meena Devi	Rikhaun	Sweet corn	Jaivik Khad

The agro-meteorological data for Uttarkashi district revealed that, temperature (minimum) was observed in the range of 2.9 -17.6 °C, while it was observed 17.4 - 24.6 °C (maximum) during the study period. The rainfall (in inches) during the study period ranged from a minimum of three (3) inches to a maximum of 19 inches. The detailed agro-meteorological data for the district of Uttarkashi is given in Table 6.18.

Table 6.18. Agro-meteorological data of district Uttarakashi (Uttarakhand) India

Duration	Temperature		Rainfall (In Inch)
	Minimum (in °C)	Maximum (in °C)	
March -2025	2.9	17.4	3
April -2025	6.7	21.8	3
May -2025	10.8	24.5	3
June -2025	15.3	24.6	8
July -2025	17.6	22.9	19
August -2025	17.1	22.5	17

(**Source:** Agro-meteorology section weather Spark)

The analysis of soil samples collected from fields in the Uttarakashi district selected for the current project study revealed variations in physical properties and nutrient compositions. The physical properties of the soil of the study area are generally observed as alluvial soil. The organic carbon is found to be variable in the moderate to very high range, whereas pH was observed as normal. The electrical conductivity was also found to be normal to slightly critical for salt-sensitive crops. A variation in available Nitrogen, Phosphorus and Potassium was also observed after the analysis of different soil samples. A detailed report of soil parameters is presented in Table 6.19.

Table 6.19. Soil properties of different soil samples collected in district Uttarakashi, Uttarakhand, India

Sample Code	pH	Organic Carbon (%)	Electrical Conductivity (dS/m)	Available Nitrogen (Kg/ha)	Available Phosphorus (Kg/ha)	Available Potassium (Kg/ha)
NMCGU001	6.63	5.1	0.81	264.26	243.25	399.24
NMCGU002	6.33	4.76	0.98	229.97	126.86	147.65
NMCGU003	5.60	5.98	0.98	397.23	331.39	291.39
NMCGU004	6.27	5.98	0.28	334.09	282.02	316.92
NMCGU005	6.10	5.38	0.40	337.85	41.09	332.94
NMCGU006	7.40	8.56	0.40	349.14	473.63	410.44
NMCGU007	7.87	9.56	0.38	376.74	445.43	569.82

Effects of Ganga sludge-based organic manures on growth parameters

Based on the observations recorded for the evaluation of Ganga sludge-based organic manures in crops (tomato, capsicum & sweet corn) during the field experimentation, it may be concluded that growth in terms of increase in plant height (in cm), leaf area (in (cm^2), chlorophyll, total number of branches and number of fruits or bunch/plant was observed in treatment plots in comparison to control. A brief account of the effects on growth parameters of different crops treated with Ganga sludge-based organic manures and their control (no manure) is given below (Table 6.20):

Table 6.20. Effects of Ganga sludge-based organic manures on growth parameters

Farmer detail/Crop	Plant Height (in cm)		Leaf area in (cm^2)		Chlorophyll		Total No. of Branches		No. of Fruits/ Bunch/Plant		No. of Bunch/Plant	
	C	T	C	T	C	T	C	T	C	T	C	T
Chatar Singh NMCGU001 (Tomato)	117 ± 7.58	192.6 ± 3.97	62.62 ± 6.58	73.34 ± 7.59	52.36 ± 7.92	59.2 ± 3.24	4 ± 0.71	6.2 ± 0.84	5.2 ± 1.30	9.6 ± 0.55	9 ± 1.22	14.2 ± 1.10
Inder Singh NMCGU002 (Tomato)	170.6 ± 14.38	201.6 ± 9.66	64.444 ± 7.42	79.86 ± 4.28	56.08 ± 5.21	56.86 ± 5.34	4.2 ± 0.84	6.2 ± 0.84	6.4 ± 1.14	10 ± 0.71	9.6 ± 2.07	13.2 ± 1.92
Bhagtu Lal NMCGU003 (Capsicum)	46.4 ± 4.04	81.2 ± 3.42	67.5 ± 5.96	94.4 ± 8.20	50.96 ± 4.98	56.78 ± 2.33	3.6 ± 0.55	5 ± 0.71	6.6 ± 1.34	10.2 ± 1.10	NA	NA
Gulabu Singh NMCGU004 (Tomato)	151.2 ± 5.26	172.8 ± 7.40	53.362 ± 4.27	76.56 ± 2.67	50.08 ± 5.28	57.56 ± 2.67	4 ± 0.71	7.2 ± 0.84	5.6 ± 0.89	8.8 ± 0.84	6 ± 0.71	12.00 ± 0.71
Dinesh Panwar NMCGU005 (Tomato)	128.6 ± 4.62	171.8 ± 4.32	35.55 ± 4.94	57.62 ± 6.39	48.22 ± 4.40	52.54 ± 3.95	5.8 ± 0.84	9.6 ± 0.55	4.6 ± 0.89	7.6 ± 0.55	5.8 ± 0.84	9.8 ± 0.84
Pyar Singh NMCGU006 (Tomato)	151.8 ± 18.34	211.2 ± 21.48	64.46 ± 5.0	72.06 ± 6.17	47.66 ± 2.71	54.76 ± 3.28	5.8 ± 0.84	9.2 ± 0.84	4.8 ± 0.84	7.8 ± 1.30	6.6 ± 1.34	9.8 ± 1.79
Meena Devi NMCGU007 (Sweet corn)	175.6 ± 25.01	203.2 ± 31.33	565.18 ± 16.06	657.22 ± 7.33	62.02 ± 7.44	67.18 ± 5.73	NA	NA	NA	NA	NA	NA

Effects of Ganga sludge-based organic manures on yield parameters

Similar to growth, a significant increase in the yield of all types of crops (tomato, capsicum & sweet corn) was observed during the present study. Based on the results, an increase in yield per plant, plot and total yield was found compared to the control. The final yield of sweet corn is yet to be calculated as the crop is still growing. The increased yield of different crops treated with Ganga sludge-based organic manure in comparison to the control (no manure) is presented in Table 6.21 & Photo-plate 6.3.

Table 6.21. Effects of Ganga sludge-based organic manures on yield parameters

Farmer detail and crop	Yield /Plant (g)		Yield /Plot (kg)		Other Yield/Plot (kg)		Total Yield/Plot (kg)	
	C	T	C	T	C	T	C	T
Chatar Singh NMCGU001 (Tomato)	198.5 ± 14.08	251.75 ± 16.05	215.25	286.75	629.0	812.0	844.25	1098.75
Inder Singh NMCGU002 (Tomato)	226.56 ± 12.29	269.59 ± 16.89	185.0	238.12	578.45	768.65	763.45	1006.77
Bhagtu Lal NMCGU003 (Capsicum)	119.39 ± 7.36	197.34 ± 13.78	300	385	480	565	780	950
Gulabu Singh NMCGU004 (Tomato)	192.19 ± 13.49	264.92 ± 14.53	185.4	225.62	561.00	735.0	746.4	960.62
Dinesh Panwar NMCGU005 (Tomato)	161.06 ± 8.12	197.98 ± 11.00	272.5	314.00	485.00	638.50	757.5	952.5
Pyar Singh NMCGU006 (Tomato)	159.82 ± 10.06	190.72 ± 12.28	269.8	337.82	556.00	733.0	825.8	1070.82
Meena Devi NMCGU007 (Sweet corn)	246.6 ± 6.35	275.6 ± 5.55	760	992			760	992

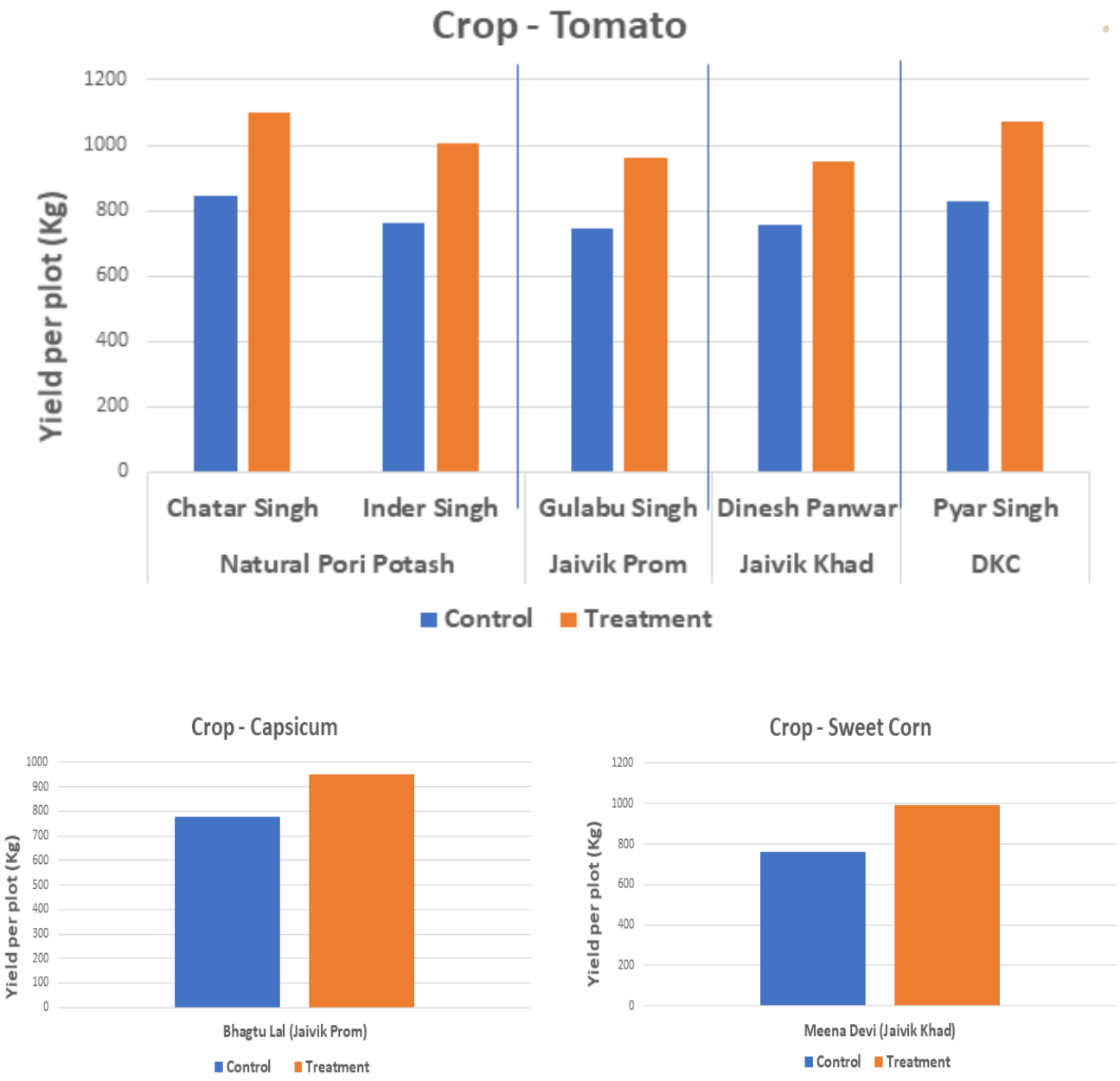


Photo-plate 6.3: Effects of Ganga sludge-based organic manures on yield potential of different crops growing in District Uttarkashi.



Figure 6.16. Selection of the farmers under NMCG project in Uttarakashi district of Uttarakhand



Figure 6.17. Pictorial glimpses of the implementation of project in the farmer fields of Uttarakashi district



Figure 6.18. Pictorial glimpses of yield attributes and distribution of bio-agent kits to the farmers of Uttarakashi district

PAURI-GARHWAL

In Pauri-Garhwal district, a total of six (06) farmers belonging to a single (01) village (Mala) were included in the present study. Total four (04) crops were evaluated to study the effects of four (04) organic Ganga sludge-based organic manures (Table 6.22).

Table 6.22. Detailed information about the number of farmers included, crops and manure used in Pauri-Garhwal district

Sample Code	Name	Village	Crop	Manure used
NMCGP001	Anand Singh	Mala	Bhindi/Okra	Jaivik Khad
NMCGP002	Akbeer Singh	Mala	Bhindi/Okra	Jaivik Khad
NMCGP003	Gabbar Singh	Mala	Bhindi/Okra	Dharti ka Chowkidar
NMCGP004	Rajpal	Mala	Cholai (Amaranth)	Natural Pori Potash
NMCGP005	Vikram Singh Negi	Mala	Capsicum	Jaivik Prom
NMCGP006	Hukum Singh Negi	Mala	Onion	Jaivik Khad

The agro-meteorological data for Pauri-Garhwal district revealed that, temperature (minimum) was observed in the range of 11.71 -21.71 °C, while it was observed 28.52 - 38.3 °C (maximum) during the study period. The rainfall (in inches) during the study period was found minimum of 1.65 inches, while a maximum of 26.85 inches. The detailed agro-meteorological data for the district Pauri-Garhwal is given in Table 6.23.

Table 6.23. Agro-meteorological data of district Pauri-Garhwal of Uttarakhand, India

Duration	Temperature		Rainfall (In Inch)
	Minimum (in °C)	Maximum (in °C)	
March -2025	11.71	28.52	1.71
April -2025	16.12	34.27	1.65
May -2025	19.62	38.1	2.23
June -2025	21.73	38.3	7.5
July -2025	20.92	33.29	24.04
August -2025	19.62	31.33	26.85

(**Source:** Agro-meteorology section weather Spark)

The analysis of soil samples collected from fields in Pauri-Garhwal district selected for the current project study revealed variations in physical properties and nutrient compositions. The physical properties of the soil of the study area are generally observed as alluvial, sandy loam to red to dark. The organic carbon is found to be in the high range, whereas pH was observed as normal. The electrical conductivity was also found to be normal. A variation in available Nitrogen, Phosphorus and Potassium was also observed after the analysis of different soil samples. A detailed report of soil parameters is presented in Table 6.24.

Table 6.24. Soil properties of different soil samples collected in district Pauri-Garhwal

Sample Code	pH	Organic Carbon (%)	Electrical Conductivity (dS/m)	Available Nitrogen (Kg/ha)	Available Phosphorus (Kg/ha)	Available Potassium (Kg/ha)
NMCGP001	6.45	7.89	0.03	277.64	54.36	70.97
NMCGP002	6.32	8.29	0.03	283.91	66.59	74.44
NMCGP003	6.25	7.94	0.03	312.35	82.51	80.43
NMCGP004	7.19	8.92	0.03	317.70	95.87	115.55
NMCGP005	6.26	9.04	0.02	331.58	39.34	112.86
NMCGP006	6.79	8.59	0.02	293.95	78.11	167.18

Effects of Ganga sludge-based organic manures on growth parameters

Based on the observations recorded for the evaluation of Ganga sludge-based organic manures in crops (Bhindi/Okra, Cholai, Capsicum & Onion) during the field experimentation, it may be concluded that increase in growth in terms plant height (in cm), leaf area (in cm^2), chlorophyll, total number of branches and number of fruits or bunch/plant was observed in treatments plots in comparison to control. Comparative effects of Ganga sludge-based organic manures and control (no manure) on growth parameters of various crops (Bhindi/Okra, Cholai, Capsicum & Onion) is given in Table 6.25.

Table 6.25. Effects of Ganga sludge-based organic manures on growth parameters

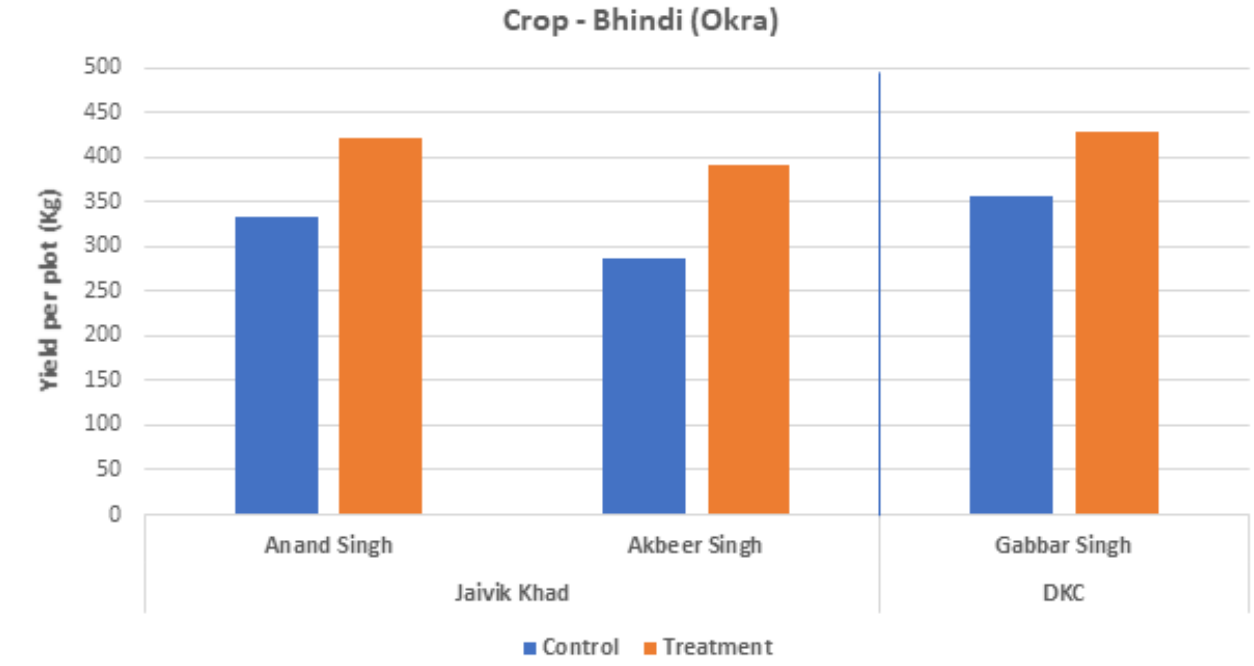
Farmer detail and crop	Plant Height (cm)		Leaf Area (cm^2)		No. of leaves/ Plant		Chlorophyll		Total No. of Branches		Onion Bulb Diameter (cm)		Onion Bulb Weight (g)	
	C	T	C	T	C	T	C	T	C	T	C	T	C	T
Anand Singh NMCGP001 (Bhindi/ Okra)	78 ± 6.12	93 ± 4.30	64.22 ± 6.03	71.72 ± 8.43	NA	NA	63.42 ± 2.73	67.68 ± 1.95	2.2 ± 0.84	2.8 ± 0.84	NA	NA	NA	NA
Akbeer Singh NMCGP002 (Bhindi/ Okra)	68.6 ± 3.78	85.8 ± 4.76	119.16 ± 6.45	153.34 ± 13.48	NA	NA	64.92 ± 4.21	72.28 ± 2.44	3.4 ± 0.55	3.8 ± 0.45	NA	NA	NA	NA
Gabbar Singh NMCGP003 (Bhindi/ Okra)	84 ± 5.15	92.6 ± 4.83	70.51 ± 9.01	77.23 ± 8.01	NA	NA	63.2 ± 8.81	70.92 ± 8.11	2.2 ± 0.45	3 ± 0.71	NA	NA	NA	NA
Rajpal NMCGP004 (Cholai)	45.4 ± 3.36	60.8 ± 2.77	114.14 ± 8.91	119.21 ± 2.35	17 ± 2.12	25 ± 2.55	44.1 ± 2.18	61.42 ± 3.75	NA	NA	NA	NA	NA	NA
Vikram Singh Negi NMCGP005 (Capsicum)	41.4 ± 2.61	51.6 ± 9.02	57.65 ± 5.65	82.08 ± 6.78	NA	NA	56.1 ± 6.42	70.12 ± 2.60	3 ± 0.71	5.4 ± 1.14	NA	NA	NA	NA
Hukum Singh Negi NMCGP006 (Onion)	24.52 ± 3.22	34.22 ± 3.45	24.98 ± 7.32	39.02 ± 3.91	5.8 ± 0.84	7.4 ± 0.89	57.06 ± 2.94	64.64 ± 3.84	NA	NA	3.26 ± 0.15	4.04 ± 0.23	88.8 ± 4.44	102.8 ± 3.11

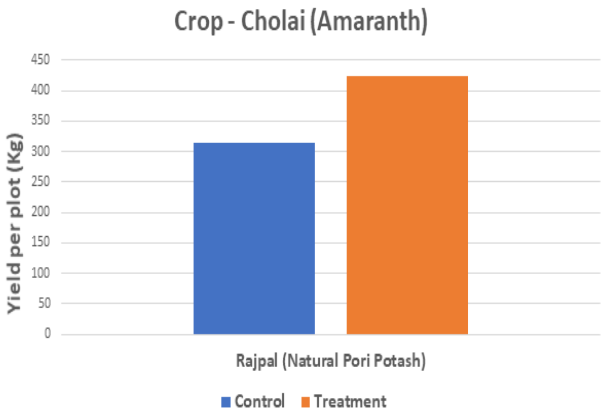
Effects of Ganga sludge-based organic manures on yield parameters

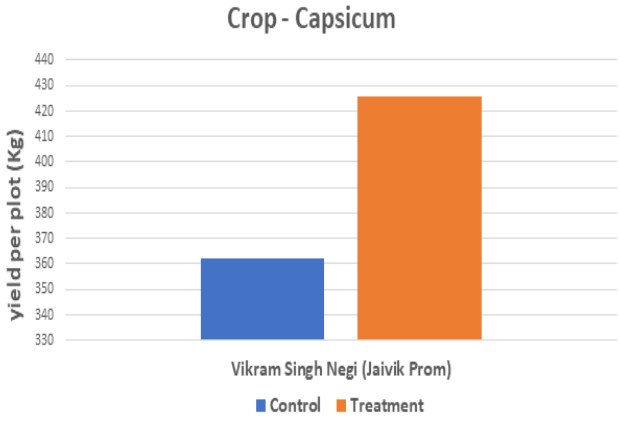
Similar to growth, a significant increase in the yield of all types of crops (okra, cholai, capsicum & onion) was observed during the present study. The results showed an increase in yield per plant, plot and total yield compared to the control (no manure). A comparative account of Ganga sludge-based organic manures and control (no manure) on the yield of various crops (Bhindi/Okra, Cholai, Capsicum & Onion) is given in Table 6.26 & Photo-plate 6.4.

Table 6.26. Effects of Ganga sludge-based organic manures on yield parameters

Farmer detail and crop	No. of Fruits/ Plant		Yield / Plant (g)		Yield/ Plot (kg)		Other Yield/ Plot (kg)		Total Yield/ Plot (kg)	
	C	T	C	T	C	T	C	T	C	T
Anand Singh NMCGP001 (Bhindi/Okra)	2.2 ± 0.84	3 ± 0.71	82.67 ± 5.86	104.17 ± 9.42	69.46	110.48	264	310	333.46	420.48
Akbeer Singh NMCGP002 (Bhindi/Okra)	4.4 ± 0.55	8.4 ± 0.55	68.8 ± 11.39	100.2 ± 12.40	67.53	85.18	275	345	342.53	430.18
Gabbar Singh NMCGP003 (Bhindi/Okra)	3.4 ± 0.55	4 ± 1.00	114.87 ± 6.40	162.43 ± 8.96	72.64	104.45	284	325	356.64	429.45
Rajpal NMCGP004 (Cholai)	NA	NA	54 ± 5.29	71.8 ± 6.83	315	425	NA	NA	315	425
Vikram Singh Negi NMCGP005 (Capsicum)	8 ± 1.22	10 ± 1.87	140.35 ± 17.14	171.10 ± 11.12	128.34	158.67	234	267	362.34	425.67
Hukum Singh Negi NMCGP006 (Onion)	NA	NA	NA	NA	424.00	565	NA	NA	424.00	565







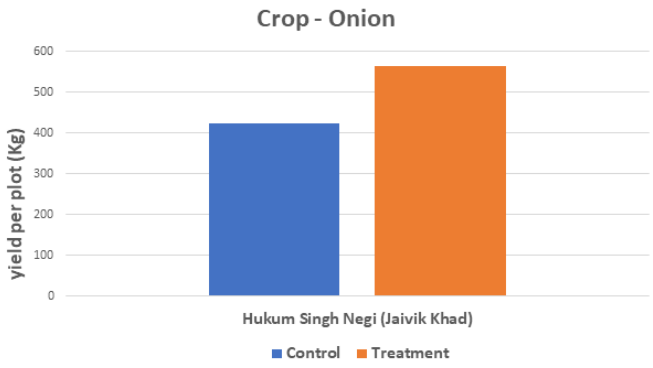


Photo-plate 6.4: Effects of Ganga sludge-based organic manures on yield potential of different crops growing in District Pauri-Garhwal.



Figure 6.19. Pictorial glimpses of implementation of project in the farmer fields of Pauri-Garhwal district of Uttarakhand

TEHRI-GARHWAL

In Tehri-Garhwal district, a total of five (05) farmers belonging to a single (01) village (Bhut Gaon) were included in the present study. Total two (02) crops were evaluated to study the effects of organic Ganga sludge-based organic manures (Table 6.27).

Table 6.27. Detailed information about the number of farmers included, crops and manure used in Tehri-Garhwal district

Sample Code	Name	Village	Crop	Manure used
NMCGT001	Mahipal Singh	Bhut Gaon (Dwarikapuri)	Capsicum	Jaivik Khad
NMCGT002	Surbeer Singh	Bhut Gaon (Dwarikapuri)	Capsicum	Jaivik Khad
NMCGT003	Rajender Singh	Bhut Gaon (Dwarikapuri)	Capsicum	Dharti ka Chowkidar
NMCGT004	Jasveer Singh	Bhut Gaon (Dwarikapuri)	Capsicum	Natural Pori Potash
NMCGT005	Jaspal Chauhan	Bhut Gaon (Dwarikapuri)	Tomato	Natural Pori Potash

The agro-meteorological data for Tehri-Garhwal district revealed that, temperature (minimum) was observed in the range of 3.0 -15.0 °C, while it was observed 22.22 - 31.23 °C (maximum) during the study period. Besides, the rainfall (in inches) during the study period was found minimum of 1.13 inches, while a maximum of 23.43 inches. The detailed agro-meteorological data for the district Tehri-Garhwal is given in Table 6.28.

Table 6.28. Agro-meteorological data of district Tehri-Garhwal of Uttarakhand, India

Duration	Temperature		Rainfall (In Inch)
	Minimum (in °C)	Maximum (in °C)	
March -2025	3.0	22.22	2.11
April -2025	7.0	27.54	1.13
May -2025	10.0	30.89	1.99
June -2025	12.0	31.23	6.52
July -2025	15.0	27.06	22.95
August -2025	15.0	25.47	23.43

(**Source:** Agro-meteorology section weather Spark)

The analysis of soil samples collected from fields in Tehri-Garhwal district selected for the current project study revealed variations in physical properties and nutrient compositions. The physical properties of the soil of the study area are generally observed as sandy loam to silty clay loam. The organic carbon is found to be in high range, whereas pH was observed as slightly acidic to normal. The electrical conductivity was also found to be normal. A variation in available Nitrogen, Phosphorus and Potassium was also observed after the analysis of different soil samples. A detailed report of soil parameters is presented in Table 6.29.

Table 6.29. Soil properties of different soil samples collected in district Tehri-Garhwal

Sample Code	pH	Organic Carbon (%)	Electrical Conductivity (dS/m)	Available Nitrogen (Kg/ha)	Available Phosphorus (Kg/ha)	Available Potassium (Kg/ha)
NMCGU001	5.97	3.42	0.05	223.28	150.55	81.86
NMCGU002	6.03	2.48	0.95	213.67	114.94	100.95
NMCGU003	7.30	4.40	0.06	277.64	337.87	169.42
NMCGU004	6.80	2.58	0.05	223.28	130.47	103.11
NMCGU005	7.21	1.31	0.41	309.70	321.70	214.90

Effects of Ganga sludge-based organic manures on growth parameters

Based on the observations recorded for the evaluation of Ganga sludge-based organic manures in crops (capsicum & tomato) during the field experimentation, it may be concluded that growth based on the observations recorded increase in plant height (in cm), leaf area (in (cm^2), chlorophyll, total number of branches and number of fruits or bunch/plant was observed in treatments plots in comparison to control. The enhanced growth effects in capsicum & tomato crops treated with Ganga sludge-based organic manures in comparison to their control (no manure) are given in Table 6.30.

Table 6.30. Effects of Ganga sludge-based organic manures on growth parameters

Farmer detail and crop	Plant Height (cm)		Leaf Area (cm^2)		Chlorophyll		Total No. of Branches		No. of Fruits/ Plant		No. of Bunch/Plant	
	C	T	C	T	C	T	C	T	C	T	C	T
Mahipal Singh NMCGT001 (Capsicum)	53 ± 8.46	74 ± 4.18	70.31 ± 12.36	89.57 ± 15.77	53.52 ± 6.65	71.48 ± 5.75	3.6 ± 0.55	6.2 ± 2.68	6.6 ± 4.22	13.6 ± 1.82	NA	NA
Surbeer Singh NMCGT002 (Capsicum)	49 ± 7.97	71.6 ± 10.36	60.77 ± 12.30	92.28 ± 2.56	47.98 ± 4.18	68.64 ± 7.38	4 ± 0.71	6 ± 0.71	4.6 ± 1.14	9.8 ± 0.84	NA	NA

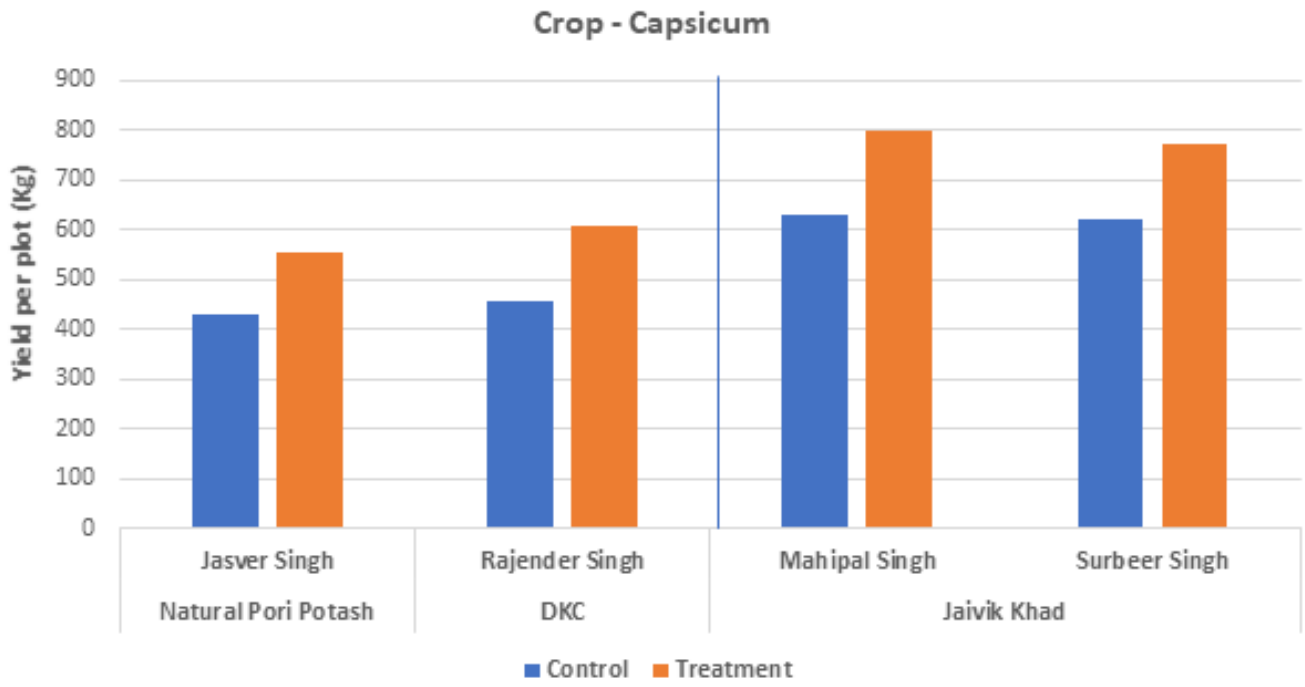
Farmer detail and crop	Plant Height (cm)		Leaf Area (cm^2)		Chlorophyll		Total No. of Branches		No. of Fruits/ Plant		No. of Bunch/Plant	
	C	T	C	T	C	T	C	T	C	T	C	T
Rajender Singh NMCGT003 (Capsicum)	38.8 ± 2.59	52.8 ± 15.40	66.23 ± 4.86	81.62 ± 13.81	53.68 ± 8.37	68.58 ± 3.99	3 ± 0.71	5 ± 1.58	6.8 ± 1.92	8.8 ± 2.77	NA	NA
Jasveer Singh NMCGT004 (Capsicum)	48 ± 6.96	69.6 ± 5.03	64.96 ± 3.12	84.79 ± 6.62	56.78 ± 8.20	69.06 ± 5.58	3.4 ± 0.55	6.6 ± 1.52	4 ± 1.58	11 ± 2.00	NA	NA
Jaspal Chauhan NMCGT005 (Tomato)	150.6 ± 16.56	211.2 ± 19.92	62.42 ± 6.92	83.68 ± 9.01	39.34 ± 19.58	58.38 ± 5.74	5.2 ± 1.30	11.2 ± 1.64	6.8 ± 1.79	8.4 ± 3.36	6 ± 1.41	14 ± 1.87

Effects of Ganga sludge-based organic manures on yield parameters

Similar to growth, a significant increase in the yield of all types of crops (capsicum & tomato) was observed during the present study. Based on the results, an increase in yield per plant, plot and total yield was found as compared to the control. A comparative account of Ganga sludge-based organic manures and control (no manure) on the yield of various crops (capsicum & tomato) is given in Table 6.31 & Photo-plate 6.5.

Table 6.31. Effects of Ganga sludge-based organic manures on yield parameters

Farmer detail and crop	Yield / Plant (g)		Yield / Plot (kg)		Other Yield/ Plot (kg)		Total Yield/ Plot (kg)	
	C	T	C	T	C	T	C	T
Mahipal Singh NMCGT001 (Capsicum)	110.86 ± 33.74	184.33 ± 39.41	252	375	378	423	630	798
Surbeer Singh NMCGT002 (Capsicum)	98.82 ± 17.97	130.90 ± 15.66	265	287	355	483	620	770
Rajender Singh NMCGT003 (Capsicum)	110.97 ± 41.54	164.27 ± 22.80	125.39	160.54	332	448	457.39	608.54
Jasveer Singh NMCGT004 (Capsicum)	109.82 ± 31.19	131.10 ± 48.84	146	185	284	367	430	552
Jaspal Chauhan NMCGT005 (Tomato)	128.76 ± 47.06	272.09 ± 16.30	225.33	303	525	668	750.33	971



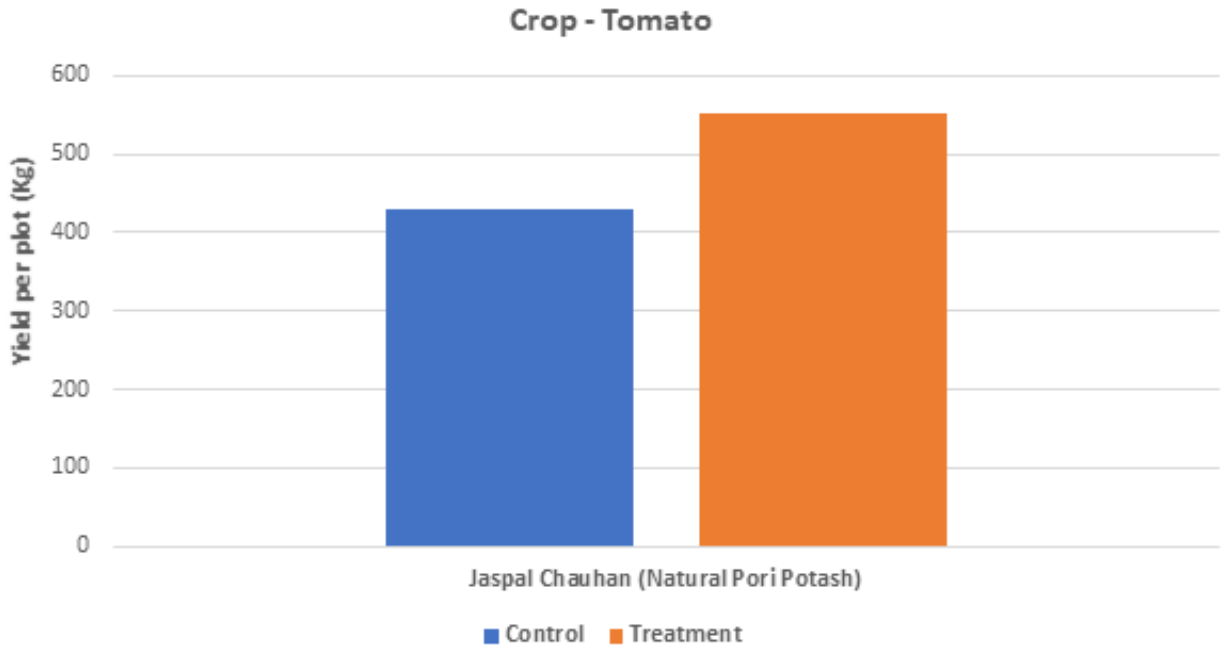


Photo-plate 6.5: Effects of Ganga sludge-based organic manures on yield potential of different crops growing in District Tehri-Garhwal.



Figure 6.20. Farmers selection and DKD training under NMCG project in Tehri-Garhwal district (Uttarakhand)



Figure 6.21. Pictorial glimpses of the implementation of the project in the farmer fields of Tehri-Garhwal district of Uttarakhand

Effect on net profit and benefit-cost (B: C) ratio:

Data on economic parameters were calculated based on the total cost of cultivation among the treatments, and the total yield (per experimental plot and per acre). The results obtained are presented as net profit and benefit-cost (B: C) ratio. Overall, the crop cultivation in different districts under different treatments shows an increased net profit and strong benefit-cost ratios. The general parameters involved in the calculation of the per-acre cost of cultivation are presented in Table 6.32. The general formula used to calculate the benefit-cost ratio is given below:

Benefit-Cost Ratio (BCR) = Present Value (PV) of Benefits / Present Value (PV) of Costs

Table 6.32 Detailed analysis of the per-acre cost of cultivation

Sr. No	Items of expenditure (Input)
1.	Cost involved in Field Preparation
2.	Cost involved for Seeds or Planting material
3.	Cost involved for Irrigation
4.	Fertilizers cost
5.	Cost involved in Fertigation
6.	Weed control and inter-culture practices
7.	Harvesting and cleaning
8.	Interest on working capital
9.	Dhulan (Transport)

6.5 General outputs in terms of percentage (%age) increase in yield

HARIDWAR

Total seven crops were analyzed under NMCG project in the Haridwar district, of which six crops have been completed upto harvesting, while a single crop (Sugarcane) is still growing in the fields. The percentage (%age) increase in yield in different crops with the use of Ganga sludge-based organic manures is given below:

Dharti Ka Chowkidar (DKC)

- Bhindi: About 32% increase in yield was observed.
- Cowpea: About 26% increase in yield was observed.

Jaivik Khad

- Rice (60 days): About 17% increase in yield was observed.
- Brinjal: About 20 – 33% increase in yield was observed.
- Black Gram: About 27% increase in yield was observed.

Jaivik Prom

- Menthol: About 32% increase in yield was observed.

Natural Pori Potash

- Bhindi: About 25% increase in yield was observed.

DEHRADUN

Seven crops were analyzed under NMCG project in the district Dehradun, of which six crops have been completed upto harvesting, while a single crop (Sugarcane) is still growing in the fields. The percentage (%age) increase in yield in different crops with the use of Ganga sludge-based organic manures is given below:

Dharti Ka Chowkidar (DKC)

- Tulsi: About 28% increase in yield was observed.
- Mint: About 22% increase in yield was observed.
- Cholai: About 33% increase in yield was observed.
- Bhindi: About 24-30% increase in yield was observed.
- Cucumber: About 21% increase in yield was observed.

Jaivik Khad

- Cholai: About 25% increase in yield was observed.
- Karela: About 37% increase in yield was observed.
- Bhindi: About 24-32% increase in yield was observed.
- Sweet Corn: About 31% increase in yield was observed.

Jaivik Prom

- Bhindi: About 32% increase in yield was observed

Natural Pori Potash

- Cucumber: About 18% increase in yield was observed.

UTTARKASHI

Three crops namely, sweet corn, capsicum and tomato were analyzed under NMCG project in district Uttarkashi. All the crops have been completed upto harvesting. The percentage (%age) increase in yield in different crops with the use of Ganga sludge based organic manures is given below:

Dharti Ka Chowkidar (DKC)

- Tomato: About 29% increase in yield was observed.

Jaivik Khad

- Tomato: About 26% increase in yield was observed.
- Sweet Corn: About 30% increase in yield was observed.

Jaivik Prom

- Tomato: About 29-31% increase in yield was observed.
- Capsicum: About 21% increase in yield was observed

Natural Pori Potash

- Tomato: About 30-31% increase in yield was observed.

PAURI-GARHWAL

Three crops namely, bhindi/okra, capsicum, cholai and onion were analyzed under NMCG project in district Pauri-Garhwal. All the crops have been completed upto harvesting. The percentage (%age) increase in yield in different crops with the use of Ganga sludge based organic manures is given below:

Dharti Ka Chowkidar (DKC)

- Bhindi: About 20% increase in yield was observed.

Jaivik Khad

- Bhindi: About 25-26% increase in yield was observed.
- Onion: About 33% increase in yield was observed.

Jaivik Prom

- Capsicum: About 17% increase in yield was observed

Natural Pori Potash

- Cholai: About 34% increase in yield was observed.

TEHRI-GARHWAL

Three crops namely, capsicum and tomato were analyzed under NMCG project in district Tehri-Garhwal. All the crops have been completed upto harvesting. The percentage (%age) increase in yield in different crops with the use of Ganga sludge based organic manures is given below:

Dharti Ka Chowkidar (DKC)

- Capsicum: About 33% increase in yield was observed.

Jaivik Khad

- Capsicum: About 24-26% increase in yield was observed.

Jaivik Prom

- Capsicum: About 17% increase in yield was observed

Natural Pori Potash

- Capsicum: About 28% increase in yield was observed.
- Tomato: About 29% increase in yield was observed.

HARIDWAR



Farmer Name: Sachin Saini (NMCGH001)

Village: Ahmedpur Grant

District: Haridwar

Crop: Rice (60 days)

Total cost incurred for different treatments of Rice Crop per Bigha (770 Square Meter)

Treatment details	Treatment cost of Rs/Bigha	Common cultivation Cost of Rs/Bigha	Total cost of cultivation Rs/Bigha	Rice yield (qtl/Bigha)	Rice Selling Price @ 2500/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	485.77	2965.37	3451.14	3.52	8800	5326.13	2.54
Jaivik Khad @ 80 kg/ acre + FYM @ 85 qtl/ acre	942.97	2965.37	3908.34	4.1	10301.27	6392.93	2.64
Total	**1428.75**	**5930.73**	**7359.48**	**7.63**	**19078.55**	**11719.07**	2.59

Total cost incurred for different treatments of Rice Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/acre	Common cultivation cost of Rs/ acre	Total cost of cultivation Rs/acre	Rice yield (qtl/acre)	Rice Selling Price @ 2500/ quintal (qtl)	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	2550	15566.25	18116.25	18.43	46075	27958.75	2.54
Jaivik Khad @ 80 kg / acre + FYM @ 85qtl/acre	4950	15566.25	20516.25	21.63	54075	33558.75	2.64
Total	**7500**	**31132.5**	**38632.5**	**40.06**	**100150**	**61517.50**	2.59

The final yield of rice has been found to be increased by more than 17% in treatment (with the use of Jaivik Khad) as compared to control.



Farmer Name: Aakash Saini(NMCGH002)

Village: Jaswawala

District: Haridwar

Crop: Bhindi/Okra

Total cost incurred for different treatments of Bhindi Crop per Plot (385 Square Meter)

Treatment details	Treatment cost of Rs/ 385 Square meter	Common cultivation Cost of Rs/ 385 Square meter	Total cost of cultivation Rs/ 385 Square meter	Bhindi yield (qtl/ 385 Square meter)	Bhindi Selling Price @ 3200/ quintal (qtl)	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	242.89	3135.39	3378.27	4.07	13024.00	9645.81	3.86
Dharti ka Chowkidar @ 10 kg /acre + FYM @ 85 qtl/acre	319.09	3135.39	3454.47	5.4	17280.00	13824.61	5.00
Total	**561.97**	**6270.78**	**6832.75**	**9.47**	**30303.18**	**23470.43**	**4.43**

Total cost incurred for different treatments of Bhindi Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/acre	Common cultivation cost of Rs/acre	Total cost of cultivation Rs/acre	Bhindi yield (qtl/acre)	Bhindi Selling Price @ 3200/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	2550	32917.5	35467.5	42.73	136736	101268.5	3.86
Dharti ka Chowkidar @ 10 kg /acre + FYM @ 85qtl/acre	3350	32917.5	36267.5	56.69	181408	145140.5	5.00
Total	**5900**	**65835**	**71735**	**99.42**	**318144**	**246409**	4.43

The final yield of Okra/Bhindi has been found to be increased by more than 32% in treatment (with the use of Dharti Ka Chowkidar) as compared to control.



Farmer Name: Mahepal (NMCGH0011)

Village: Sohalpur Sikrodha

District: Haridwar

Crop: Brinjal

Total cost incurred for different treatments of Brinjal Crop per Bigha (770 Square Meter)

Treatment details	Treatment cost of Rs/770 Square meter	Common cultivation Cost of Rs/ Bigha	Total cost of cultivation Rs/ Bigha	Brinjal yield (qtl/ Bigha)	Brinjal Selling Price @ 2500/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	485.77	4482.55	4968.33	5.94	14850.00	9881.13	2.99
Jaivik Khad @ 80 kg/ acre + FYM @ 85 qtl/ acre	942.97	4482.55	5425.53	7.18	17950.00	12524.31	3.31
Total	**1428.75**	**8965.11**	**10393.86**	**13.12**	**32799.29**	**22405.44**	3.16

Total cost incurred for different treatments of Brinjal Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/acre	Common cultivation cost of Rs/acre	Total cost of cultivation Rs/ acre	Brinjal yield (qtl/acre)	Brinjal Selling Price @ 2500/quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	2550	23530.5	26080.5	31.18	77950	51869.5	2.99
Jaivik Khad @ 80 kg / acre + FYM @ 85qtl/acre	4950	23530.5	28480.5	37.69	94225	65744.5	3.31
Total	**7500**	**47061**	**54561**	**68.87**	**172175**	**117614.00**	3.16

The final yield of Brinjal has been found to be increased by more than 20% in treatment (with the use of Jaivik Khad) as compared to control.



Farmer Name: Munna Lal (NMCGH0012)

Village: Ibrahimpur Masahi

District: Haridwar

Crop: Menthol

Total cost incurred for different treatments of Menthol Crop per Plot (385 Square Meter)

Treatment details	Treatment cost of Rs/ 385 Square meter	Common cultivation Cost of Rs/ 385 Square meter	Total cost of cultivation Rs/ 385 Square meter	Menthol yield (qtl/ 385 Square meter)	Menthol Selling Price @ 3500/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	242.89	2010.25	2253.14	3.5	12251.52	9998.38	5.44
Jaivik Prom @ 100 kg / acre+ FYM @ 85qtl/ acre	442.91	2010.25	2453.16	4.65	16275.35	13822.19	6.63
Total	**685.80**	**4020.50**	**4706.30**	**8.15**	**28526.86**	**23820.57**	**6.06**

Total cost incurred for different treatments of Menthol Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/ acre	Common cultivation cost of Rs/ acre	Total cost of cultivation Rs/ acre	Menthol yield (qtl/acre)	Menthol Selling price @ 3500/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	2550	21105	23655	36.75	128625	104970	5.44
Jaivik Prom @ 100 kg / acre + FYM @ 85qtl/acre	4650	21105	25755	48.82	170870	145115	6.63
Total	**7200**	**42210**	**49410**	**85.57**	**299495**	**250085.00**	6.06

The final yield of Menthol has been found to be increased by more than 32% in treatment (with the use of Jaivik Prom) as compared to control.



Farmer Name: Ram Kumar (NMCGH0013)

Village: Sohalpur Sikrodha

District: Haridwar

Crop: Brinjal

Total cost incurred for different treatments of Brinjal Crop per Bigha (770 Square Meter)

Treatment details	Treatment cost of Rs/ Bigha	Common cultivation cost of Rs/ Bigha	Total cost of cultivation Rs/ Bigha	Brinjal yield (qtl/ Bigha)	Brinjal Selling price @ 3200/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	485.77	4482.55	4968.33	6.57	21024.00	16056.75	4.23
Jaivik Khad @ 80 kg/acre + FYM @ 85qtl/ acre	942.97	4482.55	5425.53	8.8	28192.00	22768.44	5.19
Total	**1428.75**	**8965.11**	**10393.86**	**15.38**	**49219.04**	**38825.18**	4.73

Total cost incurred for different treatments of Brinjal Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/ acre	Common cultivation cost of Rs/acre	Total cost of cultivation Rs/ acre	Brinjal yield (qtl/acre)	Brinjal Selling Price @3200/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	2550	23530.5	26080.5	34.49	110368	84287.5	4.23
Jaivik Khad @ 80 kg/acre + FYM @ 85qtl/acre	4950	23530.5	28480.5	46.25	148000	119519.5	5.19
Total	**7500**	**47061**	**54561**	**80.74**	**258368**	**203807**	4.73

The final yield of Brinjal has been found to be increased by more than 33% in treatment (with the use of Jaivik Khad) as compared to control.



Farmer Name: Ram Singh (NMCGH0015)

Village: Daulatpur

District: Haridwar

Crop: Black Gram (Urad)

Total cost incurred for different treatments of Black Gram Crop per Bigha (770 Square Meter)

Treatment details	Treatment cost of Rs/Bigha	Common cultivation cost of Rs/ Bigha	Total cost of cultivation Rs/Bigha	Black Gram yield (qtl/ Bigha)	Black Gram Selling price @ 14000/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	485.77	2560.32	3046.09	0.65	9094.46	6048.37	2.99
Jaivik Khad @ 80 kg / acre + FYM @ 85 qtl/acre	942.97	2560.32	3503.29	0.83	11628.10	8124.81	3.32
Total	**1428.75**	**5120.63**	**6549.38**	**1.48**	**20722.56**	**14173.18**	3.16

Total cost incurred for different treatments of Black Gram Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/ acre	Common cultivation cost of Rs/ acre	Total cost of cultivation Rs/ acre	Black Gram yield (qtl/acre)	Black Gram Selling price @ 14000/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	2550	13440	15990	3.41	47740	31750	2.99
Jaivik Khad @ 80 kg/ acre + FYM @ 85qtl/ acre	4950	13440	18390	4.36	61040	42650	3.32
Total	**7500**	**26880**	**34380**	**7.77**	**108780**	**74400.00**	3.16

The final yield of Black Gram has been found to be increased by more than 27% in treatment (with the use of Jaivik Khad) as compared to control.



Farmer Name: Dhyan Singh (NMCGH0016)

Village: Daulatpur

District: Haridwar

Crop: Bhindi/Okra

Total cost incurred for different treatments of Bhindi Crop per Bigha (770 Square Meter)

Treatment details	Treatment cost of Rs/Bigha	Common cultivation cost of Rs/ Bigha	Total cost of cultivation Rs/Bigha	Bhindi yield (qtl/ Bigha)	Bhindi Selling Price @ 3500/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	485.77	6190.77	6676.54	7.85	27490.07	20813.53	4.12
Natural Pori Potash @ 100 kg / acre + FYM @ 85qtl/acre	771.52	6190.77	6962.29	9.83	34404.26	27441.97	4.94
Total	**1257.30**	**12381.53**	**13638.83**	**17.68**	**61894.32**	**48255.49**	4.54

Total cost incurred for different treatments of Bhindi Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/ acre	Common cultivation cost of Rs/ acre	Total cost of cultivation Rs/ acre	Bhindi yield (qtl/acre)	Bhindi Selling Price @ 3500/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	2550	32497.5	35047.5	41.23	144305	109257.5	4.12
Natural Pori Potash @ 100 kg / acre + FYM @ 85 qtl/acre	4050	32497.5	36547.5	51.60	180600	144052.5	4.94
Total	**6600**	**64995**	**71595**	**92.83**	**324905**	**253310.00**	4.54

The final yield of Okra/Bhindi has been found to be increased by more than 25% in treatment (with the use of Natural Pori Potash) as compared to control.



Farmer Name: Balram (NMCGH0017)

Village: Daulatpur

District: Haridwar

Crop: Cowpea/Lobiya

Total cost incurred for different treatments of Cowpea Crop per Bigha (770 Square Meter)

Treatment details	Treatment cost of Rs/ Bigha	Common cultivation cost of Rs/ Bigha	Total cost of cultivation Rs/ Bigha	Cowpea yield (qtl/ Bigha)	Cowpea Selling Price @ 2500/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	485.77	3870.48	4356.25	4.9	12249.13	7892.88	2.81
Dharti ka Chowkidar @ 10 kg / acre + FYM @ 85 qtl/acre	638.17	3870.48	4508.65	6.2	15525.73	11017.08	3.44
Total	**1123.95**	**7740.96**	**8864.91**	**11.11**	**27774.86**	**18909.96**	3.13

Total cost incurred for different treatments of Cowpea Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/ acre	Common cultivation cost of Rs/ acre	Total cost of cultivation Rs/ acre	Cowpea yield (qtl/acre)	Cowpea Selling Price @ 2500/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	2550	20317.5	22867.5	25.72	64300	41432.5	2.81
Dharti ka Chowkidar @ 10 kg / acre+ FYM @ 85qtl/acre	3350	20317.5	23667.5	32.60	81500	57832.5	3.44
Total	**5900**	**40635**	**46535**	**58.32**	**145800**	**99265.00**	3.13

The final yield of Cowpea has been found to be increased by more than 26% in treatment (with the use of Dharti Ka Chowkidar) as compared to control.

DEHRADUN



Farmer Name: Kunwar Singh (NMCGD001)

Village: Resham Majri grant

District: Dehradun

Crop: Tulsi

Total cost incurred for different treatments of Tulsi Crop per Bigha (770 Square Meter)

Treatment details	Treatment cost of Rs/ Bigha	Common cultivation Cost of Rs/Bigha	Total cost of cultivation Rs/ Bigha	Tulsi yield (qtl/ Bigha)	Tulsi Selling Price @ 1600/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/ acre)	485.77	2515.31	3001.09	8.42	13472.14	10471.06	4.49
Dharti ka Chowkidar @ 10 kg / acre + FYM @ 85 qtl/acre	638.17	2515.31	3153.49	10.84	17343.10	14189.61	5.50
Total	**1123.95**	**5030.62**	**6154.57**	**19.26**	**30815.24**	**24660.67**	5.01

Total cost incurred for different treatments of Tulsi Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/ acre	Common cultivation cost of Rs/ acre	Total cost of cultivation Rs/ acre	Tulsi yield (qtl/acre)	Tulsi Selling Price @ 1600/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	2550	13203.75	15753.75	44.20	70720	54966.25	4.49
Dharti ka Chowkidar @ 10 kg / acre + FYM @ 85qtl/acre	3350	13203.75	16553.75	56.90	91040	74486.25	5.50
Total	**5900**	**26407.5**	**32307.5**	**101.1**	**161760**	**129452.50**	5.01

The final yield of Tulsi is increased by more than 28% in treatment (with the use of Dharti Ka Chowkidar) as compared to control.



Farmer Name: Devender Singh (NMCGH002)

Village: Resham Majri Grant

District: Dehradun

Crop: Bhindi/Okra

Total cost incurred for different treatments of Bhindi Crop per Plot (385 Square Meter)

Treatment details	Treatment cost of Rs/385 Square meter	Common cultivation Cost of Rs/ 385 Square meter	Total cost of cultivation Rs/ 385 Square meter	Bhindi yield (qtl/ 385 Square meter)	Bhindi Selling Price @ 3200/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @85 qtl/acre)	242.89	3290.41	3533.29	4.5	14304.25	10770.95	4.05
Jaivik Khad @80 kg/acre + FYM @ 85 qtl/acre	442.91	3290.41	3733.32	5.6	17824.68	14091.36	4.77
Total	**685.80**	**6580.81**	**7266.61**	**10.04**	**32128.93**	**24862.31**	**4.42**

Total cost incurred for different treatments of Bhindi Crop per acre (4042 Square Meter)

Treatment details	Treatment Cost of Rs/ acre	Common cultivation cost of Rs/ acre	Total cost of cultivation Rs/ acre	Bhindii yield (qtl/acre)	Bhindi Selling Price @ 3200/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	2550	34545	37095	46.93	150176	113081	4.05
Jaivik Khad @80 kg/acre + FYM @85qtl/acre	4650	34545	39195	58.48	187136	147941	4.77
Total	**7200**	**69090**	**76290**	**105.41**	**337312**	**261022.00**	4.42

The final yield of Okra/Bhindi is found increased by more than 24% in treatment (with the use of Jaivik Khad) as compared to control.



Farmer Name: Yaspal Singh (NMCGD003)

Village: Resham Majri Grant

District: Dehradun

Crop: Cholai (Red)

Total cost incurred for different treatments of Cholai Crop per Plot (385 Square Meter)

Treatment details	Treatment cost of Rs/ 385 Square meter	Common cultivation Cost of Rs/ 385 Square meter	Total cost of cultivation Rs/ 385 Square meter	Cholai yield (qtl/ 385 Square meter)	Cholai Selling Price @ 3000/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	242.89	1380.17	1623.06	3.2	9629.76	8006.70	5.93
Jaivik Khad @ 80 kg / acre + FYM @ 85 qtl/acre	471.49	1380.17	1851.66	4.0	12118.64	10266.98	6.54
Total	**714.37**	**2760.34**	**3474.72**	**7.25**	**21748.40**	**18273.69**	**6.26**

Total cost incurred for different treatments of Cholai Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/ acre	Common cultivation cost of Rs/ acre	Total cost of cultivation Rs/ acre	Cholai yield (qtl/ acre)	Cholai Selling price @ 3000/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	2550	14490	17040	33.7	101100	84060	5.93
Jaivik Khad @ 80 kg/ acre + FYM @ 85qtl/ acre	4950	14490	19440	42.41	127230	107790	6.54
Total	**7500**	**28980**	**36480**	**76.11**	**228330**	**191850.00**	6.26

The final yield of Cholai (Amaranth) is found increased by more than 25% in treatment (with the use of Jaivik Khad) as compared to control.



Farmer Name: Chaitan (NMCGD004)

Village: Resham Majri Grant

District: Dehradun

Crop: Mint

Total cost incurred for different treatments of Mint Crop per Bigha (770 Square Meter)

Treatment details	Treatment cost of Rs/Bigha	Common cultivation Cost of Rs/Bigha	Total cost of cultivation Rs/ Bigha	Mint yield (qtl/ Bigha)	Mint Selling Price @ 3200/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	485.77	6580.81	7066.59	5.58	17861.26	10794.67	2.53
Dharti ka Chowkidar @ 10 kg / acre + FYM @ 85 qtl/acre	638.17	6580.81	7218.99	6.83	21854.13	14635.14	3.03
Total	**1123.95**	**13161.63**	**14285.58**	**12.41**	**39715.39**	**25429.81**	2.78

Total cost incurred for different treatments of Mint Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/ acre	Common cultivation cost of Rs/ acre	Total cost of cultivation Rs/ acre	Mint yield (qtl/ acre)	Mint Selling price @ 3200/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	2550	34545	37095	29.30	93760	56665	2.53
Dharti ka Chowkidar @ 10 kg / acre + FYM @ 85qtl/acre	3350	34545	37895	35.85	114720	76825	3.03
Total	**5900**	**69090**	**74990**	**65.15**	**208480**	**133490.00**	2.78

The final yield of Mint is found increased by more than 22% in treatment (with the use of Dharti ka Chowkidar) as compared to control.



Farmer Name: Nikhil Kumar (NMCGD005)

Village: Resham Majri Grant

District: Dehradun

Crop: Cholai

Total cost incurred for different treatments of Cholai Crop per Plot (385 Square Meter)

Treatment details	Treatment cost of Rs/385 Square meter	Common cultivation cost of Rs/ 385 Square meter	Total cost of cultivation Rs/ 385 Square meter	Cholai yield (qtl/ 385 Square meter)	Cholai Selling price @ 2000/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	242.89	1380.17	1623.06	2.8	5621.65	3998.59	3.46
Dharti ka Chowkidar @ 10 kg / acre + FYM @ 85 qtl/acre	319.09	1380.17	1699.26	3.7	7469.50	5770.24	4.40
Total	**561.97**	**2760.34**	**3322.32**	**6.55**	**13091.14**	**9768.83**	**3.94**

Total cost incurred for different treatments of Cholai Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/ acre	Common cultivation cost of Rs/ acre	Total cost of cultivation Rs/ acre	Cholai yield (qtl/acre)	Cholai Selling price @ 2000/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	2550	14490	17040	29.51	59020	41980	3.46
Dharti ka Chowkidar @ 10 kg / acre + FYM @ 85qtl/acre	3350	14490	17840	39.21	78420	60580	4.40
Total	**5900**	**28980**	**34880**	**68.72**	**137440**	**102560.00**	3.94

The final yield of Cholai (Amaranth) is found increased by more than 33% in treatment (with the use of Dharti ka Chowkidar) as compared to the control.



Farmer Name: Satypal Singh (NMCGD006)

Village: Resham Majri Grant

District: Dehradun

Crop: Bhindi/Okra

Total cost incurred for different treatments of Bhindi Crop per Bigha (770 Square Meter)

Treatment details	Treatment cost of Rs/ Bigha	Common cultivation Cost of Rs/ Bigha	Total cost of cultivation Rs/ Bigha	Bhindi yield (qtl/ Bigha)	Bhindi Selling price @ 3500/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	485.77	6580.81	7066.59	7.57	26496.61	19430.02	3.75
Dharti ka Chowkidar @ 10 kg / acre + FYM @ 85 qtl/acre	638.17	6580.81	7218.99	9.40	32897.40	25678.41	4.56
Total	**1123.95**	**13161.63**	**14285.58**	**16.97**	**59394.01**	**45108.44**	4.16

Total cost incurred for different treatments of Bhindi Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/acre	Common cultivation cost of Rs/ acre	Total cost of cultivation Rs/acre	Bhindii yield (qtl/ acre)	Bhindi Selling price @ 3500/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	2550	34545	37095	39.74	139090	101995	3.75
Dharti ka Chowkidar @ 10 kg / acre + FYM @ 85qtl/acre	3350	34545	37895	49.34	172690	134795	4.56
Total	**5900**	**69090**	**74990**	**89.08**	**311780**	**326790**	4.16

The final yield of Okra/Bhindi is found increased by more than 24% in treatment (with the use of Dharti ka Chowkidar) as compared to control.



Farmer Name: Hritik Kumar (NMCGH007)

Village: Resham Majri Grant

District: Dehradun

Crop: Karela

Total cost incurred for different treatments of Karela Crop per Bigha (770 Square Meter)

Treatment details	Treatment cost of Rs/ Bigha	Common cultivation Cost of Rs/ Bigha	Total cost of cultivation Rs/ Bigha	Karela yield (qtl/ Bigha)	Karela Selling price @ 7000/ quintal	Net Return	Benefit-cost (B:C) ratio
Control (FYM @ 85 qtl/acre)	485.77	8938.25	9424.02	4.9	34497.60	25073.58	3.66
Jaivik Khad @ 80 kg / acre + FYM @ 85 qtl/acre	942.97	8938.25	9881.22	6.7	46899.13	37017.91	4.75
Total	**1428.75**	**17876.50**	**19305.24**	**11.63**	**81396.73**	**62091.49**	4.22

Total cost incurred for different treatments of Karela Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/ acre	Common cultivation cost of Rs/ acre	Total cost of cultivation Rs/ acre	Karela yield (qtl/ acre)	Karela Selling price @ 7000/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	2550	46920	49470	25.87	181090	131620	3.66
Jaivik Khad @ 80 kg / acre + FYM @ 85qtl/acre	4950	46920	51870	35.17	246190	194320	4.75
Total	**7500**	**93840**	**101340**	**61.04**	**427280**	**325940.00**	4.22

The final yield of Karela is found increased by more than 37% in treatment (with the use of Jaivik Khad) as compared to control.



Farmer Name: Kuldeep Saini (NMCGD008)

Village: Bheemawala

District: Dehradun

Crop: Bhindi/Okra

Total cost incurred for different treatments of Bhindi Crop per Plot (385 Square Meter)

Treatment details	Treatment cost of Rs/385 Square meter	Common cultivation cost of Rs/385 Square meter	Total cost of cultivation Rs/ 385 Square meter	Bhindi yield (qtl/385 Square meter)	Bhindi Selling price @ 3500/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	242.89	3170.39	3413.28	3.26	11411.41	7998.13	3.34
Dharti ka Chowkidar @ 10 kg / acre + FYM @ 85 qtl/acre	319.09	3170.39	3489.48	4.27	14945.18	11455.70	4.28
Total	**561.97**	**6340.78**	**6902.76**	**7.53**	**26356.59**	**19453.83**	**3.82**

Total cost incurred for different treatments of Bhindi Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/ acre	Common cultivation cost of Rs/ acre	Total cost of cultivation Rs/ acre	Bhindi yield (qtl/acre)	Bhindi Selling price @ 3500/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	2550	33285	35835	34.23	119805	83970	3.34
Dharti ka Chowkidar @ 10 kg / acre + FYM @ 85qtl/acre	3350	33285	36635	44.83	156905	120270	4.28
Total	**5900**	**66570**	**72470**	**79.06**	**276710**	**204240.00**	3.82

The final yield of Okra/Bhindi is found increased by more than 30% in treatment (with the use of Dharti ka Chowkidar) as compared to control.



Farmer Name: Tara Chand Saini (NMCGD009)

Village: Jassowala

District: Dehradun

Crop: Cucumber

Total cost incurred for different treatments of Cucumber Crop per Plot (385 Square Meter)

Treatment details	Treatment cost of Rs/ 385 Square meter	Common cultivation cost of Rs/ 385 Square meter	Total cost of cultivation Rs/ 385 Square meter	Cucumber yield (qtl/ 385 Square meter)	Cucumber Selling price @ 2500/ quintal	Net Return	Benefit-cost (B:C) ratio
Control (FYM @ 85 qtl/acre)	242.89	4991.09	5233.98	9.96	24900.70	19666.72	4.76
Dharti ka Chowkidar @ 10 kg / acre + FYM @ 85 qtl/acre	319.09	4991.09	5310.18	12.09	30225.17	24914.99	5.69
Total	**561.97**	**9982.19**	**10544.16**	**22.05**	**55125.87**	**44581.70**	**5.23**

Total cost incurred for different treatments of Cucumber Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/ acre	Common cultivation cost of Rs/ acre	Total cost of cultivation Rs/ acre	Cucumber yield (qtl/ acre)	Cucumber Selling price @ 2500/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	2550	52400	54950	104.57	261425	206475	4.76
Dharti ka Chowkidar @ 10 kg / acre + FYM @ 85qtl/acre	3350	52400	55750	126.93	317325	261575	5.69
Total	**5900**	**104800**	**110700**	**231.5**	**578750**	**468050.00**	5.23

The final yield of Cucumber is found increased by more than 21% in treatment (with the use of Dharti ka Chowkidar) as compared to control.



Farmer Name: Rajender Singh (NMCGD0012)

Village: Jamnipur (Goodrich T-State)

District: Dehradun

Crop: Bhindi/Okra

Total cost incurred for different treatments of Bhindi Crop per Bigha (770 Square Meter)

Treatment details	Treatment cost of Rs/770 Square meter	Common culti vation cost ofRs/ 770 Square meter	Total cost of cultivation Rs/ 770 Square meter	Bhindi yield (qtl/770 Square meter)	Bhindi Selling price @ 3500/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/ac)	485.77	6620.82	7106.59	5.87	20542.54	13435.95	2.89
Jaivik Khad @ 80 kg / ac + FYM @ 85 qtl/ac	771.52	6620.82	7392.34	7.61	26636.63	19244.29	3.60
Total	**1257.30**	**13241.64**	**14498.94**	**13.48**	**47179.17**	**32680.23**	3.25

Total cost incurred for different treatments of Bhindi Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/ ac	Common culti vation cost of Rs/ac	Total cost of cultivation Rs/ ac	Bhindi yield (qtl/Rs/ ac)	Bhindi Selling price @ 3500/ quintal	Net Return	Benefit-cost (B:C) ratio
Control (FYM @ 85 qtl/ac)	2550	34755	37305	30.81	107835	70530	2.89
Jaivik Khad @ 80 kg/ ac + FYM @ 85 qtl/ac	4050	34755	38805	39.95	139825	101020	3.60
Total	**6600**	**69510**	**76110**	**70.76**	**247660**	**171550.00**	3.25

The final yield of Okra/Bhindi is found increased by more than 29% in treatment (with the use of Jaivik Khad) as compared to control.



Farmer Name: Ashish Kumar (NMCGD0013)

Village: Jamnipur (Goodrich T-State)

District: Dehradun

Crop: Bhindi/Okra

Total cost incurred for different treatments of Bhindi Crop per Bigha (770 Square Meter)

Treatment details	Treatment cost of Rs/Bigha	Common cultivation Cost of Rs/ Bigha	Total cost of cultivation Rs/ Bigha	Bhindi yield (qtl/ Bigha)	Bhindi Selling price @ 3500/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	485.77	7240.90	7726.67	6.4	22436.11	14709.44	2.90
Jaivik Prom @ 100 kg / acre + FYM @ 85 qtl/acre	885.82	7240.90	8126.72	8.5	29717.01	21590.29	3.66
Total	**1371.60**	**14481.79**	**15853.39**	**14.90**	**52153.12**	**36299.73**	3.29

Total cost incurred for different treatments of Bhindi Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/ acre	Common cultivation cost of Rs/ acre	Total cost of cultivation Rs/ acre	Bhindi yield (qtl/ acre)	Bhindi Selling price @ 3500/ quintal	Net Return	Benefit-cost (B:C) ratio
Control (FYM @ 85 qtl/acre)	2550	38010	40560	33.65	117775	77215	2.90
Jaivik Prom @ 100 kg / acre + FYM @ 85qtl/acre	4650	38010	42660	44.57	155995	113335	3.66
Total	**7200**	**76020**	**83220**	**78.22**	**273770**	**190550.00**	3.29

The final yield of Okra/Bhindi is found increased by more than 32% in treatment (with the use of Jaivik Prom) as compared to control.



Farmer Name: Shubham (NMCGD0014)

Village: Jamnipur (Goodrich T-State)

District: Dehradun

Crop: Bhindi/Okra

Total cost incurred for different treatments of Bhindi Crop per Bigha (770 Square Meter)

Treatment details	Treatment cost of Rs/ Bigha	Common cultivation Cost of Rs/ Bigha	Total cost of cultivation Rs/ Bigha	Bhindi yield (qtl/ Bigha)	Bhindi Selling price @ 3800/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	485.77	5900.73	6386.50	4.9	18734.51	12348.00	2.93
Jaivik Khad @ 80 kg / acre + FYM @ 85 qtl/acre	942.97	5900.73	6843.70	6.5	24887.65	18043.95	3.64
Total	**1428.75**	**11801.46**	**13230.21**	**11.48**	**43622.16**	**30391.95**	3.30

Total cost incurred for different treatments of Bhindi Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/acre	Common cultivation cost of Rs/ acre	Total cost of cultivation Rs/ acre	Bhindi yield (qtl/ acre)	Bhindi Selling price @ 3800/ quintal	Net Return	Benefit-cost (B:C) ratio
Control (FYM @ 85 qtl/acre)	2550	30975	33525	25.88	98344	64819	2.93
Jaivik Khad @ 80 kg/ acre + FYM @ 85qtl/ acre	4950	30975	35925	34.38	130644	94719	3.64
Total	**7500**	**61950**	**69450**	**60.26**	**228988**	**159538.00**	3.30

The final yield of Okra/Bhindi is found increased by more than 32% in treatment (with the use of Jaivik Khad) as compared to control.



Farmer Name: Aryan Saini (NMCGD0016)

Village: Jassowala

District: Dehradun

Crop: Cucumber

Total cost incurred for different treatments of Cucumber Crop per Plot (385 Square Meter)

Treatment details	The treatment cost of Rs/385 Square meter	Common cultivation cost of Rs/ 385 Square meter	Total cost of cultivation Rs/385 Square meter	Cucumber yield (qtl/385 Square meter)	Cucumber Selling price @ 2500/ quintal	Net Return	Benefit-cost (B:C) ratio
Control (FYM @ 85 qtl/acre)	242.89	4271.00	4513.89	9.2	23002.85	18488.95	5.10
Natural Pori Potash @ 100 kg / acre + FYM @85 qtl/acre	385.76	4271.00	4656.77	10.9	27334.33	22677.57	5.87
Total	**628.65**	**8542.01**	**9170.66**	**20.13**	**50337.18**	**41166.52**	**5.49**

Total cost incurred for different treatments of Cucumber Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/ acre	Common cultivation cost of Rs/ acre	Total cost of cultivation Rs/ acre	Cucumber yield (qtl/ acre)	Cucumber Selling price @ 2500/ quintal	Net Return	Benefit-cost (B:C) ratio
Control (FYM @ 85 qtl/ acre)	2550	44840	47390	96.60	241500	194110	5.10
Natural Pori Potash @ 100 kg /acre + FYM @ 85qtl/acre	4050	44840	48890	114.79	286975	238085	5.87
Total	**6600**	**89680**	**96280**	**211.39**	**528475**	**432195.00**	5.49

The final yield of Cucumber is found increased by more than 18% in treatment (with the use of Natural Pori Potash) as compared to control.



Farmer Name: Rishipal (NMCGD0017)

Village: Jassowala

District: Dehradun

Crop: Sweet Corn

Total cost incurred for different treatments of Sweet Corn Crop per Bigha (770 Square Meter)

Treatment details	Treatment cost of Rs/Bigha	Common cultivation Cost of Rs/ Bigha	Total cost of cultivation Rs/Bigha	Sweet Corn yield (qtl/Bigha)	Sweet Corn Selling price @ 1800/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	485.77	3470.43	3956.20	9.8	17604.46	13648.26	4.45
Jaivik Khad @ 80 kg/ acre + FYM @ 85 qtl/ acre	942.97	3470.43	4413.40	12.9	23166.29	18752.89	5.25
Total	**1428.75**	**6940.86**	**8369.61**	**22.65**	**40770.76**	**32401.15**	4.87

Total cost incurred for different treatments of Sweet Corn Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/acre	Common cultivation Cost of Rs/ acre	Total cost of cultivation Rs/ acre	Sweet Corn yield (qtl/acre)	Sweet Corn Selling price @ 1800/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	2550	18217.5	20767.5	51.34	92412	71644.5	4.45
Jaivik Khad @ 80 kg / acre + FYM @ 85qtl/acre	4950	18217.5	23167.5	67.56	121608	98440.5	5.25
Total	**7500**	**36435**	**43935**	**118.9**	**214020**	**170085.00**	4.87

The final yield of Sweet Corn is found increased by more than 31% in treatment (with the use of Jaivik Khad) as compared to control.

UTTARKASHI

Farmer Name: Chatar Singh (NMCGU001)

Village: Setwari.

District: Uttarkashi

Crop: Tomato



Total cost incurred for different treatments of Tomato Crop per Plot (385 Square Meter)

Treatment details	Treatment cost of Rs/ 385 Square meter	Common cultivation Cost of Rs/ 385 Square meter	Total cost of cultivation Rs/ 385 Square meter	Tomato yield (qtl/385 Square meter)	Tomato Selling price @ 3750/ quintal	Net Return	Benefit-cost (B:C) ratio
Control (FYM @ 31.5 qtl/acre)	90.01	6390.79	6480.80	8.43	31618.20	25137.39	4.88
Natural Pori Potash @ 100 kg / acre + FYM @ 31.5 qtl/acre	232.89	6390.79	6623.68	10.97	41147.95	34524.27	6.21
Total	**322.90**	**12781.58**	**13104.48**	**19.40**	**72766.14**	**59661.67**	**5.55**

Total cost incurred for different treatments of Tomato Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/acre	Common cultivation Cost of Rs/ acre	Total cost of cultivation Rs/ Rs/acre	Tomato yield (qtl/ acre)	Tomato Selling price @3750/ quintal	Net Return	Benefit-cost (B:C) ratio
Control (FYM @ 31.5 qtl/acre)	945	67095	68040	88.52	331950	263910	4.88
Natural Pori Potash @ 100 kg / acre + FYM @ 31.5 qtl/acre	2445	67095	69540	115.2	432000	362460	6.21
Total	**3390**	**134190**	**137580**	**203.72**	**763950**	**626370**	5.55

The final yield of Tomato is found increased by more than 30% in treatment (with the use of Natural Pori Potash) as compared to control.



Farmer Name: Inder Singh (NMCGU002)

Village: Diyari

District: Uttarkashi

Crop: Tomato

Total cost incurred for different treatments of Tomato Crop per Plot (385 Square Meter)

Treatment details	Treatment cost of Rs/ 385 Square meter	Common cultivation cost of Rs/ 385 Square meter	Total cost of cultivation Rs/ 385 Square meter	Tomato yield (qtl/ 385 Square meter)	Tomato Selling price @ 3750/ quintal	Net Return	Benefit-cost (B:C) ratio
Control (FYM @ 31.5 qtl/acre)	90.01	4630.57	4720.58	7.62	28585.68	23865.09	6.06
Natural Pori Potash @ 100 kg/acre + FYM @ 31.5qtl/acre	232.89	4630.57	4863.46	10.05	37683.23	32819.77	7.75
Total	**322.90**	**9261.15**	**9584.04**	**17.67**	**66268.91**	**56684.87**	**6.91**

Total cost incurred for different treatments of Tomato Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/acre	Common cultivation cost of Rs/ acre	Total cost of cultivation Rs/ Rs/acre	Tomato yield (qtl/ acre)	Tomato Selling price @ 3750/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 31.5 qtl/acre)	945	48615	49560	80.03	300112.5	250552.5	6.06
Natural Pori Potash @ 100 kg / acre + FYM @ 31.5qtl/acre	2445	48615	51060	105.5	395625	344565	7.75
Total	**3390**	**97230**	**100620**	**185.53**	**695737.5**	**595117.5**	6.91

The final yield of Tomato is found increased by more than 31% in treatment (with the use of Natural Pori Potash) as compared to control.



Farmer Name: Bhagtu lal (NMCGU003)

Village: Setwari

District: Uttarkashi

Crop: Capsicum

Total cost incurred for different treatments of Capsicum Crop per Bigha (770 Square Meter)

Treatment details	Treatment cost of Rs/Bigha	Common cultivation Cost of Rs/ Bigha	Total cost of cultivation Rs/Bigha	Tomato yield (qtl/ Bigha)	Tomato Selling Price @ 5000/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 31.5 qtl/ acre)	180.02	9081.12	9261.15	7.8	38881.00	29619.85	4.20
Jaivik Prom @ 100 kg / acre + FYM @ 31.5qtl/acre	580.07	9081.12	9661.19	9.5	47358.24	37697.04	4.90
Total	**760.09**	**18162.25**	**18922.34**	**17.25**	**86239.24**	**67316.90**	4.56

Total cost incurred for different treatments of Capsicum Crop per acre (4042 Square Meter)

Treatment details	Treatment cost (Rs/ acre)	Common cultivation Cost of Rs/ acre	Total cost of cultivation Rs/acre	Tomato yield (qtl/ Rs/ acre)	Tomato Selling Price @ 5000/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 31.5 qtl/acre)	945	47670	48615	40.8	204100	155485	4.20
Jaivik Prom @ 100 kg / acre + FYM @ 31.5qtl/acre	3045	47670	50715	49.7	248600	197885	4.90
Total	**3990**	**95340**	**99330**	**90.54**	**452700**	**353370**	4.56

The final yield of Capsicum is found increased by more than 21% in treatment (with the use of Jaivik Prom) as compared to control.



Farmer Name: Gulabu Singh (NMCGU004)

Village: Setwari

District: Uttarkashi

Crop: Tomato

Total cost incurred for different treatments of Tomato Crop per 385 Square Meter

Treatment details	Treatment cost of Rs/385 Square meter	Common cultivation cost of Rs/ 385 Square meter	Total cost of cultivation Rs/ 385 Square meter	Tomato yield (qtl/385 Square meter)	Tomato Selling price @ 3500/ quintal	Net Return	Benefit-cost (B:C) ratio
Control (FYM @ 85 qtl/acre)	242.89	4460.55	4703.44	7.46	26123.23	21419.79	5.55
Jaivik Prom @ 100 kg/acre + FYM @ 85qtl/acre	442.91	4460.55	4903.46	9.61	33620.83	28717.36	6.86
Total	**685.80**	**8921.10**	**9606.90**	**17.07**	**59744.06**	**50137.15**	**6.22**

Total cost incurred for different treatments of Tomato Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/acre	Common cultivation cost of Rs/ acre	Total cost of cultivation Rs/ Rs/acre	Tomato yield (qtl/acre)	Tomato Selling price @ 3500/ quintal	Net Return	Benefit-cost (B:C) ratio
Control (FYM @ 85 qtl/acre)	2550	46830	49380	78.36	274260	224880	5.55
Jaivik Prom @ 100 kg/acre + FYM @ 85 qtl/acre	4650	46830	51480	100.85	352975	301495	6.86
Total	**7200**	**93660**	**100860**	**179.21**	**627235**	**526375.00**	6.22

The final yield of Tomato is found increased by more than 29% in treatment (with the use of Jaivik Prom) as compared to control.



Farmer Name: Dinesh Panwar (NMCGU005)

Village: Rikhaun

District: Uttarkashi

Crop: Tomato

Total cost incurred for different treatments of Tomato Crop per Bigha (770 Square Meter)

Treatment details	Treatment cost of Rs/Bigha	Common cultivation Cost of Rs/ Bigha	Total cost of cultivation Rs/ Bigha	Tomato yield (qtl/ Bigha)	Tomato Selling price @ 3875/ quintal	Net Return	Benefit-cost (B:C) ratio
Control (FYM @31.5 qtl/acre)	180.02	8871.10	9051.12	7.55	29239.57	20188.44941	3.23
Jaivik Khad @ 80 kg/acre + FYM @ 31.5qtl/acre	637.22	8871.10	9508.32	9.55	36997.91	27489.59055	3.89
Total	**817.24**	**17742.19**	**18559.43**	**17.09**	**66237.47**	**47678.03**	3.57

Total cost incurred for different treatments of Tomato Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/acre	Common cultivation cost of Rs/ acre	Total cost of cultivation Rs/acre	Tomato yield (qtl/acre)	Tomato Selling price @ 3875/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 31.5 qtl/acre)	945	46567.5	47512.5	39.61	153488.75	105976.25	3.23
Jaivik Khad @ 80 kg/acre + FYM @ 31.5qtl/acre	3345	46567.5	49912.5	50.12	194215.00	144302.5	3.89
Total	**4290**	**93135**	**97425**	**89.73**	**347703.75**	**250278.75**	3.57

The final yield of Tomato is found increased by more than 26% in treatment (with the use of Jaivik Khad) as compared to control.



Farmer Name: Pyar Singh (NMCGU006)

Village: Rikhaun

District: Uttarkashi

Crop: Tomato

Total cost incurred for different treatments of Tomato Crop per Bigha (770 Square Meter)

Treatment details	Treatment cost of Rs/Bigha	Common cultivation Cost of Rs/ Bigha	Total cost of cultivation Rs/Bigha	Tomato yield (qtl/ Bigha)	Tomato Selling Price @ 3875/ quintal	Net Return	Benefit-cost (B:C) ratio
Control (FYM @ 31.5 qtl/acre)	180.02	8871.10	9051.12	8.24	31926.57	22875.45	3.53
Dharti ka Chowkidar @ 10 kg / acre + FYM @ 31.5qtl/acre	332.42	8871.10	9203.52	10.70	41471.32	32267.80	4.51
Total	**512.44**	**17742.19**	**18254.64**	**18.94**	**73397.89**	**55143.25**	4.02

Total cost incurred for different treatments of Tomato Crop per acre (4042 Square Meter)

Treatment details	Treatment Cost of Rs/acre	Common cultivation cost of Rs/ acre	Total cost of cultivation Rs/acre	Tomato yield (qtl/acre)	Tomato Selling Price @ 3875/ quintal	Net Return	Benefit-cost (B:C) ratio
Control (FYM @ 31.5 qtl/acre)	945	46567.5	47512.5	43.25	167593.75	120081.25	3.53
Dharti ka Chowkidar @ 10 kg / acre + FYM @ 31.5qtl/acre	1745	46567.5	48312.5	56.18	217697.50	169385	4.51
Total	**2690**	**93135**	**95825**	**99.43**	**385291.25**	**289466.25**	4.02

The final yield of Tomato is found increased by more than 29% in treatment (with the use of Dharti ka Chowkidar) as compared to control.



Farmer Name: Meena Devi (NMCGU007)

Village: Rikhaun

District: Uttarkashi

Crop: Sweet Corn

The total cost incurred for different treatments of Sweet Corn Crop per Bigha (770 Square Meter)

Treatment details	Treatment cost of Rs/770 Square meter	Common cultivation cost of Rs/770 Square meter	Total cost of cultivation Rs/770 Square meter	Sweet Corn yield (qtl/ 770 Square meter)	Sweet Corn Selling price @ 1900/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	485.77	3943.99	4429.76	7.60	14441.79	10012.03	3.26
Jaivik Khad @ 80 kg/acre + FYM @85 qtl/acre	942.97	3943.99	4886.96	9.92	18846.71	13959.75	3.86
Total	**1428.75**	**7887.97**	**9316.72**	**17.52**	**33288.50**	**23971.78**	3.57

The total cost incurred for different treatments of Sweet Corn Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/acre	Common culti vation cost of Rs/ acre	Total cost of cultivation Rs/acre	Sweet Corn yield (qtl/ Rs/acre)	Sweet Corn Selling price @ 1900/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	2550	20703.37	23253.37	39.90	75810	52556.63	3.26
Jaivik Khad @ 80 kg/acre + FYM @ 85qtl/acre	4950	20703.37	25653.37	52.07	98933	73279.63	3.86
Total	**7500**	**41406.74**	**48906.74**	**91.97**	**174743**	**125836.26**	**3.57**

The final yield of Sweet corn is found increased by more than 30% in treatment (with the use of Jaivik Khad) as compared to the control.

PAURI-GARHWAL



Farmer Name: Anand Singh (NMCGP001)

Village: Mala

District: Pauri-Garhwal

Crop: Bhindi/Okra

Total cost incurred for different treatments of Bhindi Crop per Plot (385 Square Meter)

Treatment details	Treatment cost of Rs/385 Square meter	Common cultivation cost of Rs/385 Square meter	Total cost of cultivation Rs/385 Square meter	Bhindi yield (qtl/385 Square meter)	Bhindi Selling price @ 3500/ quintal	Net Return	Benefit-cost (B:C) ratio
Control (FYM @ 85 qtl/acre)	242.89	2575.32	2818.21	3.3	11671.44	8853.24	4.14
Jaivik Khad @ 80 kg / acre + FYM @ 85 qtl/acre	471.49	2575.32	3046.81	4.2	14715.15	11668.35	4.83
Total	**714.37**	**5150.64**	**5865.01**	**7.54**	**26386.60**	**20521.59**	**4.50**

Total cost incurred for different treatments of Bhindi Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/acre	Common cultivation cost of Rs/ acre	Total cost of cultivation Rs/ acre	Bhindi yield (qtl/ acre)	Bhindi Selling price @ 3500/ quintal	Net Return	Benefit-cost (B:C) ratio
Control (FYM @ 85 qtl/acre)	2550	27037.5	29587.5	35.01	122535	92947.5	4.14
Jaivik Khad @ 80 kg/acre + FYM @ 85qtl/acre	4950	27037.5	31987.5	44.14	154490	122502.5	4.83
Total	**7500**	**54075**	**61575**	**79.15**	**277025**	**215450.00**	4.50

The final yield of Okra/Bhindi is found increased by more than 26% in treatment (with the use of Jaivik Khad) as compared to control.



Farmer Name: Akbeer Singh (NMCGP002)

Village: Mala

District: Pauri-Garhwal

Crop: Bhindi/Okra

Total cost incurred for different treatments of Bhindi Crop per Plot (385 Square Meter)

Treatment details	Treatment cost of Rs/ 385 Square meter	Common cultivation Cost of Rs/385 Square meter	Total cost of cultivation Rs/385 Square meter	Bhindi yield (qtl/385 Square meter)	Bhindi Selling Price @3500/ quintal	Net Return	Benefit-cost (B:C) ratio
Control (FYM @ 85 qtl/acre)	242.89	2755.34	2998.23	3.43	11988.15	8989.92	4.00
Jaivik Khad @ 80 kg / acre + FYM @ 85 qtl/acre	471.49	2755.34	3226.83	4.30	15055.20	11828.37	4.67
Total	**714.37**	**5510.68**	**6225.06**	**7.73**	**27043.34**	**20818.29**	**4.34**

Total cost incurred for different treatments of Bhindi Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/ acre	Common cultivation Cost of Rs/ acre	Total cost of cultivation Rs/ acre	Bhindi yield (qtl/acre)	Bhindi Selling Price @ 3500/ quintal	Net Return	Benefit-cost (B:C) ratio
Control (FYM @ 85 qtl/acre)	2550	28927.5	31477.5	35.96	125860	94382.5	4.00
Jaivik Khad @ 80 kg / acre + FYM @ 85qtl/acre	4950	28927.5	33877.5	45.16	158060	124182.5	4.67
Total	**7500**	**57855**	**65355**	**81.12**	**283920**	**218565**	4.34

The final yield of Okra/Bhindi is found increased by more than 25% in treatment (with the use of Jaivik Khad) as compared to control.



Farmer Name: Gabbar Singh (NMCGP003)

Village: Mala

District: Pauri-Garhwal

Crop: Bhindi/Okra

Total cost incurred for different treatments of Bhindi Crop per Plot (385 Square Meter)

Treatment details	Treatment cost of Rs/ 385 Square meter	Common cultivation cost of Rs/385 Square meter	Total cost of cultivation Rs/385 Square meter	Bhindi yield (qtl/385 Square meter)	Bhindi Selling price @ 3500/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	242.89	2935.36	3178.25	3.6	12481.54	9303.29	3.93
Dharti ka Chowkidar @ 10 kg / acre + FYM @ 85 qtl/acre	319.09	2935.36	3254.45	4.3	15031.86	11777.41	4.62
Total	**561.97**	**5870.73**	**6432.70**	**7.86**	**27513.40**	**21080.70**	**4.28**

Total cost incurred for different treatments of Bhindi Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/ acre	Common cultivation cost of Rs/ acre	Total cost of cultivation Rs/acre	Bhindi yield (qtl/ acre)	Bhindi Selling price @ 3500/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/acre)	2550	30817.5	33367.5	37.44	131040	97672.5	3.93
Dharti ka Chowkidar @ 10 kg / acre + FYM @ 85qtl/acre	3350	30817.5	34167.5	45.09	157815	123647.5	4.62
Total	**5900**	**61635**	**67535**	**82.53**	**288855**	**221320.00**	4.28

The final yield of Okra/Bhindi is found increased by more than 20% in treatment (with the use of Dharti ka Chowkidar) as compared to control.



Farmer Name: Rajpal (NMCGP004)

Village: Mala

District: Pauri-Garhwal

Crop: Cholai (Red)

Total cost incurred for different treatments of Cholai Crop per Plot (385 Square Meter)

Treatment details	Treatment cost of Rs/ 385 Square meter	Common cultivation Cost of Rs/ 385 Square meter	Total cost of cultivation Rs/ 385 Square meter	Cholai yield (qtl/ 385 Square meter)	Cholai Selling Price @2200/ quintal	Net Return	Benefit-cost (B:C) ratio
Control (FYM @ 85 qtl/ac)	242.89	1525.19	1768.08	3.15	6929.81	5161.73	3.92
Natural Pori Potash @ 100 kg/ac + FYM @ 85 qtl/ac	385.76	1525.19	1910.95	4.25	9350.11	7439.16	4.89
Total	**628.65**	**3050.38**	**3679.03**	**7.40**	**16279.92**	**12600.89**	**4.43**

Total cost incurred for different treatments of Cholai Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/ ac	Common cultivation Cost of Rs/ac	Total cost of cultivation Rs/ ac	Cholai yield (qtl/ ac)	Cholai Selling Price @ 2200/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 85 qtl/ac)	2550	16012.5	18562.5	33.07	72754	54191.5	3.92
Natural Pori Potash @ 100 kg / ac + FYM @ 85qtl/ac	4050	16012.5	20062.5	44.62	98164	78101.5	4.89
Total	**6600**	**32025**	**38625**	**77.69**	**170918**	**132293.00**	4.43

The final yield of Cholai is found increased by more than 34% in treatment (with the use of Natural Pori Potash) as compared to control.



Farmer Name: Vikram Singh Negi (NMCGP005)

Village: Mala

District: Pauri-Garhwal

Crop: Capsicum

Total cost incurred for different treatments of Capsicum Crop per Plot (385 Square Meter)

Treatment details	Treatment cost of Rs/ 385 Square meter	Common cultivation Cost of Rs/ 385 Square meter	Total cost of cultivation Rs/ 385 Square meter	Capsicum yield (qtl/ 385 Square meter)	Capsicum Selling Price @ 5000/ quintal	Net Return	Benefit-cost (B:C) ratio
Control (FYM @ 52 qtl/acre)	148.59	4140.51	4289.10	3.62	18116.53	13827.42	4.22
Jaivik Prom @ 100 kg / acre + FYM @ 52 qtl/ acre	348.61	4140.51	4489.13	4.26	21283.58	16794.46	4.74
Total	**497.20**	**8281.02**	**8778.23**	**7.88**	**39400.11**	**30621.88**	**4.49**

Total cost incurred for different treatments of Capsicum Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/ acre	Common cultivation Cost of Rs/ acre	Total cost of cultivation Rs/ acre	Capsicum yield (qtl/ acre)	Capsicum Selling Price @5000/quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 52 qtl/acre)	1560	43470	45030	38.04	190200	145170	4.22
Jaivik Prom @ 100 kg / acre + FYM @ 52qtl/acre	3660	43470	47130	44.69	223450	176320	4.74
Total	**5220**	**86940**	**92160**	**82.73**	**413650**	**321490**	4.49

The final yield of Capsicum is found increased by more than 17% in treatment (with the use of Jaivik Prom) as compared to control.



Farmer Name: Hukum Singh (NMCGP006)

Village: Mala

District: Pauri-Garhwal

Crop: Onion

Total cost incurred for different treatments of Onion Crop per Plot (385 Square Meter)

Treatment details	Treatment cost of Rs/ 385 Square meter	Common cultivation cost of Rs/ 385 Square meter	Total cost of cultivation Rs/ 385 Square meter	Onion yield (qtl/ 385 Square meter)	Onion Selling price @ 2300/ quintal	Net Return	Benefit-cost (B:C) ratio
Control (FYM @ 50 qtl/acre)	142.87	3660.45	3803.33	4.24	9751.02	5947.69	2.56
Jaivik Khad @ 80 kg / acre + FYM @ 50 qtl/acre	371.47	3660.45	4031.93	5.65	12995.51	8963.58	3.22
Total	**514.35**	**7320.91**	**7835.25**	**9.89**	**22746.53**	**14911.27**	**2.90**

Total cost incurred for different treatments of Onion Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/ acre	Common cultivation cost of Rs/acre	Total cost of cultivation Rs/ acre	Onion yield (qtl/acre)	Onion Selling price @ 2300/ quintal	Net Return	Benefit-cost (B:C) ratio
Control (FYM @ 50 qtl/acre)	1500	38430	39930	44.51	102373	62443	2.56
Jaivik Khad @ 80 kg / acre + FYM @ 50 qtl/ acre	3900	38430	42330	59.32	136436	94106	3.22
Total	**5400**	**76860**	**82260**	**103.83**	**238809**	**156549**	2.90

The final yield of Onion is found increased by more than 33% in treatment (with the use of Jaivik Khad) as compared to control.

TEHRI-GARHWAL



Farmer Name: Mahipal Singh (NMCGT001)

Village: Bhut Gaon (Dwarikapuri)

District: Tehri-Garhwal

Crop: Capsicum

Total cost incurred for different treatments of Capsicum Crop per Bigha (770 Square Meter)

Treatment details	Treatment cost of Rs/ Bigha	Common cultivation Cost of Rs/ Bigha	Total cost of cultivation Rs/Bigha	Capsicum yield (qtl/ Bigha)	Capsicum Selling Price @5000/quintal	Net Return	Benefit-cost (B:C) ratio
Control (FYM @ 31.5 qtl/acre)	180.02	8151.01	8331.03	6.30	31499.13	23168.10	3.78
Jaivik Khad @ 80 kg / acre + FYM @ 31.5qtl/acre	637.22	8151.01	8788.23	7.98	39900.17	31111.94	4.54
Total	**817.24**	**16302.02**	**17119.26**	**14.28**	**71399.31**	**54280.05**	4.17

Total cost incurred for different treatments of Capsicum Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/ acre	Common cultivation cost of Rs/ acre	Total cost of cultivation Rs/ acre	Capsicum yield (qtl/ acre)	Capsicum Selling price @ 5000/quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 31.5 qtl/acre)	945	42787.5	43732.5	33.07	165350	121617.5	3.78
Jaivik Khad @ 80 kg / acre + FYM @ 31.5qtl/acre	3345	42787.5	46132.5	41.89	209450	163317.5	4.54
Total	**4290**	**85575**	**89865**	**74.96**	**374800**	**284935**	4.17

The final yield of Capsicum is found increased by more than 26% in treatment (with the use of Jaivik Khad) as compared to control.



Farmer Name: Surbeer Singh (NMCGT002)

Village: Bhut Gaon (Dwarikapuri)

District: Tehri-Garhwal

Crop: Capsicum

Total cost incurred for different treatments of Capsicum Crop per Bigha (770 Square Meter)

Treatment details	Treatment cost of Rs/ Bigha	Common cultivation Cost of Rs/ Bigha	Total cost of cultivation Rs/ Bigha	Capsicum yield (qtl/ Bigha)	Capsicum Selling Price @ 5000/quintal	Net Return	Benefit-cost (B:C) ratio
Control (FYM @ 31.5 qtl/acre)	180.02	8151.01	8331.03	6.2	31003.83	22672.80	3.72
Jaivik Khad @ 80 kg/acre + FYM @ 31.5qtl/acre	637.22	8151.01	8788.23	7.7	38500.00	29711.77	4.38
Total	**817.24**	**16302.02**	**17119.26**	**13.90**	**69503.83**	**52384.57**	4.06

Total cost incurred for different treatments of Capsicum Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/ acre	Common cultivation Cost of Rs/ acre	Total cost of cultivation Rs/ acre	Capsicum yield (qtl/ acre)	Capsicum Selling Price @ 5000/quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 31.5 qtl/acre)	945	42787.5	43732.5	32.55	162750	119017.5	3.72
Jaivik Khad @ 80 kg / acre + FYM @ 31.5qtl/ acre	3345	42787.5	46132.5	40.42	202100	155967.5	4.38
Total	**4290**	**85575**	**89865**	**72.97**	**364850**	**274985**	4.06

The final yield of Capsicum is found increased by more than 24% in treatment (with the use of Jaivik Khad) as compared to control.



Farmer Name: Rajender Singh (NMCGT003)

Village: Bhut Gaon (Dwarikapuri)

District: Tehri-Garhwal

Crop: Capsicum

Total cost incurred for different treatments of Capsicum Crop per Plot (385 Square Meter)

Treatment details	Treatment cost of Rs/ 385 Square meter	Common cultivation cost of Rs/ 385 Square meter	Total cost of cultivation Rs/ 385 Square meter	Capsicum yield (qtl/ 385 Square meter)	Capsicum Selling price @ 5000/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 31.5 qtl/acre)	90.01	4265.53	4355.54	4.6	22869.50	18513.96	5.25
Dharti ka Chowkidar @ 10 kg / acre + FYM @ 31.5qtl/acre	166.21	4265.53	4431.74	6.1	30427.57	25995.83	6.87
Total	**256.22**	**8531.06**	**8787.28**	**10.66**	**53297.07**	**44509.79**	**6.07**

Total cost incurred for different treatments of Capsicum Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/ acre	Common cultivation cost of Rs/ acre	Total cost of cultivation Rs/ acre	Capsicum yield (qtl/ acre)	Capsicum Selling price @ 5000/quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 31.5 qtl/acre)	945	44782.5	45727.5	48.02	240100	194372.5	5.25
Dharti ka Chowkidar @ 10 kg / acre + FYM @ 31.5qtl/acre	1745	44782.5	46527.5	63.89	319450	272922.5	6.87
Total	**2690**	**89565**	**92255**	**111.91**	**559550**	**467295**	6.07

The final yield of Capsicum is found increased by more than 33% in treatment (with the use of Dharti ka Chowkidar) as compared to control.



Farmer Name: Jasveer Singh (NMCGT004)

Village: Bhut Gaon (Dwarikapuri)

District: Tehri-Garhwal

Crop: Capsicum

Total cost incurred for different treatments of Capsicum Crop per Plot (385 Square Meter)

Treatment details	Treatment cost of Rs/ 385 Square meter	Common cultivation Cost of Rs/ 385 Square meter	Total cost of cultivation Rs/ 385 Square meter	Capsicum yield (qtl/ 385 Square meter)	Capsicum Selling Price @ 5500/quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 31.5 qtl/acre)	90.01	4075.50	4165.52	4.30	23647.69	19482.17	5.68
Natural Pori Potash @ 100 kg / acre + FYM @ 31.5qtl/acre	232.89	4075.50	4308.39	5.52	30358.52	26050.13	7.05
Total	**322.90**	**8151.01**	**8473.91**	**9.82**	**54006.20**	**45532.30**	**6.37**

Total cost incurred for different treatments of Capsicum Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/ acre	Common cultivation cost of Rs/ acre	Total cost of cultivation Rs/ ac	Capsicum yield (qtl/ ac)	Capsicum Selling price @ 5500/quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 31.5 qtl/acre)	945	42787.5	43732.5	45.14	248270	204537.5	5.68
Natural Pori Potash @ 100 kg / acre + FYM @ 31.5qtl/acre	2445	42787.5	45232.5	57.95	318725	273492.5	7.05
Total	**3390**	**85575**	**88965**	**103.09**	**566995**	**478030**	6.37

The final yield of Capsicum is found increased by more than 28% in treatment (with the use of Natural Pori Potash) as compared to control.



Farmer Name: Jaspal Chauhan (NMCGT005)

Village: Bhut Gaon (Dwarikapuri)

District: Tehri-Garhwal

Crop: Tomato

Total cost incurred for different treatments of Tomato Crop per Plot (385 Square Meter)

Treatment details	Treatment cost of Rs/ 385 Square meter	Common cultivation Cost of Rs/ 385 Square meter	Total cost of cultivation Rs/ 385 Square meter	Tomato yield (qtl/ 385 Square meter)	Tomato Selling price @ 3800/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 31.5 qtl/acre)	90.01	4410.55	4500.56	7.50	28510.76	24010.21	6.33
Natural Pori Potash @ 100 kg / acre + FYM @ 31.5qtl/acre	232.89	4410.55	4643.43	9.71	36897.14	32253.70	7.95
Total	**322.90**	**8821.09**	**9143.99**	**17.21**	**65407.90**	**56263.91**	**7.15**

Total cost incurred for different treatments of Tomato Crop per acre (4042 Square Meter)

Treatment details	Treatment cost of Rs/ acre	Common cultivation cost of Rs/ acre	Total cost of cultivation Rs/acre	Tomato yield (qtl/ acre)	Tomato Selling price @ 3800/ quintal	Net Return	Benefit-cost (B: C) ratio
Control (FYM @ 31.5 qtl/ acre)	945	46305	47250	78.77	299326	252076	6.33
Natural Pori Potash @ 100 kg / acre + FYM @ 31.5qtl/acre	2445	46305	48750	101.94	387372	338622	7.95
Total	**3390**	**92610**	**96000**	**180.71**	**686698**	**590698**	7.15

The final yield of Tomato is found increased by more than 29% in treatment (with the use of Natural Pori Potash) as compared to control.

6.6 Assistance in Marketing Strategies

To provide market platforms and general awareness about ongoing government schemes for farmers of India, including Uttarakhand, training on Harit Kranti and Annadata mobile applications was provided to all the selected farmers of the five districts of Uttarakhand.

Harit Kranti mobile application

All 52 farmers of the five districts of Uttarakhand selected for field trials under the NMCG project were made aware of using the Harit Kranti mobile application to acquaint them with:

- Agronomic Advisory
- Soil Health Analysis
- Input Availability
- Weather Information
- Financial Services
- Post-Harvest and Marketing Support
- Crop Disease and Pest Management
- Digitizing Land Records

This application empowers farmers to make data-driven, timely decisions related to crop selection, sowing, input application, and marketing. In addition, it reduces risks associated with weather, disease, and market uncertainty by providing timely alerts and market integration. Overall, the Harit Kranti app bundles numerous services into a single platform, making it a powerful digital ally for modern farmers striving for sustainable and profitable agriculture (Figure 6.22a & b - 6.28).

Annadata mobile application

Like Harit Kranti, all selected farmers of the five districts of Uttarakhand under the current project were also trained for the use of the Annadata mobile application. As a dedicated mobile platform that transforms agricultural trading by connecting farmers directly to a nationwide network of buyers and sellers, fostering transparency, efficiency, and inclusivity in the supply chain. Total 33 farmers used this platform to search for suitable buyers for their agricultural produce (Table 6.33 and Figure 6.22a&b, 6.24a,b &c - 6.28). The rest of the farmers are engaged with ongoing sugarcane crop, hence, they may use this platform to search for suitable buyers for their agricultural produce at the crop maturity stage.



Figure 6.22a. Anndata Mobile Application

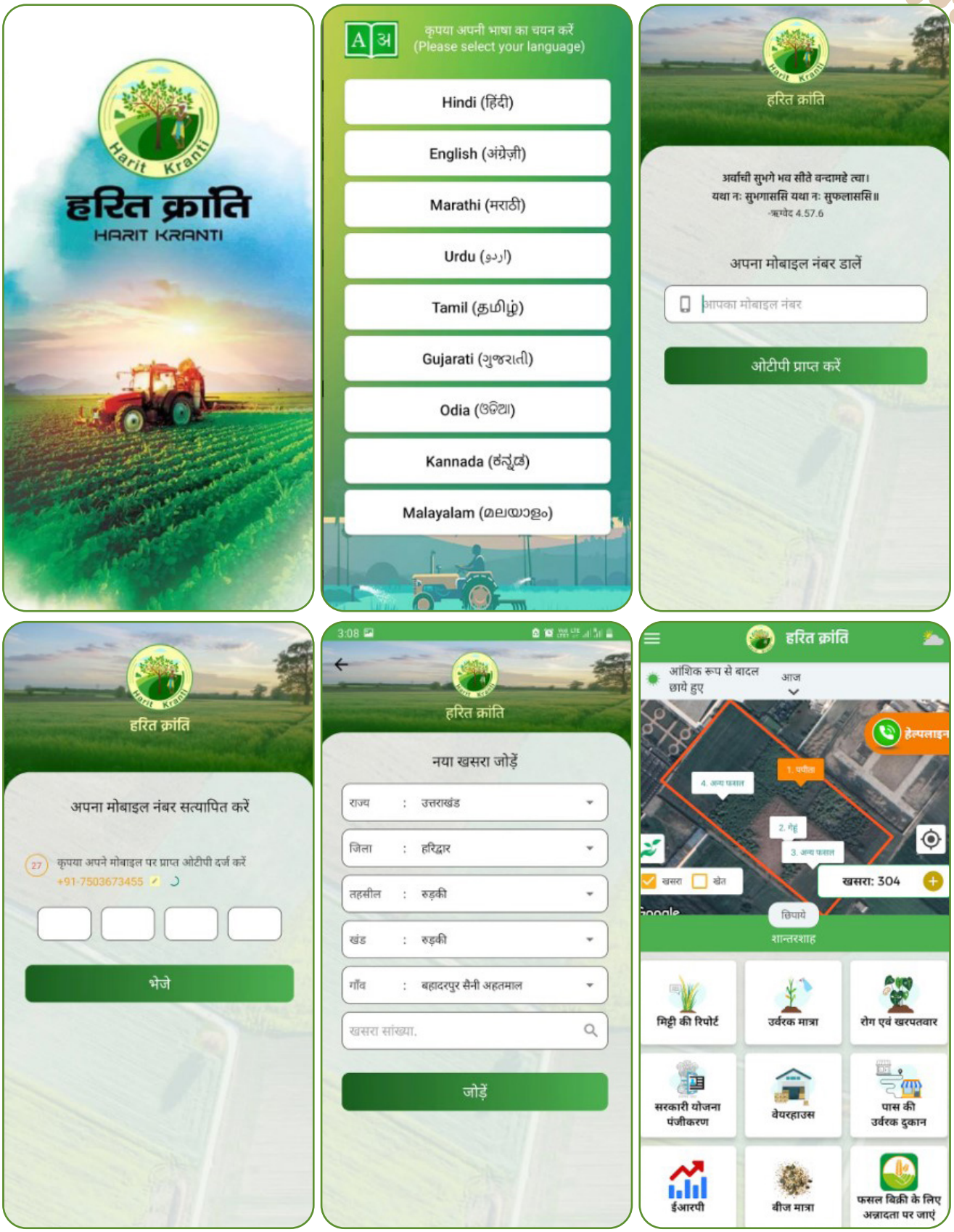
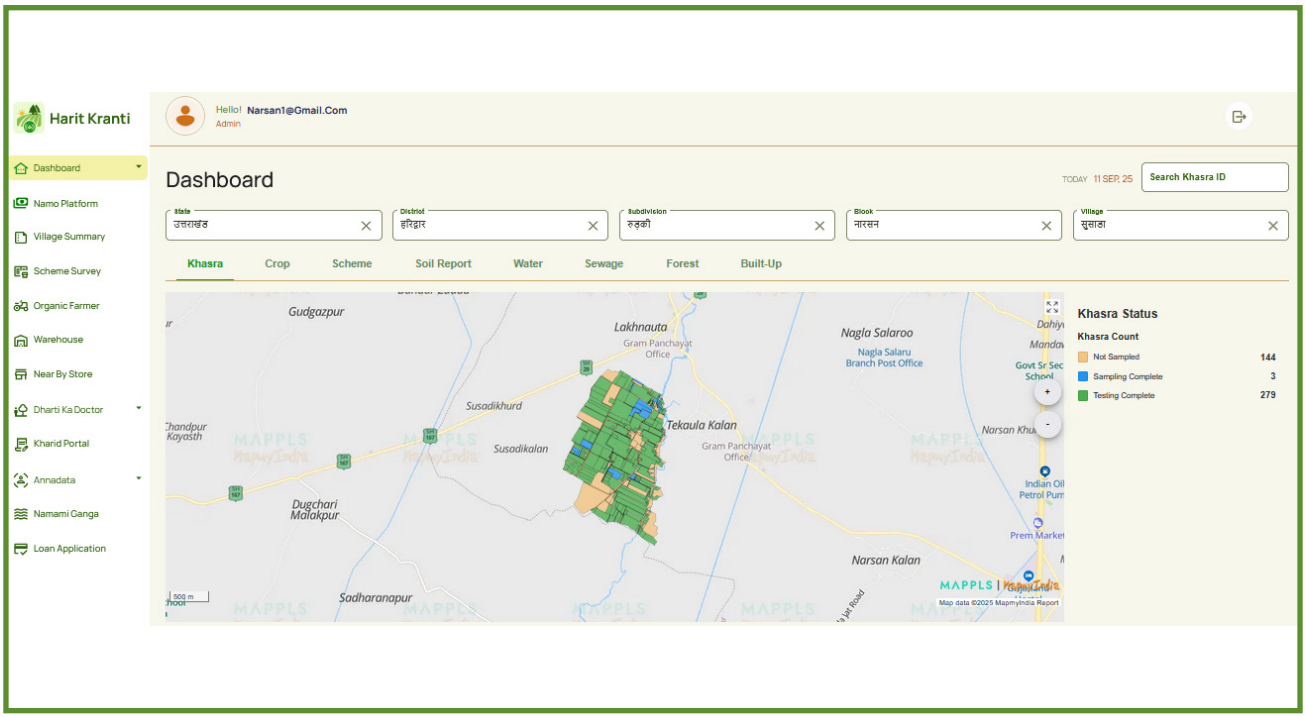


Figure 6.22b. Harit-Kranti Mobile Application



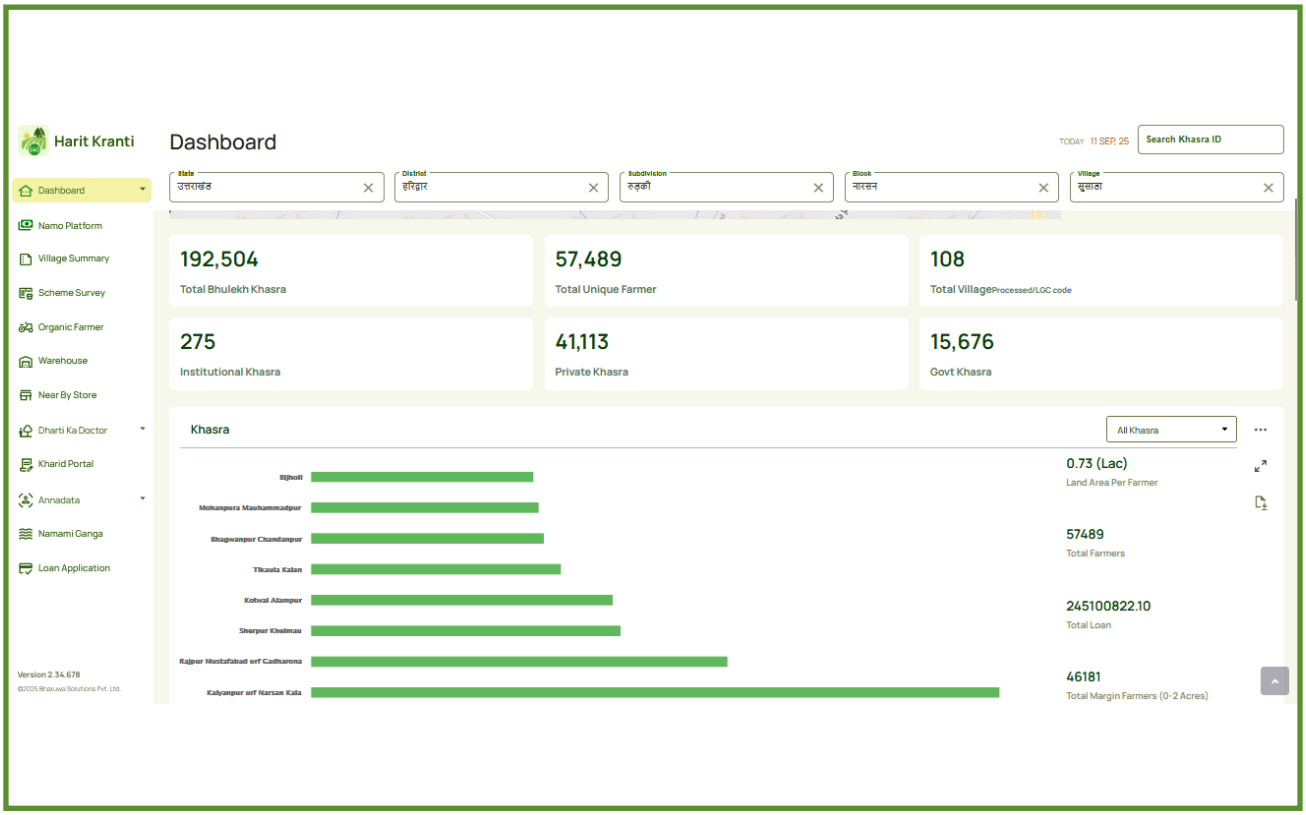


Figure 6.23a. Dashboard of Harit-Kranti Mobile Application

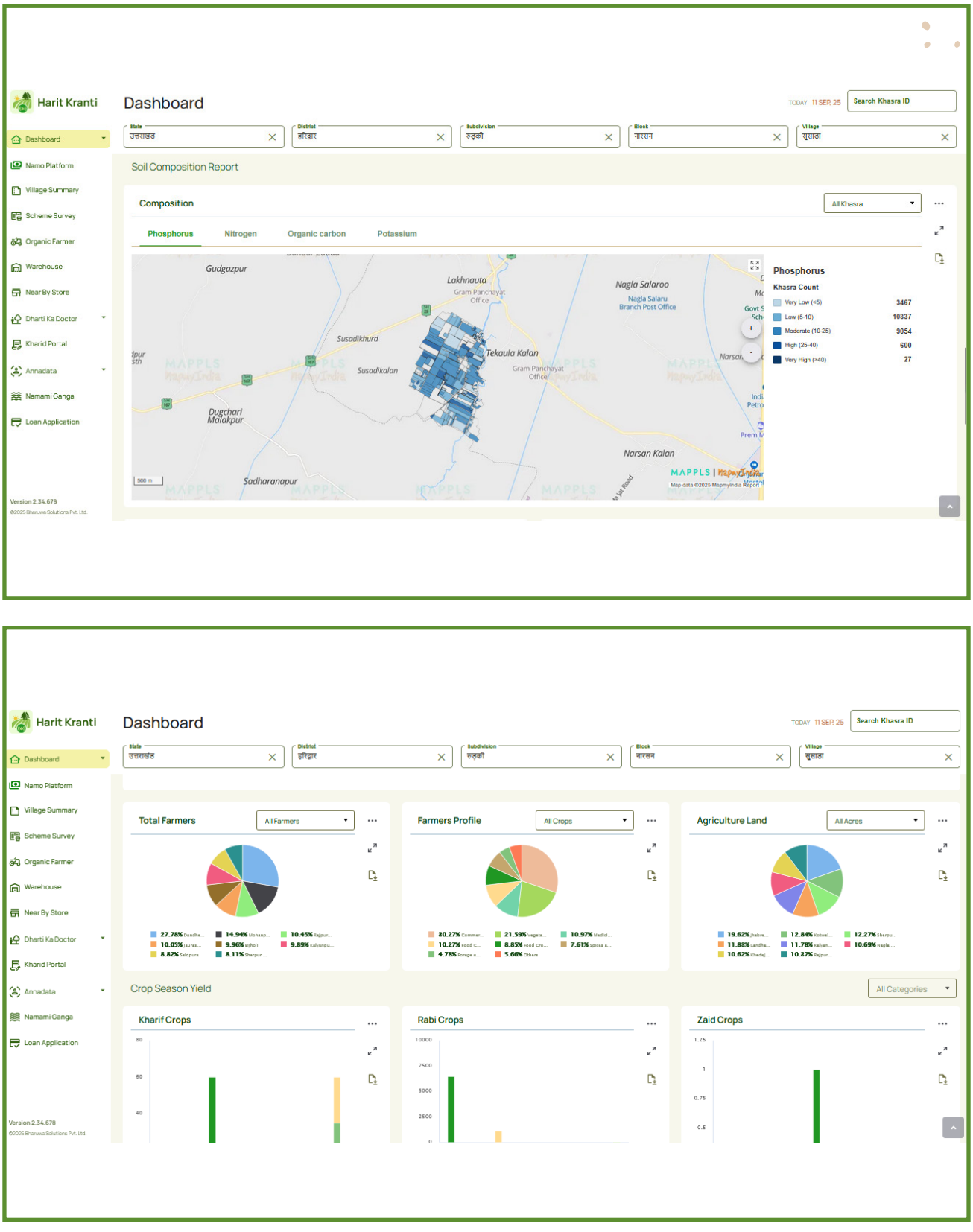
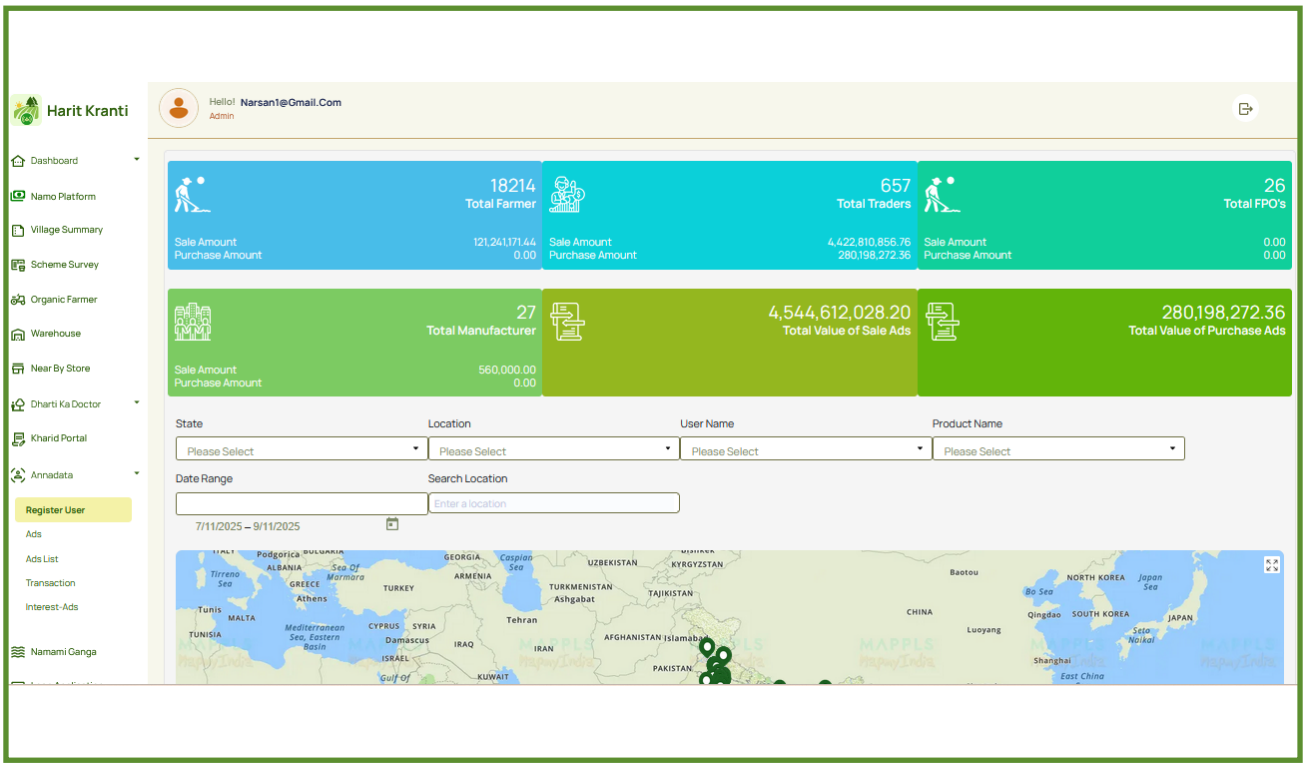


Figure 6.23b. Dashboard of Harit-Kranti Mobile Application



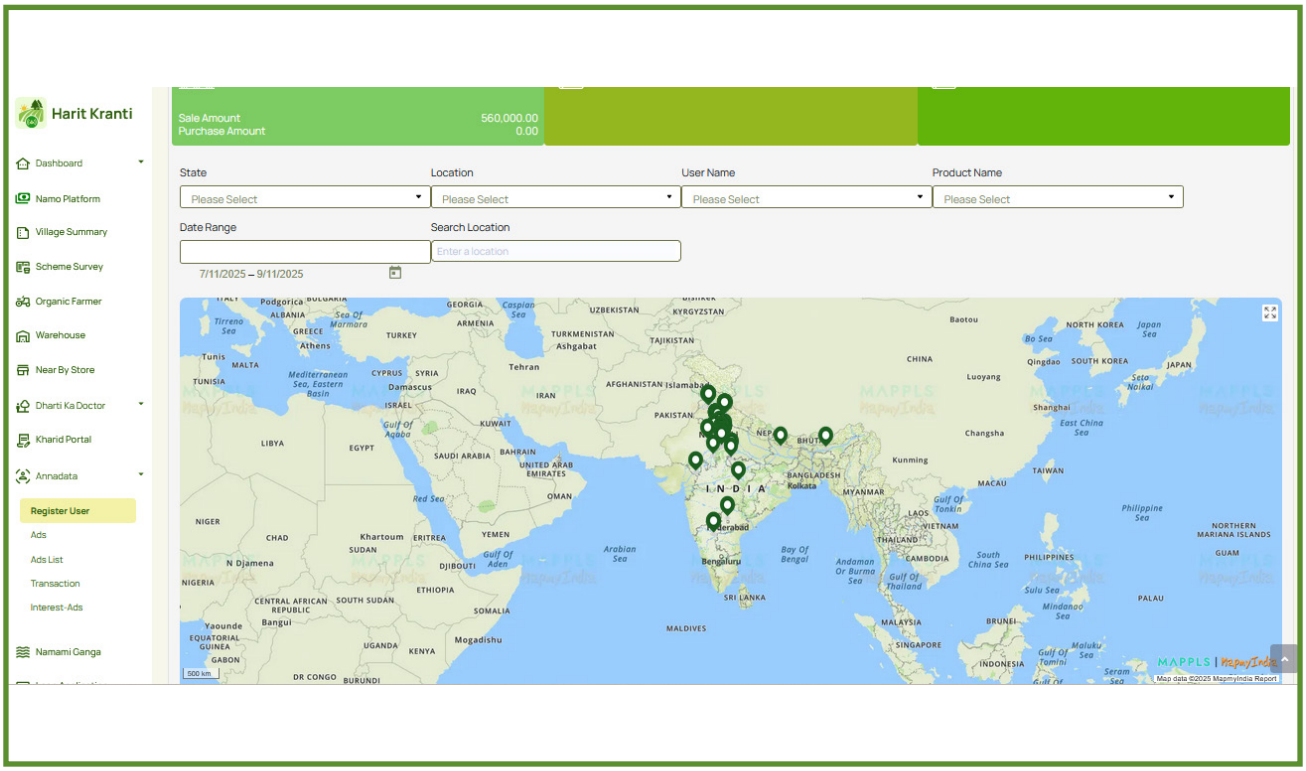


Figure 6.24a. Dashboard of Annadata Mobile Application

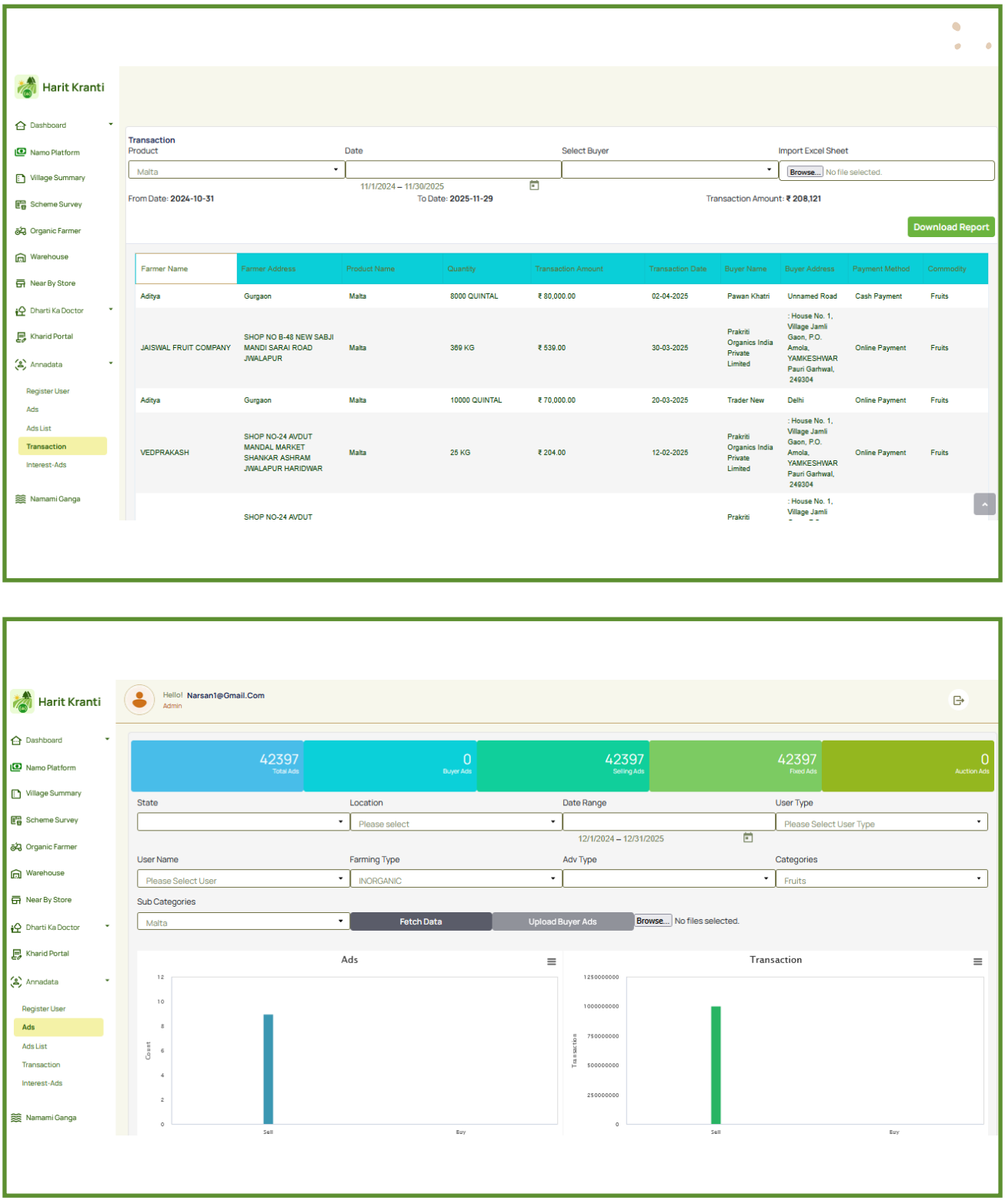


Figure 6.24b. Dashboard of Annadata Mobile Application



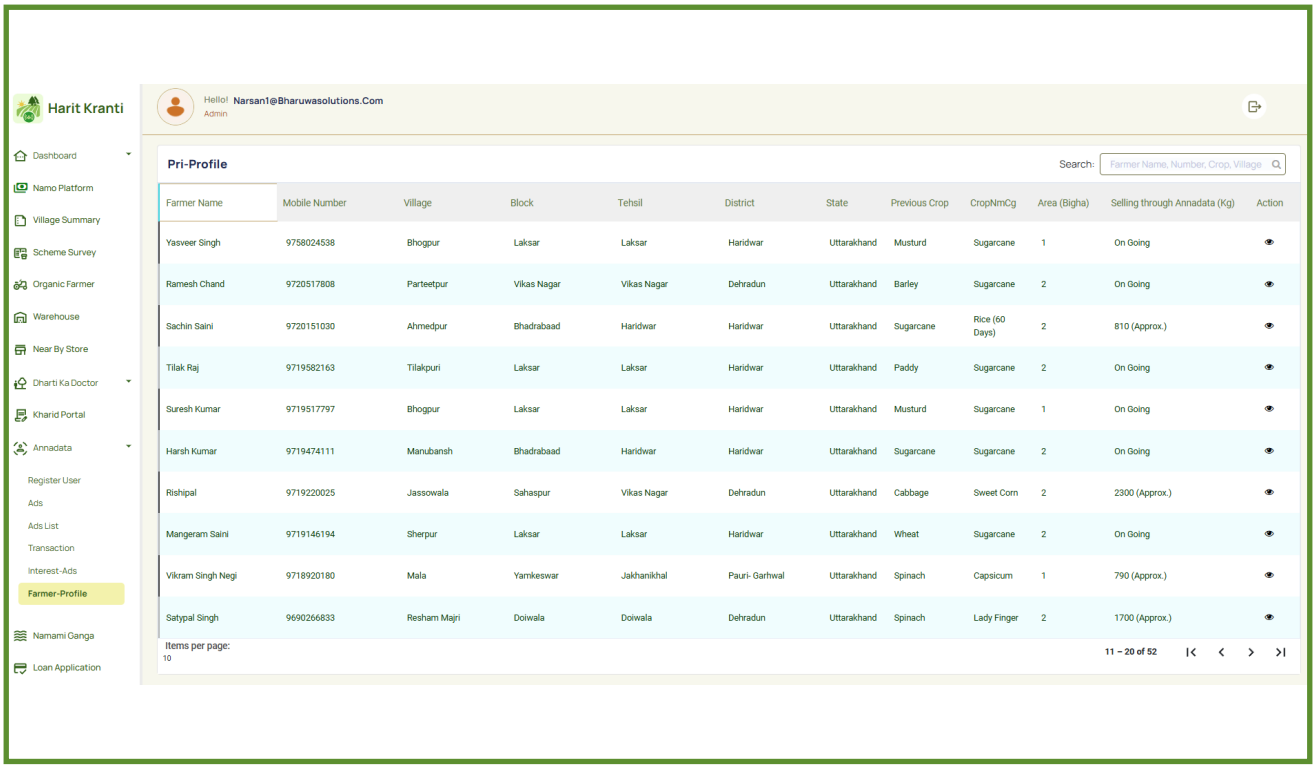


Figure 6.24c. Dashboard of Annadata Mobile Application

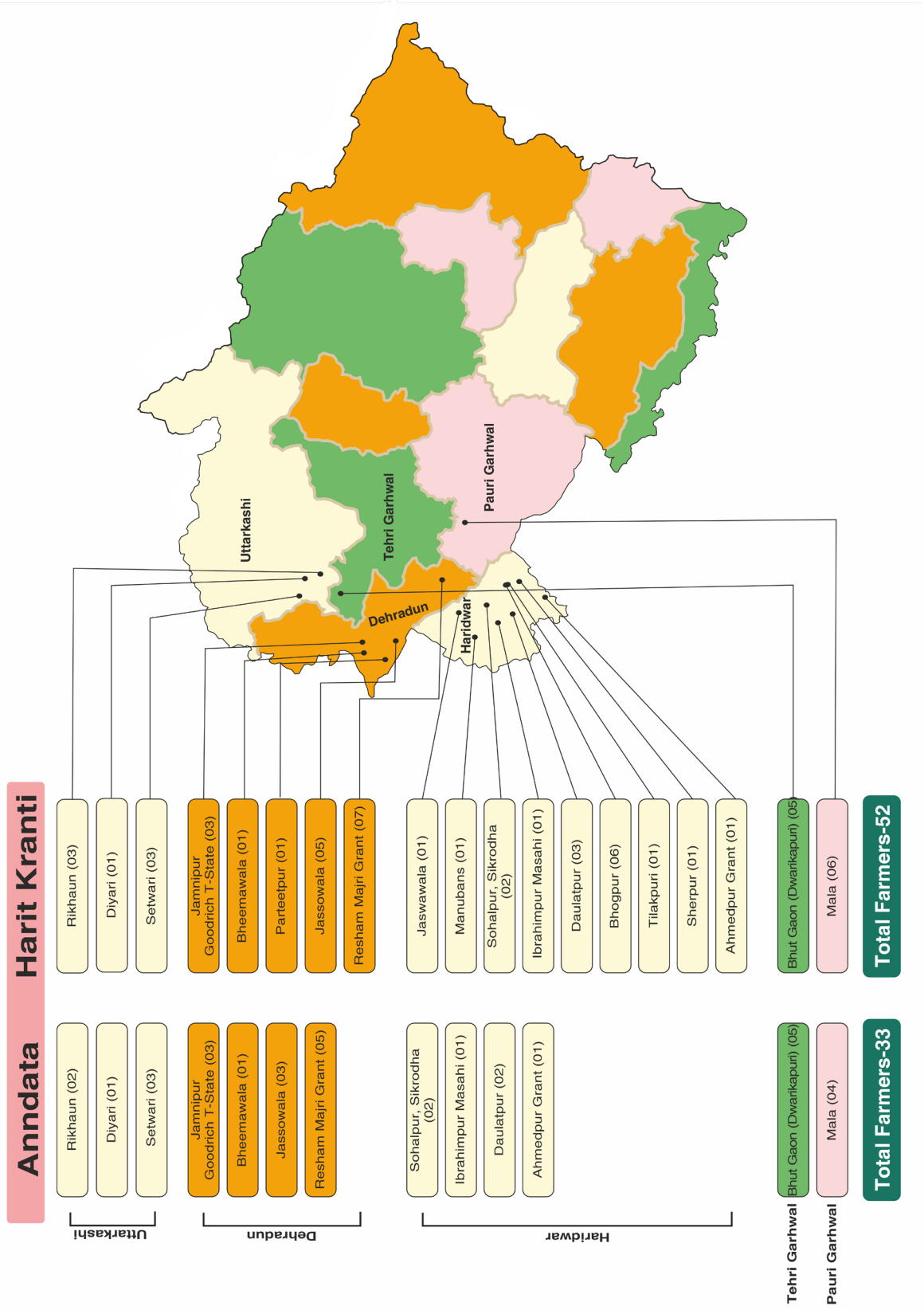


Figure 6.25. Map showing the details of farmers at district- and village-level covered under the NMCG project for demonstration of Harit-Kranti and Anndata applications



Figure 6.26. Demonstration of Harit-kranti and Anndata application with farmers in different districts of Uttarakhand

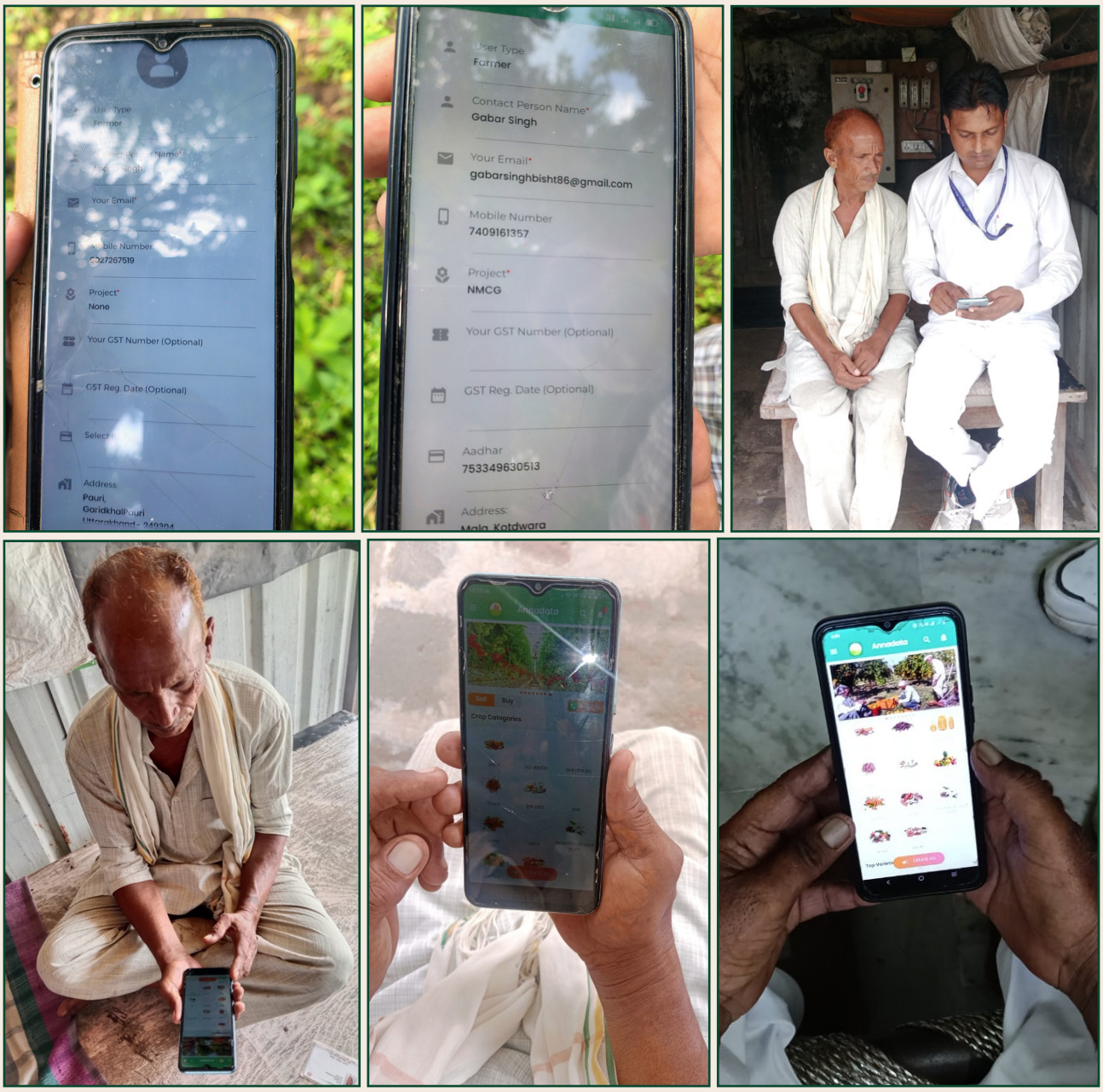


Figure 6.27. Demonstration of Harit-kranti and Anndata application with farmers in different districts of Uttarakhand



Figure 6.28. Demonstration of Harit-kranti and Anndata application with farmers in different districts of Uttarakhand

FEEDBACK FROM THE PARTICIPANT FARMERS

The qualitative feedback provided by the participating farmers was systematically recorded and analyzed. Their testimonials strongly corroborate the experimental findings, indicating that the application of Ganga sludge-based organic manure has a pronounced positive impact on crop performance. Farmers consistently reported improvements in crop growth and measurable increases in yield compared to conventional practices. To provide direct access to these farmer experiences, a QR code linking to the recorded testimonials is also presented here.

Table 6.33. List of farmers used Annadata application for selling their agri-produce produced under NMCG project

Sr. No.	Full Name	Mobile No.	Pincode	Area/Village	City	Crop
1	Sachin Saini	9720151030	249402	Ahmedpur Grant	Bahadrabad, Haridwar	Rice (60 days)
2	Aakash Saini	8006856209	247667	Jaswawala	Bahadrabad, Haridwar	Bhindi (Okra)
3	Mahepal	9027298715	247667	Sohalpur Sikrodha	Bahadrabad, Haridwar	Brinjal
4	Munna Lal	800623944	247667	Ibrahimpur Masahi	Bahadrabad, Haridwar	Menthol
5	Ram Kumar	9758054029	247667	Sohalpur Sikrodha	Bahadrabad, Haridwar	Egg-Plant
6	Ram Singh	9917265031	249402	Daulatpur	Bahadrabad, Haridwar	Black Gram
7	Dhyan Singh	7464807074	249402	Daulatpur	Bahadrabad, Haridwar	Bhindi (Okra)
8	Balram	8077979194	249402	Daulatpur	Bahadrabad, Haridwar	Cowpee (lobiya)
9	Kunwar Singh	351349848	248140	Resham Majri Grant	Doiwala, Dehradun	Tulsi
10	Devender Singh	9758727662	248140	Resham Majri Grant	Doiwala, Dehradun	Bhindi (Okra)
11	Chaitan	9528086048	248140	Resham Majri Grant	Doiwala, Dehradun	Menthol
12	Satypal Singh	9690266833	248140	Resham Majri Grant	Doiwala, Dehradun	Bhindi (Okra)
13	Hritik Kumar	9548096811	248140	Resham Majri Grant	Doiwala, Dehradun	Karela (Bittergourd)
14	Yaspal Singh	9758122830	248140	Resham Majri Grant	Doiwala, Dehradun	Amaranth (Cholai)
15	Nikhil Kumar	9761419006	248140	Resham Majri Grant	Doiwala, Dehradun	Amaranth (Cholai)
16	Kuldeep Saini	9319193953	248198	Bheemawala	Vikasnagar, Dehradun	Bhindi
17	Tara Chand Saini	9634969118	248142	Jassowala	Vikasnagar, Dehradun	Cucumber
18	Rajender Singh	9536271818	248198	Jamnipur Goodrich T-State	Vikasnagar, Dehradun	Bhindi

Sr. No.	Full Name	Mobile No.	Pincode	Area/Village	City	Crop
19	Ashish Kumar	9410379770	248198	Jamnipur Goodrich T-State	Vikasnagar, Dehradun	Bhindi
20	Shubham	8936988144	248198	Jamnipur Goodrich T-State	Vikasnagar, Dehradun	Bhindi
21	Aryan Saini	8171980568	248142	Jassowala	Vikasnagar, Dehradun	Cucumber
22	Rishipal	9719220025	248142	Jassowala	Vikasnagar, Dehradun	Sweet Corn
23	Chatar Singh	9389248355	249171	Setwari	Damta, Uttarkashi	Tomato
24	Inder Singh	7818827375	249171	Diyari	Damta, Uttarkashi	Tomato
25	Bhagtu lal	9389052320	249171	Setwari	Damta, Uttarkashi	Capsicum
26	Gulabu Singh	9258098126	249171	Setwari	Damta, Uttarkashi	Tomato
27	Dinesh Panwar	9456743448	249171	Rikhaun	Damta, Uttarkashi	Tomato
28	Pyar Singh	8218774723	249171	Rikhaun	Damta, Uttarkashi	Tomato
29	Meena Devi	9411139490	249171	Rikhaun	Damta, Uttarkashi	Sweet Corn
30	Mahipal Singh	9997138409	279186	Bhut Gaon (Dwarikapuri)	Nainbagh, Tehri	Capsicum
31	Surbeer Singh	7055153457	279186	Bhut Gaon (Dwarikapuri)	Nainbagh, Tehri	Capsicum
32	Rajender Singh	7579465558	279186	Bhut Gaon (Dwarikapuri)	Nainbagh, Tehri	Capsicum
33	Jasveer Singh	9389958217	279186	Bhut Gaon (Dwarikapuri)	Nainbagh, Tehri	Capsicum
34	Jaspal Chauhan	8433262973	279186	Bhut Gaon (Dwarikapuri)	Nainbagh, Tehri	Tomato
35	Anand Singh	9027267519	249304	Mala	Gaindkhal, Pauri	Bhindi
36	Akbeer Singh	6397617771	249304	Mala	Gaindkhal, Pauri	Bhindi
37	Gabbar Singh	6398221014	249304	Mala	Gaindkhal, Pauri	Bhindi
38	Vikram Singh Negi	9718920180	249304	Mala	Gaindkhal, Pauri	Capsicum
39	Rajpal	9910743458	249304	Mala	Gaindkhal, Pauri	Cholai (Amaranth)
40	Hukum Singh Negi	9027953768	249304	Mala	Gaindkhal, Pauri	Onion

Farmer Profile Dashboard

Farmer Profile



Mobile Number	9720151030
Gender	MALE

Land Location



Farmer Details

Farmer Name	Sachin Saini
Village	Ahmedpur
Block	Bhadrabaad
Tehsil	Haridwar
District	Haridwar
State	Uttarakhand
Previous Crop	Sugarcane
Current Crop	Rice (60 days)
Area (Bigha)	2
Selling Through Annadata (KG)	810 (approx.)
Creation Date	14/09/2025

Crop Images (Rice)






Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	ORG_01
Category	CAT_04
Subcategory	CAFG_052
Variety	RIC11105
Quantity	764 KG
Branding Image	

Base Price	25.0 / KG
Cost Price	₹ 19100
Delivery Time	2025-09-27T00:00:00.000+0000
Payment Term	2025-09-27
Home Delivery	No
Verified	Yes
Product Images	  

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
D49AC232F6	2025-09-20	KRITI TRADERS	Sachin Saini	Jwalapur Town	Rice	200 KG	₹5000	2025-09-20T04:46:55.718+0000
064FF29827	2025-09-21	KRITI TRADERS	Sachin Saini	Jwalapur Town	Rice	225 KG	₹5625	2025-09-21T05:58:17.580+0000
7E8F2C4A31	2025-09-22	KRITI TRADERS	Sachin Saini	Jwalapur Town	Rice	150 KG	₹3750	2025-09-22T06:40:26.472+0000
076FC7E0FA	2025-09-23	KRITI TRADERS	Sachin Saini	Jwalapur Town	Rice	189 KG	₹4725	2025-09-23T07:10:17.254+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	8006856209
Gender	MALE

Land Location



Farmer Details

Farmer Name	Aakash Saini
Village	Jaswawala
Block	Bhadrabaad
Tehsil	Haridwar
District	Haridwar
State	Uttarakhand
Previous Crop	Onion
Current Crop	Lady Finger
Area (Bigha)	1
Selling Through Annadata (KG)	1009 (approx.)
Creation Date	14/09/2025

Crop Images (Lady Finger)



Scan to Watch Full Video

Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	VEG_013
Variety	LAD10689
Quantity	947 KG
Branding Image	

Base Price	32.0 / KG
Cost Price	₹ 30304
Delivery Time	2025-10-01T00:00:00.000+0000
Payment Term	2025-09-29
Home Delivery	No
Verified	Yes
Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
A38550BB44	2025-09-27	KRITI TRADERS	Aakash Saini	Jwalapur Town	Ladyfinger(Bhindi)	700 KG	₹22400	2025-09-27T08:47:29.076+0000
685C34E82E	2025-09-28	KRITI TRADERS	Aakash Saini	Jwalapur Town	Ladyfinger(Bhindi)	247 KG	₹7904	2025-09-28T09:40:32.830+0000

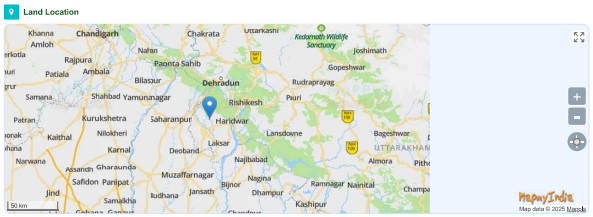
Farmer Profile Dashboard

Farmer Profile



Mobile Number	9027298715
Gender	MALE

Land Location



Farmer Details

Farmer Name	Mahepal
Village	Sohalpur, Sikronda
Block	Bhadrabaad
Tehsil	Haridwar
District	Haridwar
State	Uttarakhand
Previous Crop	Cabbage
Current Crop	Brinjal
Area (Bigha)	2
Selling Through Annadata (KG)	1350 (approx.)
Creation Date	06/09/2025

Crop Images (Brinjal)



Scan to Watch Full Video

Farmer Advertisements

Advertisement #1

Latitude	28.535517	Base Price	25.0 / KG
Longitude	77.391029	Cost Price	₹ 2500
Farming Type	IORG_01	Delivery Time	2025-09-06T00:00:00.000+0000
Category	CAT_02	Payment Term	2025-09-06
Subcategory	Egg-Plant_001	Home Delivery	Yes
Variety	Egg-Plant_001	Verified	Yes
Quantity	100 KG		
Branding Image		Product Images	

Advertisement #2

Latitude	28.535517	Base Price	25.0 / KG
Longitude	77.391029	Cost Price	₹ 5000
Farming Type	IORG_01	Delivery Time	2025-09-06T00:00:00.000+0000
Category	CAT_02	Payment Term	2025-09-06
Subcategory	Egg-Plant_001	Home Delivery	Yes
Variety	Egg-Plant_001	Verified	Yes
Quantity	200 KG		
Branding Image		Product Images	

Advertisement #3

Latitude	28.535517	Base Price	25.0 / KG
Longitude	77.391029	Cost Price	₹ 10000
Farming Type	IORG_01	Delivery Time	2025-09-06T00:00:00.000+0000
Category	CAT_02	Payment Term	2025-09-06
Subcategory	Egg-Plant_001	Home Delivery	Yes
Variety	Egg-Plant_001	Verified	Yes
Quantity	400 KG		
Branding Image		Product Images	

Advertisement #4

Latitude	28.535517	Base Price	25.0 / KG
Longitude	77.391029	Cost Price	₹ 15300
Farming Type	IORG_01	Delivery Time	2025-09-04T00:00:00.000+0000
Category	CAT_02	Payment Term	2025-08-27
Subcategory	Egg-Plant_001	Home Delivery	No
Variety	Egg-Plant_001	Verified	Yes
Quantity	612 KG		
Branding Image		Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
513B247BAF	2025-09-03	KRITI TRADERS	Mahepal	Jwalapur Town	Egg-Plant	612 KG	₹15300	2025-09-03T04:29:53.414+0000
1DE34F9256	2025-09-04	KRITI TRADERS	Mahepal	Jwalapur Town	Egg-Plant	400 KG	₹10000	2025-09-04T04:57:29.413+0000
AC0A903E26	2025-09-04	KRITI TRADERS	Mahepal	Jwalapur Town	Egg-Plant	300 KG	₹7500	2025-09-04T06:12:27.288+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	7351420503
Gender	MALE

Land Location



Farmer Details

Farmer Name	Munna Lal
Village	Masahi
Block	Bhadrabaad
Tehsil	Haridwar
District	Haridwar
State	Uttarakhand
Previous Crop	Wheat
Current Crop	Menthol
Area (Bigha)	1
Selling Through Annadata (KG)	900 (approx.)
Creation Date	18/09/2025

Crop Images (Menthol)



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Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	Mentha_001
Variety	Mentha_001
Quantity	815 KG
Branding Image	

Base Price	35.0 / KG
Cost Price	₹ 28525
Delivery Time	2025-09-25T00:00:00.000+0000
Payment Term	2025-09-25
Home Delivery	No
Verified	Yes
Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
9A6A12DA7B	2025-09-25	KRITI TRADERS	Munna Lal	Jwalapur Town	Menthol	815 KG	₹28525	2025-09-25T05:20:37.739+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	9758054029
Gender	MALE

Land Location



Farmer Details

Farmer Name	RamKumar
Village	Sohelpur,Sikronda
Block	Bhadrabaad
Tehsil	Haridwar
District	Haridwar
State	Uttarakhand
Previous Crop	Wheat
Current Crop	Brinjal
Area (Bigha)	2
Selling Through Annadata (KG)	1590 (approx.)
Creation Date	11/09/2025

Crop Images (Brinjal)



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Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	Egg-Plant_001
Variety	Egg-Plant_001
Quantity	1538 KG
Branding Image	

Base Price	32.0 / KG
Cost Price	₹ 49216
Delivery Time	2025-09-17T00:00:00.000+0000
Payment Term	2025-09-17
Home Delivery	No
Verified	Yes
Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
B4F4AE4215	2025-09-16	KRITI TRADERS	Ram Kumar	Jwalapur Town	Egg-Plant	1538 KG	₹49216	2025-09-16T05:28:46.308+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	9917265031
Gender	MALE

Land Location



Farmer Details

Farmer Name	Ram Singh
Village	Daulatpur
Block	Roorkee
Tehsil	Roorkee
District	Haridwar
State	Uttarakhand
Previous Crop	Wheat
Current Crop	Black Gram (Urad)
Area (Bigha)	2
Selling Through Annadata (KG)	185 (approx.)
Creation Date	02/09/2025

Crop Images (Black Gram (Urad))



Farmer Advertisements

Advertisement #1

Latitude	28.535517	Base Price	140.0 / KG
Longitude	77.391029	Cost Price	₹ 20720
Farming Type	ORG_01	Delivery Time	2025-09-04T00:00:00.000+0000
Category	CAT_04	Payment Term	2025-09-04
Subcategory	CAFG_011	Home Delivery	No
Variety	BLA11047	Verified	Yes
Quantity	148 KG		
Branding Image		Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
72FF04769B	2025-09-05	KRITI TRADERS	Ram Singh	Jwalapur Town	Blackgram(Urad)	148 KG	₹20720	2025-09-05T07:04:12.264+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	7464807074
Gender	MALE

Land Location



Farmer Details

Farmer Name	Dhyan Singh
Village	Daulatpur
Block	Roorkee
Tehsil	Roorkee
District	Haridwar
State	Uttarakhand
Previous Crop	Brinjal
Current Crop	Lady Finger
Area (Bigha)	2
Selling Through Annadata (KG)	1800 (approx.)
Creation Date	17/09/2025

Crop Images (Brinjal)





Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	VEG_013
Variety	LAD_001
Quantity	1770 KG
Branding Image	

Base Price	35.0 / KG
Cost Price	₹ 61950
Delivery Time	2025-09-19T00:00:00.000+0000
Payment Term	2025-09-20
Home Delivery	No
Verified	Yes
Product Images	  

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
1A0C0F32AF	2025-09-19	KRITI TRADERS	Dhyan Singh	Jwalapur Town	Ladyfinger(Bhindi)	1770 KG	₹61950	2025-09-19T05:29:35.213+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	8077979194
Gender	MALE

Land Location



Farmer Details

Farmer Name	Balram
Village	Daulatpur
Block	Roorkee
Tehsil	Roorkee
District	Haridwar
State	Uttarakhand
Previous Crop	Wheat
Current Crop	Cow pea (Lobiya)
Area (Bigha)	2
Selling Through Annadata (KG)	1211 (approx.)
Creation Date	13/09/2025

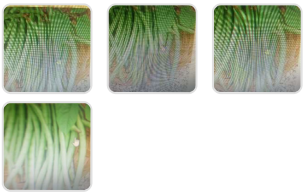
Crop Images (Cow pea (Lobiya))



Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	ORG_01
Category	CAT_02
Subcategory	VEG_061
Variety	FRE_001
Quantity	1111 KG
Branding Image	

Base Price	25.0 / KG
Cost Price	₹ 27775
Delivery Time	2025-09-15T00:00:00.000+0000
Payment Term	2025-09-15
Home Delivery	Yes
Verified	Yes
Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
487A748CA2	2025-09-14	KRITI TRADERS	Balram	Jwalapur Town	Fresh Lobia	11 KG	₹275	2025-09-13T18:30:00.001+0000
FD2ADB26EA	2025-09-14	KRITI TRADERS	Balram	Jwalapur Town	Fresh Lobia	111 KG	₹2775	2025-09-13T18:30:00.885+0000
CE42561A34	2025-09-14	KRITI TRADERS	Balram	Jwalapur Town	Fresh Lobia	450 KG	₹11250	2025-09-13T18:30:00.890+0000
6DC6D653C2	2025-09-14	KRITI TRADERS	Balram	Jwalapur Town	Fresh Lobia	539 KG	₹13475	2025-09-13T18:30:00.891+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	7351349848
Gender	MALE

Land Location



Farmer Details

Farmer Name	Kunwar Singh
Village	Resham Majri
Block	Doiwala
Tehsil	Doiwala
District	Dehradun
State	Uttarakhand
Previous Crop	Soyabean
Current Crop	Basil (Tulsi)
Area (Bigha)	2
Selling Through Annadata (KG)	1950 (approx.)
Creation Date	19/09/2025

Crop Images (Basil (Tulsi))



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Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	Tulsi_001
Variety	Tulsi_001
Quantity	1926 KG
Branding Image	

Base Price	16.0 / KG
Cost Price	₹ 30816
Delivery Time	2025-10-27T00:00:00.000+0000
Payment Term	2025-10-27
Home Delivery	No
Verified	Yes
Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
AF065D4710	2025-10-25	KRITI TRADERS	Kunwar Singh	Jwalapur Town	Tulsi	1926 KG	₹30816	2025-10-25T05:40:12.483+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	9758727662
Gender	MALE

Land Location



Farmer Details

Farmer Name	Devender Singh
Village	Resham Majri
Block	Doiwala
Tehsil	Doiwala
District	Dehradun
State	Uttarakhand
Previous Crop	Sugarcane
Current Crop	Lady Finger
Area (Bigha)	1
Selling Through Annadata (KG)	1054 (approx.)
Creation Date	07/09/2025

Crop Images (Lady Finger)





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Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	VEG_013
Variety	LAD10689
Quantity	1004 KG
Branding Image	

Base Price	32.0 / KG
Cost Price	₹ 32128
Delivery Time	2025-09-15T00:00:00.000+0000
Payment Term	2025-09-15
Home Delivery	No
Verified	Yes
Product Images	  

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
5F6E76BD2E	2025-09-12	KRITI TRADERS	Devender Singh	Jwalapur Town	Ladyfinger(Bhindi)	1004 KG	₹32128	2025-09-12T06:02:23.994+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	9528086048
Gender	MALE

Land Location



Farmer Details

Farmer Name	Chaitan
Village	Resham Majri
Block	Doiwala
Tehsil	Doiwala
District	Dehradun
State	Uttarakhand
Previous Crop	Coriander
Current Crop	Mint
Area (Bigha)	2
Selling Through Annadata (KG)	1287 (approx.)
Creation Date	25/09/2025

Crop Images (Mint)



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Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	Mentha_001
Variety	Mentha_001
Quantity	1241 KG
Branding Image	

Base Price	32.0 / KG
Cost Price	₹ 39712
Delivery Time	2025-09-28T00:00:00.000+0000
Payment Term	2025-09-28
Home Delivery	No
Verified	Yes
Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
3EA822A4DF	2025-09-27	KRITI TRADERS	Chetan	Jwalapur Town	Mint	1241 KG	₹39712	2025-09-27T11:06:38.687+0000

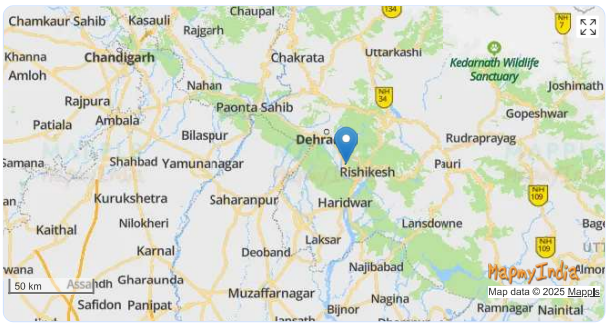
Farmer Profile Dashboard

Farmer Profile



Mobile Number	9690266833
Gender	MALE

Land Location



Farmer Details

Farmer Name	Satypal Singh
Village	Resham Majri
Block	Doiwala
Tehsil	Doiwala
District	Dehradun
State	Uttarakhand
Previous Crop	Spinach
Current Crop	Lady Finger
Area (Bigha)	2
Selling Through Annadata (KG)	1700 (approx.)
Creation Date	21/09/2025

Crop Images (Lady Finger)



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Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	VEG_013
Variety	LAD10689
Quantity	1697 KG
Branding Image	

Base Price	35.0 / KG
Cost Price	₹ 59395
Delivery Time	2025-09-25T00:00:00.000+0000
Payment Term	2025-09-25
Home Delivery	No
Verified	Yes
Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
70FD0F0C29	2025-09-24	KRITI TRADERS	Satypal Singh	Jwalapur Town	Ladyfinger(Bhindi)	1697 KG	₹59395	2025-09-24T04:28:43.581+0000

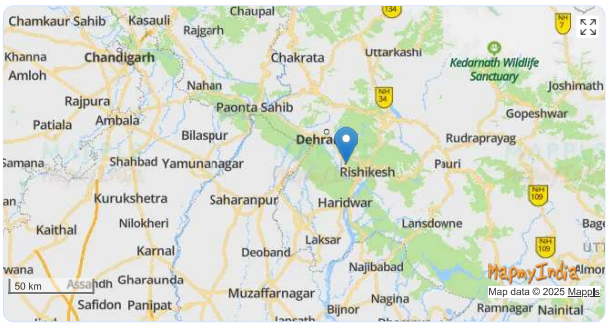
Farmer Profile Dashboard

Farmer Profile



Mobile Number	9548096811
Gender	MALE

Land Location



Farmer Details

Farmer Name	Hritik Kumar
Village	Resham Majri
Block	Doiwala
Tehsil	Doiwala
District	Dehradun
State	Uttarakhand
Previous Crop	Spinach
Current Crop	Bitter Gourd(Karela)
Area (Bigha)	2
Selling Through Annadata (KG)	1195 (approx.)
Creation Date	23/09/2025

Crop Images (Bitter Gourd (Karela))



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Farmer Advertisements

Advertisement #1

Latitude	30.1497935
Longitude	78.1569558
Farming Type	IORG_01
Category	CAT_02
Subcategory	VEG_032
Variety	BIT10823
Quantity	1159 KG
Branding Image	

Base Price	70.0 / KG
Cost Price	₹ 81130
Delivery Time	2025-09-28T00:00:00.000+0000
Payment Term	2025-09-28
Home Delivery	No
Verified	Yes
Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
F1B982B038	2025-09-25	KRITI TRADERS	Hritik	Jwalapur Town	Bitter Gourd	500 KG	₹35000	2025-09-24T18:30:00.479+0000
378C3FDAEF	2025-09-27	KRITI TRADERS	Hritik	Jwalapur Town	Bitter Gourd	659 KG	₹46130	2025-09-26T18:30:00.249+0000

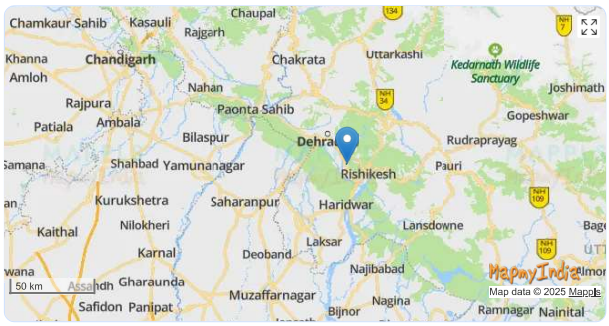
Farmer Profile Dashboard

Farmer Profile



Mobile Number	9758122830
Gender	MALE

Land Location



Farmer Details

Farmer Name	Yaspal Singh
Village	Resham Majri
Block	Doiwala
Tehsil	Doiwala
District	Dehradun
State	Uttarakhand
Previous Crop	Wheat
Current Crop	Amaranth (Cholai)
Area (Bigha)	1
Selling Through Annadata (KG)	765 (approx.)
Creation Date	08/09/2025

Crop Images (Amaranth (Cholai))



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Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	VEG_058
Variety	CHA_001
Quantity	725.0 KG
Branding Image	

Base Price	30.0 / KG
Cost Price	₹ 21750
Delivery Time	2025-09-10T00:00:00.000+0000
Payment Term	2025-09-10
Home Delivery	No
Verified	Yes
Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
14A6543EC6	2025-09-10	KRITI TRADERS	Yaspal Singh	Jwalapur Town	Red Chaulai	725 KG	₹21750	2025-09-10T10:25:21.188+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	9761419006
Gender	MALE

Land Location



Farmer Details

Farmer Name	Nikhil Kumar
Village	Resham Majari
Block	Doiwala
Tehsil	Doiwala
District	Dehradun
State	Uttarakhand
Previous Crop	Sugarcane
Current Crop	Amaranth (Cholai)
Area (Bigha)	1
Selling Through Annadata (KG)	700 (approx.)
Creation Date	04/09/2025

Crop Images (Amaranth (Cholai))



Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	VEG_058
Variety	CHA_002
Quantity	656.0 KG
Branding Image	

Base Price	20.0 / KG
Cost Price	₹ 13120
Delivery Time	2025-09-07T00:00:00.000+0000
Payment Term	2025-09-10
Home Delivery	No
Verified	Yes
Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
E6D91A5072	2025-09-07	KRITI TRADERS	Nikhil Kumar	Jwalapur Town	Leafy Green Chaulai	656 KG	₹13120	2025-09-07T10:16:51.674+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	9319193953
Gender	MALE

Land Location



Farmer Details

Farmer Name	Kuldeep Saini
Village	Bheemawala
Block	Vikas Nagar
Tehsil	Vikas Nagar
District	Dehradun
State	Uttarakhand
Previous Crop	Cabbage
Current Crop	Lady Finger
Area (Bigha)	1
Selling Through Annadata (KG)	760 (approx.)
Creation Date	02/09/2025

Crop Images (Lady Finger)





Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	VEG_013
Variety	LAD10689
Quantity	753 KG
Branding Image	

Base Price	35.0 / KG
Cost Price	₹ 26355
Delivery Time	2025-09-10T00:00:00.000+0000
Payment Term	2025-09-10
Home Delivery	No
Verified	Yes
Product Images	  

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
BFA7D95B1A	2025-09-08	KRITI TRADERS	Kuldeep Saini	Jwalapur Town	Ladyfinger(Bhindi)	753 KG	₹26355	2025-09-08T04:39:41.854+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	9634969118
Gender	MALE

Land Location



Farmer Details

Farmer Name	Tara Chand Saini
Village	Jassowala
Block	Sahaspur
Tehsil	Vikas Nagar
District	Dehradun
State	Uttarakhand
Previous Crop	Cauliflower
Current Crop	Cucumber
Area (Bigha)	1
Selling Through Annadata (KG)	2255 (approx.)
Creation Date	22/09/2025

Crop Images (Cucumber)






Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	VEG_024
Variety	CUC10742
Quantity	2205 KG
Branding Image	

Base Price	25.0 / KG
Cost Price	₹ 55125
Delivery Time	2025-09-27T00:00:00.000+0000
Payment Term	2025-09-26
Home Delivery	No
Verified	Yes
Product Images	  

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
1EE4D418C7	2025-09-27	KRITI TRADERS	Tara Chand Saini	Jwalapur Town	Cucumber	2205 KG	₹55125	2025-09-27T05:49:59.118+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	9536271818
Gender	MALE

Land Location



Farmer Details

Farmer Name	Rajender Singh
Village	Goodrich T-State
Block	Vikas Nagar
Tehsil	Vikas Nagar
District	Dehradun
State	Uttarakhand
Previous Crop	Cabbage
Current Crop	Lady Finger
Area (Bigha)	2
Selling Through Annadata (KG)	1350 (approx.)
Creation Date	24/09/2025

Crop Images (Lady Finger)



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Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	VEG_013
Variety	LAD10689
Quantity	1348 KG
Branding Image	

Base Price	35.0 / KG
Cost Price	₹ 47180
Delivery Time	2025-09-26T00:00:00.000+0000
Payment Term	2025-09-26
Home Delivery	No
Verified	Yes
Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
AA9DA95DA6	2025-09-26	KRITI TRADERS	Rajender Singh	Jwalapur Town	Ladyfinger(Bhindi)	1348 KG	₹47180	2025-09-26T05:45:28.779+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	9410379770
Gender	MALE

Land Location



Farmer Details

Farmer Name	Ashish Kumar
Village	Goodrich T-State
Block	Vikas Nagar
Tehsil	Vikas Nagar
District	Dehradun
State	Uttarakhand
Previous Crop	Spinach
Current Crop	Lady Finger
Area (Bigha)	2
Selling Through Annadata (KG)	1500 (approx.)
Creation Date	28/09/2025

Crop Images (Lady Finger)





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Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	VEG_013
Variety	LAD10689
Quantity	1490 KG
Branding Image	

Base Price	35.0 / KG
Cost Price	₹ 52150
Delivery Time	2025-09-30T00:00:00.000+0000
Payment Term	2025-10-01
Home Delivery	No
Verified	Yes
Product Images	  

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
AB9AA95DA6	2025-09-29	KRITI TRADERS	Ashish Kumar	: Jwalapur Town	Ladyfinger(Bhindi)	1490 KG	₹52150	2025-09-29T05:45:28.779+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	8936988144
Gender	MALE

Land Location



Farmer Details

Farmer Name	Shubam
Village	Goodrich T-State
Block	Vikas Nagar
Tehsil	Vikas Nagar
District	Dehradun
State	Uttarakhand
Previous Crop	Cabbage
Current Crop	Lady Finger
Area (Bigha)	2
Selling Through Annadata (KG)	1200 (approx.)
Creation Date	09/09/2025

Crop Images (Lady Finger)



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Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	ORG_01
Category	CAT_02
Subcategory	VEG_013
Variety	LAD10689
Quantity	1148 KG
Branding Image	

Base Price	38.0 / KG
Cost Price	₹ 43624
Delivery Time	2025-09-10T00:00:00.000+0000
Payment Term	2025-09-10
Home Delivery	No
Verified	Yes
Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
CFAA63533B	2025-09-10	KRITI TRADERS	Shubam	Jwalapur Town	Lady Finger	1148 KG	₹43624	2025-09-10T05:41:18.538+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	8171980568
Gender	MALE

Land Location



Farmer Details

Farmer Name	Aryan Saini
Village	Jassowala
Block	Sahaspur
Tehsil	Vikas Nagar
District	Dehradun
State	Uttarakhand
Previous Crop	Cauliflower
Current Crop	Cucumber
Area (Bigha)	1
Selling Through Annadata (KG)	2050 (approx.)
Creation Date	12/09/2025

Crop Images (Cucumber)










Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	ORG_01
Category	CAT_02
Subcategory	VEG_024
Variety	CUC10744
Quantity	2017 KG
Branding Image	

Base Price	25.0 / KG
Cost Price	₹ 50425
Delivery Time	2025-09-20T00:00:00.000+0000
Payment Term	2025-09-19
Home Delivery	No
Verified	Yes
Product Images	  

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
03C36CF58A	2025-09-19	KRITI TRADERS	Aryan Saini	Jwalapur Town	Cucumber	2017 KG	₹50425	2025-09-19T11:32:08.922+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	9719220025
Gender	MALE

Land Location



Farmer Details

Farmer Name	Rishipal
Village	Jassowala
Block	Sahaspur
Tehsil	Vikas Nagar
District	Dehradun
State	Uttarakhand
Previous Crop	Cabbage
Current Crop	Sweet Corn
Area (Bigha)	2
Selling Through Annadata (KG)	2300 (approx.)
Creation Date	18/09/2025

Crop Images (Sweet Corn)



Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_04
Subcategory	CAFG_044
Variety	YEL11087
Quantity	2265.0 KG
Branding Image	

Base Price	18.0 / KG
Cost Price	₹ 40770
Delivery Time	2025-09-25T00:00:00.000+0000
Payment Term	2025-09-25
Home Delivery	No
Verified	Yes
Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
84DFBC0C8F	2025-09-20	KRITI TRADERS	Rishipal Saini	Jwalapur Town	Sweet Corn	2265 KG	₹40770	2025-09-20T10:36:46.060+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	9389248355
Gender	MALE

Land Location



Farmer Details

Farmer Name	Chatar Singh
Village	Sitwari
Block	Naugaon
Tehsil	Barkot
District	Uttarkashi
State	Uttarakhand
Previous Crop	Rajmah
Current Crop	Tomato
Area (Bigha)	1
Selling Through Annadata (KG)	1950 (approx.)
Creation Date	30/09/2025

Crop Images (Tomato)






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Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	VEG_02
Variety	TOM10541
Quantity	1943 KG
Branding Image	

Base Price	37.50 / KG
Cost Price	₹ 72862.5
Delivery Time	2025-10-05T00:00:00.000+0000
Payment Term	2025-10-05
Home Delivery	No
Verified	Yes
Product Images	  

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
6677CC272C	2025-10-05	KRITI TRADERS	Chatar Singh	Jwalapur Town	Tomato	1943 KG	₹72862.5	2025-10-05T04:58:38.313+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	7818827375
Gender	MALE

Land Location



Farmer Details

Farmer Name	Indra Singh
Village	Diyari
Block	Naugaon
Tehsil	Barkot
District	Uttarkashi
State	Uttarakhand
Previous Crop	Arbi
Current Crop	Tomato
Area (Bigha)	1
Selling Through Annadata (KG)	1800 (approx.)
Creation Date	15/09/2025

Crop Images (Tomato)



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Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	VEG_02
Variety	TOM10543
Quantity	1770 KG
Branding Image	

Base Price	37.50 / KG
Cost Price	₹ 66375
Delivery Time	2025-09-20T00:00:00.000+0000
Payment Term	2025-09-21
Home Delivery	No
Verified	Yes
Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
69F8EE8875	2025-09-19	KRITI TRADERS	Indra Singh	Jwalapur Town	Tomato	1770 KG	₹66375	2025-09-19T05:03:10.539+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	9389052320
Gender	MALE

Land Location



Farmer Details

Farmer Name	Bhgatu lal
Village	Sitwari
Block	Naugaon
Tehsil	Barkot
District	Uttarkashi
State	Uttarakhand
Previous Crop	Pea
Current Crop	Capsicum
Area (Bigha)	2
Selling Through Annadata (KG)	1770 (approx.)
Creation Date	01/09/2025

Crop Images (Capsicum)





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Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	VEG_023
Variety	CAP10729
Quantity	1730 KG
Branding Image	

Base Price	50.0 / KG
Cost Price	₹ 86500
Delivery Time	2025-09-05T00:00:00.000+0000
Payment Term	2025-09-06
Home Delivery	No
Verified	Yes
Product Images	  

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
85BB2C0AE8	2025-09-05	KRITI TRADERS	Bhagtu Lal	Jwalapur Town	Capsicum	1730 KG	₹86500	2025-09-05T05:16:31.072+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	9258098126
Gender	MALE

Land Location



Farmer Details

Farmer Name	Gulabu Singh
Village	Sitwari
Block	Naugaon
Tehsil	Barkot
District	Uttarkashi
State	Uttarakhand
Previous Crop	Pea
Current Crop	Tomato
Area (Bigha)	1
Selling Through Annadata (KG)	1750 (approx.)
Creation Date	03/09/2025

Crop Images (Tomato)



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Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	VEG_02
Variety	TOM10544
Quantity	1707 KG
Branding Image	

Base Price	35.0 / KG
Cost Price	₹ 59745
Delivery Time	2025-09-10T00:00:00.000+0000
Payment Term	2025-09-09
Home Delivery	No
Verified	Yes
Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
12C4269E29	2025-09-10	KRITI TRADERS	Gulobu Singh	Jwalapur Town	Tomato	1707 KG	₹59745	2025-09-10T11:01:51.477+0000

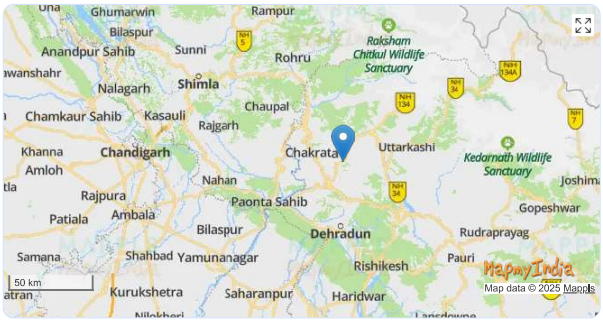
Farmer Profile Dashboard

Farmer Profile



Mobile Number	9456743448
Gender	MALE

Land Location



Farmer Details

Farmer Name	Dinesh Panwar
Village	Rikhaun
Block	Naugaon
Tehsil	Barkot
District	Uttarkashi
State	Uttarakhand
Previous Crop	Pea
Current Crop	Tomato
Area (Bigha)	2
Selling Through Annadata (KG)	1745 (approx.)
Creation Date	26/09/2025

Crop Images (Tomato)



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Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	ORG_01
Category	CAT_02
Subcategory	VEG_02
Variety	TOM10539
Quantity	1709 KG
Branding Image	

Base Price	38.75 / KG
Cost Price	₹ 66223.75
Delivery Time	2025-09-30T00:00:00.000+0000
Payment Term	2025-09-30
Home Delivery	No
Verified	Yes
Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
B3924523B4	2025-09-29	KRITI TRADERS	Dinesh Panwar	Jwalapur Town	Tomato	1709 KG	₹66223.75	2025-09-29T05:33:33.551+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	8218774723
Gender	MALE

Land Location



Farmer Details

Farmer Name	Pyar Singh
Village	Rikhaun
Block	Naugaon
Tehsil	Barkot
District	Uttarkashi
State	Uttarakhand
Previous Crop	Beans
Current Crop	Tomato
Area (Bigha)	2
Selling Through Annadata (KG)	1900 (approx.)
Creation Date	11/09/2025

Crop Images (Tomato)



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Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	VEG_02
Variety	TOM10524
Quantity	1896 KG
Branding Image	

Base Price	38.75 / KG
Cost Price	₹ 73470
Delivery Time	2025-09-15T00:00:00.000+0000
Payment Term	2025-09-16
Home Delivery	No
Verified	Yes
Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
613B2F8C70	2025-09-11	KRITI TRADERS	Pyar Singh	Jwalapur Town	Tomato	1896 KG	₹73470	2025-09-11T05:35:12.967+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	9411139490
Gender	FEMALE

Land Location



Farmer Details

Farmer Name	Meena Devi
Village	Rikhaun
Block	Naugaon
Tehsil	Barkot
District	Uttarkashi
State	Uttarakhand
Previous Crop	Onion
Current Crop	Sweet corn
Area (Bigha)	2
Selling Through Annadata (KG)	1790 (approx.)
Creation Date	27/09/2025

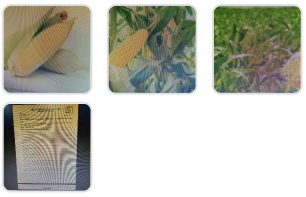
Crop Images (Sweet Corn)



Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	ORG_01
Category	CAT_04
Subcategory	CAFG_044
Variety	YEL11087
Quantity	1752.0 KG
Branding Image	

Base Price	20.0 / KG
Cost Price	₹ 35040
Delivery Time	2025-09-30T00:00:00.000+0000
Payment Term	2025-10-01
Home Delivery	No
Verified	Yes
Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
15C83D09D6	2025-09-29	KRITI TRADERS	Meena Devi	Jwalapur Town	Sweet Corn	1752 KG	₹35040	2025-09-29T05:45:25.351+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	9997138409
Gender	MALE

Land Location



Farmer Details

Farmer Name	Mahipal Singh
Village	Bhut Gaon
Block	Thatyur
Tehsil	Nainbagh
District	Tehri- Garhwal
State	Uttarakhand
Previous Crop	Rice
Current Crop	Capsicum
Area (Bigha)	2
Selling Through Annadata (KG)	1450 (approx.)
Creation Date	01/09/2025

Crop Images (Capsicum)



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Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	ORG_01
Category	CAT_02
Subcategory	VEG_023
Variety	CAP10735
Quantity	1428 KG
Branding Image	

Base Price	50.0 / KG
Cost Price	₹ 71400
Delivery Time	2025-09-10T00:00:00.000+0000
Payment Term	2025-09-10
Home Delivery	No
Verified	Yes
Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
DC915C6DE3	2025-09-07	KRITI TRADERS	Mahipal Singh	Jwalapur Town	Capsicum	729 KG	₹36450	2025-09-07T05:53:37.490+0000
A19ED4D2A2	2025-09-07	KRITI TRADERS	Mahipal Singh	Jwalapur Town	Capsicum	699 KG	₹34950	2025-09-07T06:02:27.613+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	7055153457
Gender	MALE

Land Location



Farmer Details

Farmer Name	Surbeer Singh
Village	Bhut Gaon
Block	Thatyur
Tehsil	Nainbagh
District	Tehri- Garhwal
State	Uttarakhand
Previous Crop	Rice
Current Crop	Capsicum
Area (Bigha)	2
Selling Through Annadata (KG)	1400 (approx.)
Creation Date	21/09/2025

Crop Images (Capsicum)





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Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	VEG_023
Variety	CAP10736
Quantity	1390 KG
Branding Image	

Base Price	50.0 / KG
Cost Price	₹ 69500
Delivery Time	2025-09-27T00:00:00.000+0000
Payment Term	2025-09-27
Home Delivery	No
Verified	Yes
Product Images	  

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
33895A8E87	2025-09-27	KRITI TRADERS	Surbeer Singh	Jwalapur Town	Capsicum	1390 KG	₹69500	2025-09-27T06:15:20.040+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	7579465558
Gender	MALE

Land Location



Farmer Details

Farmer Name	Rajender Singh
Village	Bhut Gaon
Block	Thatyur
Tehsil	Nainbagh
District	Tehri- Garhwal
State	Uttarakhand
Previous Crop	Rice
Current Crop	Capsicum
Area (Bigha)	1
Selling Through Annadata (KG)	1100 (approx.)
Creation Date	16/09/2025

Crop Images (Capsicum)



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Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	VEG_023
Variety	CAP10734
Quantity	1065 KG
Branding Image	

Base Price	50.0 / KG
Cost Price	₹ 53250
Delivery Time	2025-08-27T00:00:00.000+0000
Payment Term	2025-08-27
Home Delivery	No
Verified	Yes
Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
CA859C391F	2025-09-18	KRITI TRADERS	RAJENDAR SINGH	Jwalapur Town	Capsicum	1065 KG	₹53250	2025-09-18T06:21:02.143+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	9389958217
Gender	MALE

Land Location



Farmer Details

Farmer Name	Jasveer Singh
Village	Bhut Gaon
Block	Thatyur
Tehsil	Nainbagh
District	Tehri- Garhwal
State	Uttarakhand
Previous Crop	Rice
Current Crop	Capsicum
Area (Bigha)	1
Selling Through Annadata (KG)	1000 (approx.)
Creation Date	29/09/2025

Crop Images (Capsicum)



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Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	VEG_023
Variety	CAP10737
Quantity	982 KG
Branding Image	

Base Price	55.0 / KG
Cost Price	₹ 54010
Delivery Time	2025-10-01T00:00:00.000+0000
Payment Term	2025-10-02
Home Delivery	No
Verified	Yes
Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
61A168FFF3	2025-09-30	KRITI TRADERS	Jasveer SINGH	Jwalapur Town	Capsicum	982 KG	₹54010	2025-09-30T06:25:54.371+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	8433262973
Gender	MALE

Land Location



Farmer Details

Farmer Name	Jaspal Chauhan
Village	Bhut Gaon
Block	Thatyur
Tehsil	Nainbagh
District	Tehri- Garhwal
State	Uttarakhand
Previous Crop	Rice
Current Crop	Tomato
Area (Bigha)	1
Selling Through Annadata (KG)	1755 (approx.)
Creation Date	10/09/2025

Crop Images (Tomato)



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Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	VEG_02
Variety	TOM10529
Quantity	1721 KG
Branding Image	

Base Price	38.0 / KG
Cost Price	₹ 65398
Delivery Time	2025-09-15T00:00:00.000+0000
Payment Term	2025-09-15
Home Delivery	No
Verified	Yes
Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
DC8A5B0077	2025-09-14	KRİTİ TRADERS	Jaspal Chauhan	Jwalapur Town	Tomato	1721 KG	₹65398	2025-09-14T06:31:51.695+0000

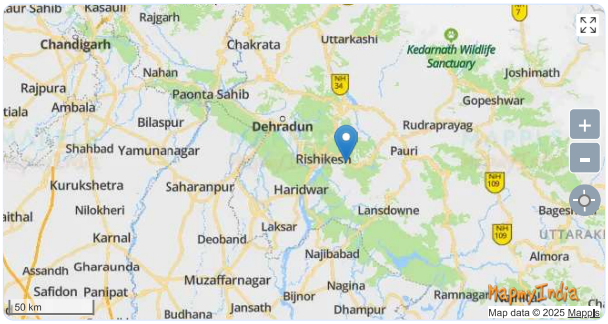
Farmer Profile Dashboard

Farmer Profile



Mobile Number	9027267519
Gender	MALE

Land Location



Farmer Details

Farmer Name	Anand Singh
Village	Mala
Block	Yamkeswar
Tehsil	Jakhanikhal
District	Pauri- Garhwal
State	Uttarakhand
Previous Crop	Wheat
Current Crop	Lady Finger
Area (Bigha)	1
Selling Through Annadata (KG)	795 (approx.)
Creation Date	07/09/2025

Crop Images (Lady Finger)



Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	ORG_01
Category	CAT_02
Subcategory	VEG_013
Variety	LAD10689
Quantity	754 KG
Branding Image	

Base Price	35.0 / KG
Cost Price	₹ 26390
Delivery Time	2025-09-10T00:00:00.000+0000
Payment Term	2025-09-12
Home Delivery	No
Verified	Yes
Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
0DE86EA60F	2025-09-10	KRITI TRADERS	Anand Singh	Jwalapur Town	Ladyfinger(Bhindi)	754 KG	₹26390	2025-09-10T05:14:29.622+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	6397617771
Gender	MALE

Land Location



Farmer Details

Farmer Name	Akbeer Singh
Village	Mala
Block	Yamkeswar
Tehsil	Jakhanikhal
District	Pauri- Garhwal
State	Uttarakhand
Previous Crop	Wheat
Current Crop	Lady Finger
Area (Bigha)	1
Selling Through Annadata (KG)	700 (approx.)
Creation Date	23/09/2025

Crop Images (Lady Finger)



Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	VEG_013
Variety	LAD_001
Quantity	674 KG
Branding Image	

Base Price	35.0 / KG
Cost Price	₹ 23590
Delivery Time	2025-09-27T00:00:00.000+0000
Payment Term	2025-09-27
Home Delivery	No
Verified	Yes
Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
CF181EA0E6	2025-09-27	KRITI TRADERS	Akbeer Singh	Jwalapur Town	Ladyfinger(Bhindi)	365 KG	₹12775	2025-09-27T06:43:16.028+0000
CBD742F406	2025-09-27	KRITI TRADERS	Akbeer Singh	Jwalapur Town	Ladyfinger(Bhindi)	309 KG	₹10815	2025-09-27T06:46:04.156+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	6398221014
Gender	MALE

Land Location



Farmer Details

Farmer Name	Gabbar Singh
Village	Mala
Block	Yamkeswar
Tehsil	Jakhanikhal
District	Pauri- Garhwal
State	Uttarakhand
Previous Crop	Wheat
Current Crop	Lady Finger
Area (Bigha)	1
Selling Through Annadata (KG)	795 (approx.)
Creation Date	22/09/2025

Crop Images (Lady Finger)



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Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	VEG_013
Variety	LAD10689
Quantity	786 KG
Branding Image	

Base Price	35.0 / KG
Cost Price	₹ 27510
Delivery Time	2025-09-25T00:00:00.000+0000
Payment Term	2025-09-25
Home Delivery	No
Verified	Yes
Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
460E7A02DE	2025-09-24	KRITI TRADERS	Gabbar Singh	Jwalapur Town	Ladyfinger(Bhindi)	786 KG	₹27510	2025-09-24T06:51:50.363+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	9718920180
Gender	MALE

Land Location



Farmer Details

Farmer Name	Vikram Singh Negi
Village	Mala
Block	Yamkeswar
Tehsil	Jakhanikhal
District	Pauri- Garhwal
State	Uttarakhand
Previous Crop	Spinach
Current Crop	Capsicum
Area (Bigha)	1
Selling Through Annadata (KG)	790 (approx.)
Creation Date	20/09/2025

Crop Images (Capsicum)



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Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	VEG_023
Variety	CAP10739
Quantity	788 KG
Branding Image	

Base Price	50.0 / KG
Cost Price	₹ 39400
Delivery Time	2025-09-27T00:00:00.000+0000
Payment Term	2025-09-27
Home Delivery	No
Verified	Yes
Product Images	

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
8347B30298	2025-09-25	KRITI TRADERS	Vikram Singh Negi	Jwalapur Town	Capsicum	788 KG	₹39400	2025-09-25T06:57:20.048+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	9910743458
Gender	MALE

Land Location



Farmer Details

Farmer Name	Rajpal
Village	Mala
Block	Yamkeswar
Tehsil	Jakhanikhal
District	Pauri- Garhwal
State	Uttarakhand
Previous Crop	Potato
Current Crop	Amaranth (Cholai)
Area (Bigha)	1
Selling Through Annadata (KG)	760 (approx.)
Creation Date	03/09/2025

Crop Images (Amaranth (Cholai))






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Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	VEG_058
Variety	CHA_001
Quantity	740.0 KG
Branding Image	

Base Price	22.0 / KG
Cost Price	₹ 16280
Delivery Time	2025-09-07T00:00:00.000+0000
Payment Term	2025-09-07
Home Delivery	No
Verified	Yes
Product Images	  

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
BFF3032374	2025-09-06	KRITI TRADERS	Rajpal	Jwalapur Town	Red Cholai	740 KG	₹16280	2025-09-06T10:08:26.829+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	9027953768
Gender	MALE

Land Location



Farmer Details

Farmer Name	Hukum Singh Negi
Village	Mala
Block	Yamkeswar
Tehsil	Jakhanikhal
District	Pauri- Garhwal
State	Uttarakhand
Previous Crop	Potato
Current Crop	Onion
Area (Bigha)	1
Selling Through Annadata (KG)	995 (approx.)
Creation Date	05/09/2025

Crop Images (Onion)




Farmer Advertisements

Advertisement #1

Latitude	28.535517
Longitude	77.391029
Farming Type	IORG_01
Category	CAT_02
Subcategory	VEG_05
Variety	ONI10602
Quantity	989.0 KG
Branding Image	

Base Price	23.0 / KG
Cost Price	₹ 22747
Delivery Time	2025-09-10T00:00:00.000+0000
Payment Term	2025-09-10
Home Delivery	No
Verified	Yes
Product Images	  

Seller Orders

Order No	Date	Buyer	Seller	Address	Category	Quantity	Amount	Transaction
126751D579	2025-09-08	KRITI TRADERS	Hukum Singh Negi	Jwalapur Town	Onion	989 KG	₹22747	2025-09-08T11:07:15.835+0000

Farmer Profile Dashboard

Farmer Profile



Mobile Number	9149034834
Gender	MALE

Land Location



Farmer Details

Farmer Name	Dhani Ram
Village	Bhogpur
Block	Laksar
Tehsil	Laksar
District	Haridwar
State	Uttarakhand
Previous Crop	Sugarcane
Current Crop	Sugarcane
Area (Bigha)	2
Selling Through Annadata (KG)	On Going
Creation Date	04/09/2025

Crop Images (Sugarcane)





Scan to Watch Full Video

Farmer Profile Dashboard

Farmer Profile



Mobile Number	9719474111
Gender	MALE

Land Location



Farmer Details

Farmer Name	Harsh Kumar
Village	Manubansh
Block	Bhadrabaad
Tehsil	Haridwar
District	Haridwar
State	Uttarakhand
Previous Crop	Sugarcane
Current Crop	Sugarcane
Area (Bigha)	2
Selling Through Annadata (KG)	On Going
Creation Date	17/09/2025

Crop Images (Sugarcane)







Scan to Watch Full Video

Farmer Profile Dashboard

Farmer Profile



Mobile Number	9758901201
Gender	MALE

Land Location



Farmer Details

Farmer Name	Jitender singh
Village	Jassowala
Block	Sahaspur
Tehsil	Vikas Nagar
District	Dehradun
State	Uttarakhand
Previous Crop	Sugarcane
Current Crop	Sugarcane
Area (Bigha)	2
Selling Through Annadata (KG)	On Going
Creation Date	06/09/2025

Crop Images (Sugarcane)



Scan to Watch Full Video

Farmer Profile Dashboard

Farmer Profile



Mobile Number	9758953587
Gender	MALE

Land Location



Farmer Details

Farmer Name	Madan Pal
Village	Bhogpur
Block	Laksar
Tehsil	Laksar
District	Haridwar
State	Uttarakhand
Previous Crop	Wheat
Current Crop	Sugarcane
Area (Bigha)	2
Selling Through Annadata (KG)	On Going
Creation Date	05/09/2025

Crop Images (Sugarcane)





Farmer Profile Dashboard

Farmer Profile



Mobile Number	9719146194
Gender	MALE

Land Location



Farmer Details

Farmer Name	Mangeram Saini
Village	Sherpur
Block	Laksar
Tehsil	Laksar
District	Haridwar
State	Uttarakhand
Previous Crop	Wheat
Current Crop	Sugarcane
Area (Bigha)	2
Selling Through Annadata (KG)	On Going
Creation Date	19/09/2025

Crop Images (Sugarcane)







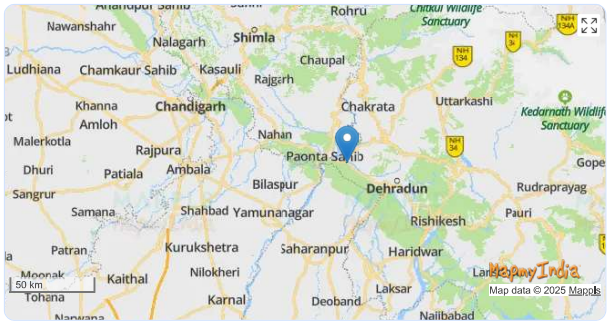
Farmer Profile Dashboard

Farmer Profile



Mobile Number	9720517808
Gender	MALE

Land Location



Farmer Details

Farmer Name	Ramesh Chand
Village	Parteetpur
Block	Vikas Nagar
Tehsil	Vikas Nagar
District	Dehradun
State	Uttarakhand
Previous Crop	Barley
Current Crop	Sugarcane
Area (Bigha)	2
Selling Through Annadata (KG)	On Going
Creation Date	13/09/2025

Crop Images (Sugarcane)





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Farmer Profile Dashboard

Farmer Profile



Mobile Number	7060796758
Gender	MALE

Land Location



Farmer Details

Farmer Name	Sachin
Village	Jassowala
Block	Sahaspur
Tehsil	Vikas Nagar
District	Dehradun
State	Uttarakhand
Previous Crop	Sugarcane
Current Crop	Sugarcane
Area (Bigha)	2
Selling Through Annadata (KG)	On Going
Creation Date	20/09/2025

Crop Images (Sugarcane)





Scan to Watch Full Video

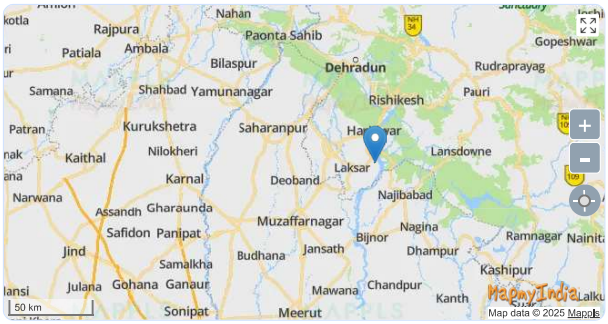
Farmer Profile Dashboard

Farmer Profile



Mobile Number	9012229191
Gender	MALE

Land Location



Farmer Details

Farmer Name	Sonu Kumar
Village	Bhogpur
Block	Laksar
Tehsil	Laksar
District	Haridwar
State	Uttarakhand
Previous Crop	Sugarcane
Current Crop	Sugarcane
Area (Bigha)	1
Selling Through Annadata (KG)	On Going
Creation Date	08/09/2025

Crop Images (Sugarcane)



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Farmer Profile Dashboard

Farmer Profile



Mobile Number	9719517797
Gender	MALE

Land Location



Farmer Details

Farmer Name	Suresh Kumar
Village	Bhogpur
Block	Laksar
Tehsil	Laksar
District	Haridwar
State	Uttarakhand
Previous Crop	Musturd
Current Crop	Sugarcane
Area (Bigha)	1
Selling Through Annadata (KG)	On Going
Creation Date	16/09/2025

Crop Images (Sugarcane)






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Farmer Profile Dashboard

Farmer Profile



Mobile Number	9719582163
Gender	MALE

Land Location



Farmer Details

Farmer Name	Tilak Raj
Village	Tilakpuri
Block	Laksar
Tehsil	Laksar
District	Haridwar
State	Uttarakhand
Previous Crop	Paddy
Current Crop	Sugarcane
Area (Bigha)	2
Selling Through Annadata (KG)	On Going
Creation Date	15/09/2025

Crop Images (Sugarcane)





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Farmer Profile Dashboard

Farmer Profile



Mobile Number	9758024538
Gender	MALE

Land Location



Farmer Details

Farmer Name	Yasveer Singh
Village	Bhogpur
Block	Laksar
Tehsil	Laksar
District	Haridwar
State	Uttarakhand
Previous Crop	Musturd
Current Crop	Sugarcane
Area (Bigha)	1
Selling Through Annadata (KG)	On Going
Creation Date	12/09/2025

Crop Images (Sugarcane)






Scan to Watch Full Video

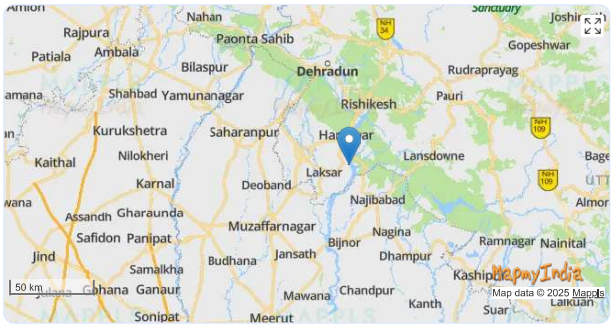
Farmer Profile Dashboard

Farmer Profile



Mobile Number	9758087561
Gender	MALE

Land Location



Farmer Details

Farmer Name	Yugveer Singh
Village	Bhogpur
Block	Laksar
Tehsil	Laksar
District	Haridwar
State	Uttarakhand
Previous Crop	Sugarcane
Current Crop	Sugarcane
Area (Bigha)	1
Selling Through Annadata (KG)	On Going
Creation Date	10/09/2025

Crop Images (Sugarcane)





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SECTION III

DISCUSSION AND CONCLUSION

Discussion

The comparative evaluation of raw sludge, thermally treated sludge, and final organic manure products highlights the significant improvement in both physico-chemical and microbiological quality following treatment. Raw sludge exhibited multiple undesirable characteristics, including high electrical conductivity (11.35 mS/cm), acidic pH (5.6), excessive levels of nitrogen (25.55%), phosphorus (1.6%), and potassium (3.9%), alongside elevated concentrations of certain heavy metals, notably chromium (77.8 mg/kg), cadmium (6.34 mg/kg), and zinc (2134.42 mg/kg). These exceedances clearly rendered the raw sludge unsuitable for direct agricultural application under Fertilizer Control Order (FCO) regulations.

Thermal treatment proved highly effective in addressing these issues. Heavy metal concentrations in the treated sludge were considerably reduced and fell well below the FCO permissible limits. Specifically, copper (Cu) was reduced to 55.73 mg/kg, chromium (Cr) to 23.1 mg/kg, and cadmium (Cd) to 0.65 mg/kg, all safely within regulatory thresholds. Lead (Pb) and nickel (Ni) were recorded at 8.28 mg/kg and 19.73 mg/kg, respectively, far below the limits of 50 mg/kg and 100 mg/kg. Mercury (Hg) was entirely absent (0 mg/kg), and arsenic (As) was detected at a minimal 0.15 mg/kg against a limit of 10 mg/kg. Zinc (Zn) was reduced substantially to 120.9 mg/kg, compared to the permissible 1000 mg/kg. These findings confirm the effectiveness of the treatment process in minimizing heavy metal contamination.

Microbiological assessments further supported the success of thermal treatment. Raw sludge (Sample A) exhibited high pathogenic loads (fecal coliforms: 8.1 $\log_{10}$ CFU/mL, TBC: 7.6 $\log_{10}$ CFU/mL, MPN: 11,000/100 mL). While initial treatment at 300°C (Sample B) reduced the total bacterial count, fecal coliforms and MPN remained elevated. Subsequent treatment at 500°C (Sample C) resulted in further reductions. Complete microbial deactivation was achieved at 600°C (Sample D), evidenced by an MPN of 0, fecal coliforms reduced to 1.1 $\log_{10}$ CFU/mL, and TBC reduced to 1.5 $\log_{10}$ CFU/mL.

The final organic manure products (Jaivik Prom, Jaivik Khad, DKC, Poshak, and PDM) demonstrated complete elimination of coliform bacteria (MPN = 0; fecal coliforms = 0). While total bacterial counts varied among products (Poshak: 7.37 $\log_{10}$ CFU/mL; PDM: 1.70 $\log_{10}$ CFU/mL), these figures reflect the typical presence of beneficial, non-pathogenic microbial communities associated with organic soil amendments.

Additionally, physico-chemical parameters of treated sludge improved considerably. Electrical conductivity dropped to 1.46 mS/cm, pH increased to 6.38 (approaching neutrality), and moisture content reduced to 15.7%, enhancing handling and storage properties. Nutrient content stabilized within acceptable agronomic ranges, although potassium remained slightly below the optimal threshold (0.21%).

Further, the field studies carried out on various field crops cultivated in five districts (Haridwar, Dehradun, Uttarkashi, Pauri-Garhwal, and Tehri-Garhwal) of Uttarakhand to study the efficacy of Ganga Sludge-based organic manures (Jaivik Prom, Jaivik Khad, Dharti ka Chowkidar,

and Natural Pori Potash), showed that crop yields increased with the application of **Dharti ka Chowkidar** (10 kg/ acre), in Bhindi/ladyfinger (20 - 32%), Cowpea (26%), Tulsi (28%), Mint (22%), Cholai (33%), Cucumber (21%), Tomato (29%), and Capsicum (33%) as compared to the control. Similarly, the results showed that crop yields increased with the application of Jaivik Kha**d** (80kg/acre) on Rice (17%), Brinjal (20 -33%), Black Gram (27%), Cholai (25%), Karela (37%), Bhindi/ladyfinger (25 - 32%), Sweet Corn (31%), Tomato (26%), Onion (33%), and Capsicum (24 - 26%) as compared to the control. The application of Jaivik Pro**m** (100 kg/acre) increased the crop yields in Menthol (32%), Bhindi/ladyfinger (24 - 32%), Tomato (29%), and Capsicum (17- 21%) as compared to the control. The yield also increased with the application of **Natural Pori Potash** (100 kg/acre) on Bhindi/ladyfinger (32%), Cucumber (32%), Tomato (29-31%), Cholai (34%), and Capsicum (28%) compared to the control.

Conclusion

The present study clearly demonstrates that untreated sewage sludge is unsuitable for direct application in agriculture due to its high contamination levels, both in terms of microbiological safety and heavy metal concentrations. The raw sludge showed excessive levels of pathogens (fecal coliforms, high MPN counts, total bacterial loads), salinity (EC 11.35 mS/cm), acidity (pH 5.6), moisture (66%), and nutrient imbalances (excess nitrogen, phosphorus, and potassium), along with the presence of heavy metals such as chromium, cadmium, and zinc beyond permissible limits. Such sludge, if applied directly, poses risks to soil health, agricultural productivity, groundwater quality, and human health through the food chain.

However, the application of thermal treatment, particularly at 600°C, significantly improved the safety and quality of the sludge. The process effectively reduced pathogen loads to negligible levels (MPN = 0; fecal coliforms = 0), lowered heavy metal concentrations below the Fertilizer Control Order (FCO) limits, and stabilized physico-chemical parameters, making the treated sludge suitable for safe reuse in agriculture. The final manure products (Jaivik Prom, Jaivik Khad, DKC, Poshak, and PDM) met all microbiological and chemical safety standards, highlighting the potential of thermally treated sludge as a valuable resource for sustainable agriculture and soil health improvement.

This study establishes thermal treatment as a reliable, scalable, and effective strategy for transforming sewage sludge into high-quality, pathogen-free, nutrient-enriched biosolids, contributing to sustainable waste management, environmental protection, and the circular bioeconomy.

Further it was observed that the treated Ganga sludge-based organic fertilizers can significantly improve the growth and yield properties of different field crops. Therefore, it is concluded that the use of Ganga sludge as manure in the agriculture sector not only improves crop productivity, but it also highlights a good, safer and environment friendly alternative to its management when treated properly.

List of Research Publications

Sr. No.	Authors	Title	Current status
1	Acharya Balkrishna, Sourav Ghosh, Ilika Kaushik, Vedpriya Arya, Divya Joshi, Diksha Semwal, Aditi Saxena, Shelly Singh	Sequential distribution, potential sources, and health risk assessment of persistent toxic substances in sewage sludge used as organic fertilizer in Indo-Gangetic region	Published (in Environmental Science and Pollution Research)
2	Acharya Balkrishna, Shalini Mishra, Shalini Singh, Satyendra Kumar Rajput, Maneesha Rana, Vedpriya Arya	Hazardous Consequences and Management of Heavy Metals in Sewage Sludge: An Overview	Published (in International Journal of Science and Research)
3	Acharya Balkrishna, Ilika Kaushik, Srimoyee Banerjee, Vedpriya Arya, Sourav Ghosh, Sumit Kumar Singh	Reuse of Sewage Sludge as Organic Agricultural Products: An Efficient Technology-Based Initiative	Published (in Applied and Environmental Soil Science)
4	Acharya Balkrishna, Nidhi Sharma, Ajay Kumar Gautam, Vedpriya Arya, and Vikram Khelwade	Enhancement of Wheat (Triticum aestivum L.) Growth and Yield Attributes in a Subtropical Humid Climate through Treated Ganga Sludge-Based Organic Fertilizers	Published (in Recent Advances in Food, Nutrition & Agriculture)
5	Acharya Balkrishna, Ajay Kumar Gautam, Nidhi Sharma, Vedpriya Arya, Vikram Khelwade, Prashant Kumar	Enhancement of Growth, Yield and Fruit Quality Attributes of Tomatoes (Solanum lycopersicum L.) through Treated Ganga Sludge-based Organic Fertilizers	Published (in Suan Sunandha Science and Technology Journal)
6	Acharya Balkrishna, Ajay Kumar Gautam, Nidhi Sharma, Vedpriya Arya and Vikram Khelwade	Growth and Yield Enhancement of Carrot (Daucus carota L.) through Treated Ganga Sludge-based Organic Fertilizers	Published (in Biological Forum – An International Journal)
7	Acharya Balkrishna, Ajay. Kumar Gautam, Nidhi Sharma, Vedpriya Arya and Vikram Khelwade	Growth and yield potential of sludge-based organic fertilizers on bell pepper Capsicum annum.	Published (in Asian Journal of Agriculture)
8	Acharya Balkrishna, Ajay. Kumar Gautam, Nidhi Sharma, Vedpriya Arya and Vikram Khelwade	Impact of organic and bio-fertilizer combinations on the growth and yield of okra (Abelmoschus esculentus (L.) Moench) under field conditions	Published (in Farming & Management)
9	Acharya Balkrishna, Ajay Kumar Gautam, Nidhi Sharma, Vedpriya Arya, Vikram Khelwade	Response of black wheat to combined organic and bio-fertilizers under field conditions	Published (in Current Agronomy)
10	Acharya Balkrishna, Ajay Kumar Gautam, Nidhi Sharma, Vedpriya Arya, Vikram Khelwade	Use of Ganga sludge as organic manure and their effect on the growth and yield of Pea (Pisum sativum)	Published (in Journal of Wastes and Biomass Management)

Sr. No.	Authors	Title	Current status
11	Acharya Balkrishna, Ajay Kumar Gautam, Nidhi Sharma, Vedpriya Arya, Vikram Khelwade	Effects of organic and bio-fertilizers on growth and yield performance of leafy vegetables	Published (in Journal of Wastes and Biomass Management)
12	Acharya Balkrishna, Ajay Kumar Gautam, Nidhi Sharma, Vedpriya Arya, Vikram Khelwade, Deepika Arya	*Effects of organic fertilizers on growth and yield of field crop cowpea.*	Published (in *Asian Journal of Agriculture)*
13	Acharya Balkrishna, Sourav Ghosh, Vedpriya Arya, Divya Joshi, Shelly Singh, Kumud Kannojia, Adity Saxena, Aswani Nagose, Sanyam Taneja, Durgesh Kumar Jaiswal	Accessing the Differential Suitability of Ganga River Water for Drinking, Irrigation, and Industrial Use: A First-Time Report Based on Index Analysis and Unsupervised Machine Learning, Highlighting the Need for Region-Specific Water Management Approaches	Published (in Environmental Science and Pollution Research)
14	Acharya Balkrishna, Sourav Ghosh, Srimoyee Banerjee, VedPriya Arya, Ilika Kaushik, Diksha Semwal, Monika Payal, Surendran Udayar Pillai, Shelly Singh	Coupled Geospatial and Biogeochemical Machine Learning Framework Reveals Soil Quality Resilience Hotspots in the Ganga Basin, India	Published (in Environmental Science & Technology Letters)
15	Acharya Balkrishna, Ajay Kumar Gautam, Priyanka Choudhary, Vedpriya Arya, Vikram Khelwade	Response of okra (Abelmoschus esculentus L.) to different sludge-based organic fertilizers under different field conditions in Uttarakhand, India	Communicated
16	Acharya Balkrishna, Ajay Kumar Gautam, Vedpriya Arya, Vikram Khelwade, Mukesh Kumar	Use of Ganga sludge-based organic manures on bell pepper Capsicum annum growing under variable field conditions in Uttarakhand, India	Communicated
17	Acharya Balkrishna, Ajay Kumar Gautam, Priyanka Choudhary, Vedpriya Arya, Vikram Khelwade	Effects of Ganga sludge-based organic manures on Growth, and Yield Potential of Sweet corn (Zea mays) under different climatic conditions of Uttarakhand, India	Communicated
18	Acharya Balkrishna, Ajay Kumar Gautam, Nidhi Sharma, Vedpriya Arya, Vikram Khelwade, Mukesh Kumar	Growth and yield potential of sludge-based organic fertilizers on Tomatoes (Solanum lycopersicum L.) growing under hilly environment of Uttarakhand, India	Communicated
19	Acharya Balkrishna, Ajay Kumar Gautam, Nidhi Sharma, Vedpriya Arya, Vikram Khelwade	Enhancement of amaranth (Amaranthus sp.) growth and yield attributes in plain and hilly climate through treated Ganga sludge-based organic fertilizers	Communicated

SECTION IV

REFERENCES

Abbey-Lee, R. N., Uhrig, E. J., Garnham, L., Lundgren, K., Child, S., and Løvlie, H. (2018). Experimental manipulation of monoamine levels alters personality in crickets. Sci. Rep. 8, 16211. doi:10.1038/s41598-018 34519-z

ADAS. (2018). *The Safe Sludge Matrix – Guidance for producers and users of sewage sludge in agriculture.* Water UK & ADAS. https://www.water.org.uk/resources/the-safe-sludge-matrix

Adeel, M., Song, X., Wang, Y., Francis, D., and Yang, Y. (2017). Environmental impact of estrogens on human, animal and plant life: A critical review. Environ. Int. 99, 107–119. doi:10.1016/j.envint.2016.12.010

Ahmed, S., Khan, M., & Iqbal, R. (2021). Heavy metal contamination in wastewater and sludge in Pakistan: Implications for agriculture. *Environmental Monitoring and Assessment, 193*, 45. https://doi.org/10.1007/s10661-021-08888-2

Akhter, F., Hewa, G. A., Ahammed, F., Myers, B., & Argue, J. R. (2020). Performance Evaluation of Stormwater Management Systems and Its Impact on Development Costing. Water 2020, Vol. 12, Page 375, 12(2), 375. https://doi.org/10.3390/W12020375

Aktar MW, Sengupta D, Chowdhury A. Impact of pesticides use in agriculture: their benefits and hazards. Interdisciplinary Toxicology. 2009;2(1):1–12

An-nori, A., Ezzariai, A., El Mejahed, K., El Fels, L., El Gharous, M., & Hafidi, M. (2022). Solar Drying as an Eco-Friendly Technology for Sewage Sludge Stabilization: Assessment of Micropollutant Behavior, Pathogen Removal, and Agronomic Value. Frontiers in Environmental Science, 10.

Appels, L., Baeyens, J., Degrève, J., & Dewil, R. (2008). Principles and potential of the anaerobic digestion of waste-activated sludge. Progress in energy and combustion science, 34(6), 755-781.

aus der Beek, T., Weber, F. A., Bergmann, A., Hickmann, S., Ebert, I., Hein, A., et al. (2016). Pharmaceuticals in the environment—global occurrences and perspectives. Environ. Toxicol. Chem. 35, 823–835. doi:10.1002/ etc.3339

Bagheri, M., Bauer, T., Burgman, L. E., & Wetterlund, E. (2023). Fifty years of sewage sludge management research: Mapping researchers' motivations and concerns. Journal of Environmental Management, 325, 116412.

Banerjee, A., Shelver, W.L., 2021. Micro- and nanoplastic induced cellular toxicity in mammals: A review. Sci. Total Environ. 755, 142518. http://dx.doi. org/10.1016/j.scitotenv.2020.142518

Ben-David, E.A., Habibi, M., Haddad, E., Hasanin, M., Angel, D.L., Booth, A.M., Sabbah, I., 2021. Microplastic distributions in a domestic wastewater treatment plant: Removal efficiency, seasonal variation and influence of sampling technique. Sci. Total Environ. 752, 141880. http://dx.doi.org/ 10.1016/j.scitotenv.2020.141880

Bi, X., Chu, S., Meng, Q., & Xu, X. (2002). Movement and retention of polychlorinated biphenyls in a paddy field of WenTai area in China. Agriculture, ecosystems & environment, 89(3), 241-252.

Biosolids Best Management Recognizing and Supporting the Best Biosolids Management Programs! (n.d.). Retrieved May 12, 2025, from https://www.wef.org/globalassets/assets-wef/2-resources/topics/a-n/biosolids-resource-recovery/national-biosolids-partnership/nbp_brochure_713.pdf

Borgman, O., & Chefetz, B. (2013). Combined effects of biosolids application and irrigation with reclaimed wastewater on transport of pharmaceutical compounds in arable soils. Water Research, 47, 3431–3443Ibenyassine

BREF, 2006. Reference Document on Best Available Techniques for the Waste Treatment Industries. http://eippcb.jrc.ec.europa.eu/reference/BREF/ wt_bref_0806.pdf.

Brune, D., Arnold, K., Magai, R., Hoormann, R., & Miles, R. (2022). Benefits and risks of biosolids.

Callegari, A., Hlavinek, P., & Capodaglio, A. G. (2018). Production of energy (biodiesel) and recovery of materials (biochar) from pyrolysis of urban waste sludge. Revista Ambiente & Água, 13 https://doi.org/10.4136/ ambi-agua.2128

Cambi (2023). A leap to advanced sewage treatmnet for India. Available at https://www.cambi.com/ resources/blog/a-leap-to-advanced-sewage treatment-for-india/. [Last accessed 7th June, 2023]

Centers for Disease Control and Prevention (2021) Guidance for reducing health risks to workers handling human waste or sewage. Available at https://www. cdc.gov/healthywater/global/sanitation/workers_ handlingwaste.html#one. [Last accesed 7th June, 2023]

Centre for Policy Research. (2021). *Reuse and recycling of faecal sludge-derived biosolids in agriculture*. CPR India. https://cprindia.org/wp-content/uploads/2021/12/Reuse-and-Recycling-of-Faecal-Sludge-derived-Biosolids-in-Agriculture.pdf

Chaturvedi, J., & Pandey, N. K. (2006). Physico-chemical analysis of river Ganga at Vindhyachal Ghat. Current World Environment, 1(2), 177.

China National Environmental Monitoring Center, 2021. Annual Report on Sludge Management in China. https://www.cnemc.cn/ (accessed 10 October 2024).

Christodoulou, A., & Stamatelatou, K. (2016). Overview of legislation on sewage sludge management in developed countries worldwide. Water Science and Technology, 73(3), 453-462.

Cordell D, Rosemarin A, Schröder JJ, Smit AL (2011) Towards global phosphorus security: asystems framework for phosphorus recovery and reuse options. Chemosphere 84:747–758.https://doi.org/10.1016/j. chemosphere.2011.02.032

CPCB (2021). National inventory of sewage treatment

CPCB | Central Pollution Control Board. (2023). CPCB. https://cpcb.nic.in/

CPCB, (2013). River Ganga. Central Pollution Control Board (Ministry of Environment and Forests, Govt. of India). https://cpcb.nic.in/wqm/pollution-assessment-ganga-2013.pdf

CPCB. (2014). *Annual Report on Municipal Solid Waste Management*. Central Pollution Control Board, India.

CPCB. https://www.downtoearth.org.in/news/ waste/india-s-sewage-treatment-plants-treat-only a-third-of-the-sewage-generated-daily-cpcb-79157

Dan, L., Hongxing, C., Hongsong, L., Schlenkc, D., Mue, J., Lacorte, S., et al. (2021). Anticancer drugs in the aquatic ecosystem: Environmental occurrence, ecotoxicological effect and risk assessment. Environ. Int. 153, 106543. doi:10.1016/j. envint.2021.106543

Daneshgar, S., Vanrolleghem, P. A., Vaneeckhaute, C., Buttafava, A., & Capodaglio, A. G. (2019). Optimization of P compounds recovery from aerobic sludge by chemical modeling and response surface methodology combination. Science of the total environment, 668, 668 677

De Amorim Júnior, S. S., de Souza Pereira, M. A., Morishigue, M., da Costa, R. B., de Oliveira Guilherme, D., & Magalhães Filho, F. J. C. (2022). Circular Economy in the Biosolids Management by Nexus Approach: A View to Enhancing Safe Nutrient Recycling—Pathogens, Metals, and Emerging Organic Pollutants Concern. Sustainability, 14(22), 14693. https://doi.org/10.3390/su142214693

DEFRA. (2012). *Code of practice for agricultural use of sewage sludge.* Department for Environment, Food & Rural Affairs.

Dermawan, D., Wang, Y.F., You, S.J., Jiang, J.J., Hsieh, Y.K., 2022. Impact of climatic and non-climatic stressors on ocean life and human health: A review. Sci. Total Environ. 821, 153387. http://dx.doi. org/10.1016/j.scitotenv.2022.153387.

Directive 2008/98/EC, 2008. Directive 2008/98/ EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives. Off. J. L 312, 3–30.

Dohányos, M., Zabranska, J., Jeníček, P., Štěpová, J., Kutil, V., & Horejš, J. (2000). The intensification of sludge digestion by the disintegration of activated sludge and the thermal conditioning of digested sludge. Water science and technology, 42(9), 57-64.

Donatello, S., & Cheeseman, C. R. (2013). Recycling and recovery routes for incinerated sewage sludge ash (ISSA): A review. Waste Management, 33(11), 2328-2340.

Environmental Protection Agency (EPA), 2021. Biosolids Management. https://www.epa.gov/biosolids (accessed 12 October 2024).

European Commission, 2022. Sludge Management in the EU. https://environment.ec.europa.eu/topics/waste-and-recycling/sewage-sludge_en (accessed 12 October 2024).

European Commission. (2000). *Working Document on Sludge (ENV.E.3/LM 27.04.2000; Brussels)*. DG Environment.

European Commission. (2024a, April 8). *New EU rules to improve urban wastewater treatment and reuse.* European Parliament.

European Commission. (2024b, January 29). *Commission welcomes provisional agreement for more thorough and more cost-effective urban wastewater management.* https://cyprus.representation.ec.europa.eu/news/commission-welcomes-provisional-agreement-more-thorough-and-more-cost-effective-urban-wastewater-2024-01-29_en

European Commission. (2024c, December 20). *New rules for urban wastewater management set to enter into force.* https://environment.ec.europa.eu/news/new-rules-urban-wastewater-management-set-enter-force-2024-12-20_en

FAO. Proceedings of the Asia Regional Workshop. Bangkok: Regional Office for Asia and the Pacific; 2005

Fiorentino, I., Gualtieri, R., Barbato, V., Mollo, V., Braun, S., Angrisani, A., Turano, M., Furia, M., Netti, P.A., Guarnieri, D., Fusco, S., Talevi, R., 2015. Energy independent uptake and release of polystyrene nanoparticles in primary mammalian cell cultures. Exp. Cell Res. 330, 240–247. http://dx.doi.org/10.1016/j. yexcr.2014.09.017.

Gatidou, G., Arvaniti, O.S., Stasinakis, A.S., 2019. Review on the occurrence and fate of microplastics in sewage treatment plants. J. Hazard. Mater. 367, 504 512. http://dx.doi.org/10.1016/j.jhazmat.2018.12.081

Giwa, A. S. (2023). Advances in sewage sludge application and treatment. *Science Progress, 106*(3), 00368504231996

Godlewska, K., Jakubus, A., Stepnowski, P., and Paszkiewicz, M. (2021). Impact of environmental factors on the sampling rate of β-blockers and sulfonamides from water by a carbon nanotube passive sampler. J. Environ. Sci. 101, 413–427. doi:10. 1016/j.jes.2020.08.034

Gómez-Garrido, M., Jiménez-Ballesta, R., & Muñoz, M. Á. (2024). Occurrence of organic micropollutants and heavy metals in soil after application of stabilized sewage sludge. *Sustainability, 16*(24), 10946. https://doi.org/10.3390/su162410946

Gong, L., Jun, L., Yang, Q., Wang, S., Ma, B., & Peng, Y. (2012). Biomass characteristics and simultaneous nitrification–denitrification under long sludge retention time in an integrated reactor treating rural domestic sewage. Bioresource Technology, 119, 277–284.

Grassi, M., Rizzo, L., & Farina, A. (2013). Endocrine disruptors compounds, pharmaceuticals and personal care products in urban wastewater: implications for agricultural reuse and their removal by adsorption process. Environmental Science and Pollution Research, 20, 3616–3628.

Grego, S., Barani, V., Hegarty-Craver, M., Raj, A., Perumal, P., Berg, A. B., & Archer, C. (2018). Soil-transmitted helminth eggs assessment in wastewater in an urban area in India. *Journal of Water and Health, 16*(1), 34–43.

Gupta PK. Pesticide exposure—Indian scene. Toxicology. 2004;198:83–90

Gupta, A., Rai, D. K., Pandey, R. S., & Sharma, B. (2009). Analysis of some heavy metals in the riverine water, sediments and fish from river Ganges at Allahabad. Environmental monitoring and assessment, 157(1), 449-458.

Gupta, N., Santra, S. C., & Bhattacharya, S. (2009). Prevalence of intestinal helminth eggs on vegetables grown in wastewater-irrigated areas of Titagarh, West Bengal, India. *Science of the Total Environment, 407*(3), 1070–1075.

Gworek, B., Kijeńska, M., Zaborowska, M., Wrzosek, J., Tokarz, L., & Chmielewski, J. (2020). Occurence of pharmaceuticals in aquatic environment – a review. Desalination and Water Treatment, 184, 375–387.

Gworek, B., Kijeńska, M., Zaborowska, M., Wrzosek, J., Tokarz, L., & Chmielewski, J. (2019). Pharmaceuticals in aquatic environment. Fate and behaviour, ecotoxicology and risk assessment – a review. Acta Poloniae Pharmaceutica, 76(3), 397–407

Hamidian, A.H., Ozumchelouei, E.J., Feizi, F., Wu, C., Zhang, Y., Yang, M., 2021. A review on the characteristics of microplastics in wastewater treatment plants: A source for toxic chemicals. J. Clean. Prod. 295, 126480.

Haritash, A. K., Gaur, S., & Garg, S. (2016). Assessment of water quality and suitability analysis of River Ganga in Rishikesh, India. Applied Water Science, 6(4), 383-392.

Harrison, E. Z., Oakes, S. R., Hysell, M., & Hay, A. (2006). Organic chemicals in sewage sludges. Science of the total environment, 367(2-3), 481-497. https://doi. org/10.1016/j.scitotenv.2006.04.002

Hernández-Arenas, R., Beltrán-Sanahuja, A., Navarro Quirant, P., Sanz-Lazaro, C., 2021. The effect of sewage sludge containing microplastics on growth and fruit development of tomato plants. Environ. Pollut. 268.

Hodkovicova, N., Hollerova, A., Blahova, J., Mikula, P., Crhanova, M., Karasova, D., et al. (2022). Non-steroidal anti-inflammatory drugs caused an outbreak of inflammation and oxidative stress with changes in the gut microbiota in rainbow trout (Oncorhynchus mykiss). Sci. Total. Environ. 849, 157921. doi:10.1016/j. scitotenv.2022.157921

Ianiro, G., Tilg, H., and Gasbarrini, A. (2016). Antibiotics as deep modulators of gut microbiota: Between good and evil. Gut 65, 1906–1915. doi:10.1136/ gutjnl2016-312297

Jayathilake, N., Drechsel, P., Keraita, B., Fernando, S., & Hanjra, M. A. (2019). Guidelines and regulations for fecal sludge management from on-site sanitation facilities (Vol. 14). IWMI.

Jiang, J.J., Hanun, J.N., Chen, K.Y., Hassan, F., Liu, K.T., Hung, Y.H., Chang, T.W., 2023. Current levels and composition profiles of microplastics in irrigation water. Environ. Pollut. 318, 120858.

Jobin, P., Mercier, G., Blais, J. F., & Taillard, V. (2015). Understanding the effect of attrition scrubbing on the efficiency of gravity separation of six inorganic contaminants. Water, Air, & Soil Pollution, 226, 1-13.

Kacprzak M, Neczaj E, Fijałkowski K, Grobelak A, Grosser A, Worwag M, Rorat A, Brattebo H, Almås Å, Singh BR. Sewage sludge disposal strategies for sustainable development. Environmental research. 2017 Jul 1;156:39 46.

Kalavrouziotis, I. K., Koukoulakis, P. H., & Varnavas, S. P. (2016). Temporal variability of sewage sludge heavy metal content from Greek wastewater treatment plants. *Environmental and Climate Technologies, 18*(1), 35–49. https://doi. org/10.1515/rtuect-2016-0019

Kar, D., Sur, P., Mandai, S. K., Saha, T., & Kole, R. K. (2008). Assessment of heavy metal pollution in surface water. International Journal of Environmental Science & Technology, 5(1), 119-124.

Karadirek, I. E., Erkaya, O., & Ciggin, A. S. (2025). Comparative life cycle assessment of sewage sludge drying by solar and thermal drying technologies. Waste Management, 201, 114826. https://doi.org/10.1016/j.wasman.2025.114826

Kataria, N., Bhushan, D., Gupta, R., Rajendran, S., Teo, M.Y.M., Khoo, K.S., 2022. Current progress in treatment technologies for plastic waste (bisphenol A) in aquatic environment: Occurrence, toxicity and remediation mechanisms. Environ. Pollut. 120319.

Katipoglu-Yazan, T., Merlin, C., Pons, M.-N., Ubay Cokgor, E., & Orhon, D. (2015). Chronic impact of tetracycline on nitrification kinetics and the activity of enriched nitrifying microbial culture. Water Research, 72, 227–238

Kelessidis, A., & Stasinakis, A. S. (2012). Comparative study of the methods used for treatment and final disposal of sewage sludge in European countries. *Waste Management, 32*(6), 1186–1195. https://doi.org/10.1016/j. wasman.2012.01.012

Kim, H., Park, J., & Choi, S. (2020). Sewage sludge heavy metal content and its use for compost in South Korea. *Journal of Environmental Management, 270*, 110896. https://doi.org/10.1016/j.jenvman.2020.110896

Kumar, V., & Chopra, A. K. (2016). Agronomical Performance of High Yielding Cultivar of Eggplant (Solanum melongena L.) Grown in Sewage Sludge Amended Soil. 1(1). www.scholink.org/ojs/index. php/ra

Kurniawan, S.B., Said, N.S.M., Imron, M.F., Abdullah, S.R.S., 2021. Microplastic pollution in the environment: Insights into emerging sources and potential threats. Environ. Technol. Innov. 23, 101790. http://dx.doi. org/10.1016/j. eti.2021.101790

Kwak, J. Il, An, Y.J., 2021. Microplastic digestion generates fragmented nanoplastics in soils and damages earthworm spermatogenesis and coelomocyte viability. J. Hazard. Mater. 402, 124034.

Lallas P. Reproductive Effects in Birds Exposed to Pesticides and Industrial Chemicals. The Stockholm Convention on persistent organic pollutants. American Journal of International Law. 2001;95:692–708.

Lee, L. H., Wu, T. Y., Shak, K. P. Y., Lim, S. L., Ng, K. Y., Nguyen, M. N., & Teoh, W. H. (2017). Sustainable approach to biotransform industrial sludge into organic fertilizer via vermicomposting: a mini-review.

Lee, W., Tan, K., & Lim, S. (2021). Monitoring heavy metals in Malaysian wastewater treatment plants. *Environmental Technology & Innovation, 23*, 101585. https://doi.org/10.1016/j.eti.2021.101585

Leena Singh, L. S., Choudhary, S. K., & Singh, P. K. (2012). Status of heavy metal concentration in water and sediment of river Ganga at selected sites in the Middle Ganga Plain.

Leslie, H.A., Brandsma, S.H., van Velzen, M.J.M., Vethaak, A.D., 2017. Microplastics en route: Field measurements in the Dutch river delta and Amsterdam canals, wastewater treatment plants, North Sea sediments and biota. Environ. Int. 101, 133 142.

Li, Z., Yu, X., Yu, F., and Huang, X. (2021). Occurrence, sources and fate of pharmaceuticals and personal products and artificial sweeteners in groundwater. Environ. Sci. Pollut. Res. Int. 28, 20903 20920. doi:10.1007/ s11356-021-12721-3

Liu, W., Zhang, J., Liu, H., Guo, X., Zhang, X., Yao, X., Cao, Z., Zhang, T., 2021. A review of the removal of microplastics in global wastewater treatment plants: Characteristics and mechanisms. Environ. Int. 146, 106277. envint.2020.106277.

Liu, Y., Wang, H., & Chen, X. (2022). Sustainable approaches for sewage sludge management in China: Current status and future perspectives. *Journal of Environmental Management, 310,* 114789. https://doi.org/10.1016/j.jenvman.2022.114789

Mao, R., Lang, M., Yu, X., Wu, R., Yang, X., Guo, X., 2020. Aging mechanism of microplastics with UV irradiation and its effects on the adsorption of heavy metals. J. Hazard. Mater. 393, 122515. http://dx.doi. org/10.1016/j.jhazmat.2020.122515

Maszkowska, J., Stolte, S., Kumirska, J., Łukaszewicz, P., Mioduszewska, K., Puckowski, A., et al. (2014). Beta-blockers in the environment: part II. Ecotoxicity study. Sci. Total. Environ. 493, 1122–1126. doi:10.1016/j. scitotenv. 2014.06.039

Mininni, G., Dentel, S., 2013. Highlights of Current Legislation on Sludge and Bio-Waste in EU Member States and in the United States.

Ministry of Environment & Energy. (2020). *National Waste Management Plan of Greece.* Athens: Government of Greece.

Ministry of Environment, Forest and Climate Change. (2016). *Solid Waste Management Rules, 2016*. Government of India.

Ministry of Housing and Urban Affairs. (2017). *National Policy on Faecal Sludge and Septage Management (FSSM)*. Government of India.

Ministry of the Environment, Japan. (2020). Wastewater and Sludge Management. Retrieved from Ministry of the Environment, Japan

MoEFCC. (2016). *Solid Waste Management Rules, 2016*. Ministry of Environment, Forest and Climate Change, Government of India.

Mowla, D., Tran, H. N., & Allen, D. G. (2013). A review of the properties of biosludge and its relevance to enhanced dewatering processes. Biomass and Bioenergy, 58, 365 378.

Nasir IM, Ghazi TI, Omar R (2012) Production of biogas from solid organic wastes through anaerobic digestion: a review. Appl Microbiol Biotechnol 95(2):321–329

National Institute of Urban Affairs – SCBP. (2020). *Characterization of faecal sludge and septage, dewatered and dried sludge*. Sustainable Cities and Benefits Platform.

Naturvårdsverket. (1994). *SNFS 1994:2: Sludge use in agriculture regulations.* Swedish Environmental Protection Agency.

Nelles, J. L., Hu, W. Y., and Prins, G. S. (2011). Estrogen action and prostate cancer. Expert. Rev. Endocrinol. Metab. 6, 437–451. doi:10.1586/eem.11.20

Netsol Water (2022) What are the STP rules in India? Available at https://www.netsolwater.com/sewage treatment-plant-rules-in-india.php?blog=2141 Accessed 7th June, 2023]

Nguyen, T., Pham, L., & Le, Q. (2019). Heavy metals in sludge and soils in the Red River Delta, Vietnam. *Environmental Science and Pollution Research, 26*, 20345–20357.

Nikolaou, A., Meric, S., & Fatta, D. (2007). Occurrence patterns of pharmaceuticals in water and wastewater environments. Analytical and Bioanalytical Chemistry, 387, 1225–1234

Nurhafizhoh Zainuddin, Mohd Fahmi Keni, Syed, N., & Mazmira, M. (2021). Effect of integrated biofertilizers with chemical fertilizers on the oil palm growth and soil microbial diversity. 39, 102237–102237. https:// doi.org/10.1016/j.bcab.2021.102237

Odigie, J. O. (2014). Harmful effects of wastewater disposal into water bodies: a case review of the Ikpoba river, Benin city, Nigeria. Tropical Freshwater Biology, 23, 87-101.

Oleszczuk, P., Malara, A., Jośko, I., & Lesiuk, A. (2012). The phytotoxicity changes of sewage sludge-amended soils. Water, Air, & Soil Pollution, 223, 4937-4948. https:// doi.org/10.1007/s11270-012-1248-8

Ortúzar, M., Esterhuizen, M., Olicón-Hernández, D. R., González-López, J., and Aranda, E. (2022). Pharmaceutical pollution in aquatic environments: a concise review of environmental impacts and bioremediation systems. Front. Microbiol. 26, 869332. doi:10.3389/fmicb.2022.86933

Pappu, A., Saxena, M., & Asolekar, S. R. (2007). Solid wastes generation in India and their recycling potential in building materials. Building and environment, 42(6), 2311 2320.

Pasda, N. (2006). Evaluation of Bangkok sewage sludge for possible agricultural use. *Waste Management & Research, 24*(6), 556–563. https://doi.org/10.1177/0734242X06067177

Planning Commission. (2014). *Report of the Task Force on Waste to Energy*. Government of India.

Pozzebon, E. A., & Seifert, L. (2023). Emerging environmental health risks associated with the land application of biosolids: a scoping review. Environmental Health, 22(1).

Prado, T., Gaspar, A. M. C., & Miagostovich, M. P. (2014). Detection of enteric viruses in activated sludge by feasible concentration methods. Brazilian Journal of Microbiology, 45(1), 343. https://doi.org/10.1590/S1517-83822014000100049

Rai, U. N., Prasad, D., Verma, S., Upadhyay, A. K., & Singh, N. K. (2012). Biomonitoring of metals in Ganga water at different ghats of Haridwar: implications of constructed wetland for sewage detoxification. Bulletin of environmental contamination and toxicology, 89(4), 805-810.

Ravindran, B., Sekaran, G., & Kim, W. H. (2023). Heavy metal standards and regulatory frameworks for biosolids application in Asia: A comparative review. *Environmental Science and Pollution Research, 30*(7), 18245–18263. https://doi.org/10.1007/s11356-022-24128-0

Ray, M., & Rahaman, M. (2016). An overview of legal framework for waste management system in India with special allusion to SWM rules, 2016. Int J Interdis Multidis Stud, 4(1), 13-19.

Revel, M., Châtel, A., Mouneyrac, C., 2018. Micro(nano) plastics: A threat to human health? Curr. Opin. Environ. Sci. Heal. 1, 17–23. http://dx.doi.org/ 10.1016/j. coesh.2017.10.003.

Roque-Diaz, Y., Sanadar, M., Han, D., López-Mesas, M., Valiente, M., Tolazzi, M., et al. (2021). The dark side of platinum based cytostatic drugs: From detection to removal. Processes 9, 1873. doi:10.3390/pr9111873

Rulkens, W. (2008). Sewage sludge as a biomass resource for the production of energy: overview and assessment of the various options. Energy & Fuels, 22(1), 9-15

Rulkens, W. H. (2004). Sustainable sludge management - what are the challenges for the future? Water Science and Technology, 49(10), 11–19.

Samolada, M. C., & Zabaniotou, A. A. (2014). Comparative assessment of municipal sewage sludge incineration, gasification and pyrolysis for a sustainable sludge-to-energy management in Greece. Waste management, 34(2), 411-420.

Sanitation Capacity Building Platform (SCPB). (2018). *Cost analysis of faecal sludge treatment plants in India*. Retrieved from

Santoso, F., Hadi, P., & Wirawan, I. (2020). Heavy metals in Indonesian paddy soils and related sewage sludge. *Environmental Monitoring and Assessment, 192*, 457. https://doi.org/10.1007/s10661-020-08362-3

Sarkar, S. K., Saha, M., Takada, H., Bhattacharya, A., Mishra, P., & Bhattacharya, B. (2007). Water quality management in the lower stretch of the river Ganges, east coast of India: an approach through environmental education. Journal of Cleaner Production, 15(16), 1559-1567.

Schirinzi, G.F., Pérez-Pomeda, I., Sanchís, J., Rossini, C., Farré, M., Barceló, D., 2017. Cytotoxic effects of commonly used nanomaterials and microplastics on cerebral and epithelial human cells. Environ. Res. 159, 579–587. http://dx.doi.org/10.1016/j. envres.2017.08.043.

Sharma, A., Bhardwaj, R., Wang, J., Shahzad, B., Kumar, V., Aditi Shreeya Bali, Shivam Jasrotia, Zheng, B., Yuan, H., & Yan, D. (2020). Chromium Bioaccumulation and Its Impacts on Plants: An Overview. 9(1), 100–100. https://doi.org/10.3390/plants9010100

Shi, J., Wang, J., Lv, J., Wang, Z., Peng, Y., Wang, X., 2022b. Microplastic presence significantly alters soil nitrogen transformation and decreases nitrogen bioavailability under contrasting temperatures. J. Environ. Manag. 317, 115473. http://dx.doi. org/10.1016/j.jenvman.2022.115473

Shiu, R.F., Vazquez, C.I., Chiang, C.Y., Chiu, M.H., Chen, C.S., Ni, C.W., Gong, G.C., Quigg, A., Santschi, P.H., Chin, W.C., 2020a. Nano- and microplastics trigger secretion of protein-rich extracellular polymeric substances from phytoplankton. Sci. Total Environ. 748, 141469. http://dx.doi.org/10.1016/ j.scitotenv.2020.141469

Singh, R. P., & Agrawal, M. (2019). Variations in heavy metal accumulation, growth, and yield of radish plants grown on sludge-amended soils: A comparative assessment. *Ecotoxicology and Environmental Safety, 176,* 64–73. https://doi.org/10.1016/j.ecoenv.2019.03.064

Singh, R., & Agrawal, M. (2019). Assessment of heavy metals in Indian sewage sludge: Implications for agriculture. *Ecotoxicology and Environmental Safety, 176*, 64–73. https://doi.org/10.1016/j.ecoenv.2019.03.064

Singh, S., Kumar, V., Dhanjal, D. S., Datta, S., Bhatia, D., Dhiman, J., Samuel, J., Prasad, R., & Singh, J. (2020). A sustainable paradigm of sewage sludge biochar: Valorization, opportunities, challenges and future prospects. Journal of Cleaner Production, 269, 122259.

Spinosa, L., Ayol, A., Baudez, J. C., Canziani, R., Jenicek, P., Leonard, A., ... & Van Dijk, L. (2011). Sustainable and innovative solutions for sewage sludge management. Water, 3(2), 702-717.

Strande, L., & Brdjanovic, D. (Eds.). (2014). Faecal sludge management: Systems approach for implementation and operation. IWA publishing

Su H, Cheng J, Zhou J, Song W, Cen K (2009) Improving hydrogen production from cassava starch by combination of dark and photo fermentation. Int J Hydrog Energy 34:1780–1786

Svensson, K., Hugmark, L., & Jönsson, H. (2016). From agricultural use of sewage sludge to nutrient extraction: A soil science outlook. *Ambio, 45*(S2), S180–S193. https://doi.org/10.1007/s13280-015-0757-4

Szeląg, B., Kiczko, · Adam, Łagód, · Grzegorz, & De Paola, F. (2021). Relationship Between Rainfall Duration and Sewer System Performance Measures Within the Context of Uncertainty. Water Resources Management 2021 35:15, 35(15), 5073–5087. https:// doi.org/10.1007/S11269-021-02998-X

Tanaka, Y., Sato, K., & Yamamoto, H. (2023). P-recovery vs current sewage sludge treatment policy in Japan. *Environmental Science and Pollution Research, 30*, 14234–14245. https://doi.org/10.1007/s11356-023-26321-2

Trevino, L. S., Wang, Q., and Walker, C. L. (2015). Hypothesis: Activation of rapid signaling by environmental estrogens and epigenetic reprogramming in breast cancer. Reprod. Toxicol. 54, 136–140. doi:10.1016/j.reprotox.2014.12.014

Turovskiy, I. S., & Mathai, P. K. (2006). Wastewater sludge processing. John Wiley & Sons.

Tyagi, V. K., & Lo, S. L. (2013). Sludge: a waste or renewable source for energy and resources recovery?. Renewable and Sustainable Energy Reviews, 25, 708-728.

Tyumina, E. A., Bazhutin, G. A., Cartagena Gómez, A. D., and Ivshina, I. B. (2020). Nonsteroidal anti-inflammatory drugs as emerging contaminants. Microbiology 89, 148–163. doi:10.1134/S0026261720020125

United States Environmental Protection Agency. (1994). *Standards for the use or disposal of sewage sludge (40 CFR Part 503)*. EPA.

Wasserman, M., Moretti, A., Goi, D., & Mainardis, M. (2025). Integrating renewable energy in sewage sludge treatment through greenhouse solar drying: A review. Science of the Total Environment, 965, 178634.

Wei, J., Wu, W., & Liu, G. (2018). Agricultural reuse of sewage sludge in Russia and China: Current practices and future trends. *Waste and Biomass Valorization, 9*(12), 2275–2290. https://doi.org/10.1007/s12649-017-0104-3

Winkler, M. K. H. Bennenbroek, M. H. Horstink, F.H. van Loosdrecht, M.C.M. van de Pol, G-J., 2013. The biodrying concept: An innovative technology creating energy. Bioresource Technology, Volume 147, pp. 124-129.

Wiśniowska, E., Grobelak, A., Kokot, P., & Kacprzak, M. (2019). Sludge legislation-comparison between different countries. In Industrial and municipal sludge (pp. 201-224). Butterworth-Heinemann.

Wu, B., Dai, X., & Chai, X. (2020). Critical review on dewatering of sewage sludge: Influential mechanism, conditioning technologies and implications to sludge re-utilizations. Water research, 180, 115912. https://doi. org/10.1016/j. watres.2020.115912

Xia, L., Zheng, L., and Zhou, J. L. (2017). Effects of ibuprofen, diclofenac and paracetamol on hatch and motor behavior in developing zebrafish (Danio rerio). Chemosphere 182, 416–425. doi:10.1016/j. chemosphere.2017.05.054

Xue, J., Verstraete, W., Ni, B.-J., Giesy, J. P., Kaur, G., Jiang, D., McBean, E., Li, Z., Shin, H.-M., Xiao, F., Liu, Y., Liu, J., Chibwe, L., Tsun, K., & Uchida, Y. (2025). Rethink biosolids: Risks and opportunities in the circular economy. Chemical Engineering Journal, 161749–161749.

Y., Nguyen, M. N., & Teoh, W. H. (2017). Sustainable approach to biotransform industrial sludge into organic fertilizer via vermicomposting: a mini-review. Journal of Chemical Technology & Biotechnology, 4(93), 925–935.

Yadav, S., Kataria, N., Khyalia, P., Rose, P.K., Mukherjee, S., Sabherwal, H., Chai, W.S., Rajendran, S., Jiang, J.J., Khoo, K.S., 2023. Recent analytical techniques, and potential eco-toxicological impacts of textile fibrous microplastics (FMPs) and its associated contaminates: A review. Chemosphere 138495.

Yang X, Du M, Lee DJ, Wan C, Zheng L, Wan F (2012) Improved volatile fatty acids production from proteins of sewage sludge with anthraquinone-2,6-disulfonate (AQDS) under anaerobic condition. Bioresour Technol 103:494–497

Yang, G., Zhang, G., & Wang, H. (2015). Current state of sludge production, management, treatment and disposal in China. *Water Research, 78,* 60–73. https://doi.org/10.1016/j.watres.2015.04.002

Yang, Z., Li, S., Ma, S., Liu, P., Peng, D., Ouyang, Z., Guo, X., 2020. Characteristics and removal efficiency of microplastics in sewage treatment plant of Xi'an City, Northwest China. Sci. Total Environ. 771, 145377.

Yuan, F., Zhao, H., Sun, H., Sun, Y., Zhao, J., Xia, T., 2022. Investigation of microplastics in sludge from five wastewater treatment plants in Nanjing, China. J. Environ. Manag. 301.

Zainaba, S. M., Junaidb, M., Xu, N., and Malik, R. N. (2020). Antibiotics and antibiotic resistant genes (ARGs) in groundwater: A global review on dissemination, sources, interactions, environmental and human health risks. Water. Res. 187, 116455. doi:10.1016/j. watres.2020.116455

Zhang, W., Ma, X., Zhang, Z., Wang, Y., Wang, Juying, Wang, Jing, Ma, D., 2015. Persistent organic pollutants carried on plastic resin pellets from two beaches in China. Mar. Pollut. Bull. 99, 28–34. http://dx.doi. org/10.1016/j. marpolbul.2015.08.002

Zhang, Y., Chen, S., & Zhou, M. (2021). Policy evolution for sewage sludge management in China: Achievements and future directions. *Environmental Science & Policy, 124,* 256–265.

Zhang, Y., Chen, S., & Zhou, M. (2023). Policy evolution for sewage sludge management in China: Achievements and future directions. *Environmental Science & Policy, 124*, 256–265. https://doi.org/10.1016/j.envsci.2021.06.008

Ziajahromi, S., Neale, P.A., Telles Silveira, I., Chua, A., Leusch, F.D.L., 2021. An audit of microplastic abundance throughout three Australian wastewater treatment plants. Chemosphere 263, 128294. http:// dx.doi.org/10.1016/j. chemosphere.2020.128294

SECTION V

ANNEXURES

Annexure I

Standard Operating Procedure for Collection/Sampling of Sludge Samples from STPs

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Patanjali Organic Research Institute

This document has been prepared, reviewed and approved by the Expert Committee comprising of:

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Dr. Prashant Chauhan	Scientist B (Microbiology)	SOP Review	
Dr. Jai Prakash	Assistant manager, PORI	SOP Preparation	

The SOPs were developed by a committee of experts and are being distributed to all team members and analysts of the current team for customization and acceptance. These are by no means all-inclusive or mandatory. A concerted attempt has been made to record all dimensions and operational features of typical processes and techniques used in the delivery of various aspects of sampling. This document is about the lab. The SOPs that are pertinent to their settings and resources may be modified, adjusted, or adopted by the respective departments. The essential technical guidelines, STGs, and manuals that are stated in the SOPs must also be made available to the stakeholders in addition to providing them with training and familiarization with the SOPs.

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1. **Amendment Sheet**

S.No.	Page no.	Date of amendment	Details of the amendment	Reasons	Signature of the reviewing authority

2. **Control of the Document**

- The holder of the copy of this manual is responsible for maintaining it in good and safe condition and in a readily identifiable and retrievable form.
- The holder of the copy of this manual shall maintain it in status by inserting latest amendments as and when the amended versions are received.
- The Manual is reviewed at least once a year (or in between SOS if so required) and is updated as relevant to the Hospital policies and procedures.

The Authority over control of this manual is as follows:

Prepared By
Name: Dr. Jaiprakash
Designation:
Signature:

Approved By
Name: Dr. Sudhesh Tiwari
Signature:

Issued By
Project Head
Name: Dr. Vedpriya Arya
Signature:

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3. Standard Procedure of Collection of Sludge Samples

3.1. Points to note before sampling.

- A week to several days prior to the proposed sampling, confirm sludge processing (dewatering and treatment) to ensure that sludge in the appropriate form (final treated sludge) will be available for sampling at the proposed date, time, and sampling point.
- A week to several days prior to the proposed sampling date, confirm that the contract laboratory performing the analyses is prepared to accept samples on the proposed sampling date.
- At least one day before collecting samples, assemble the sampling equipment. Ensure that all equipment is clean and in good working order (See attached checklist and cleaning procedure).
- On the day of sampling, obtain ice for sample storage and transportation and place it in sample coolers.
- After arrival at the sampling location/sampling point (as determined in the sampling plan), evaluate the operation of the sludge handling train (dewatering, biosolids treatment, etc.).
- Any observable deviations from normal operation should be noted prior to collecting samples.
- Put on nitrile gloves and any other required/desired personal safety equipment.

3.2. Safety Measures

- Use nitrile gloves while sampling. Discard the gloves after sampling with proper precaution and in a specified place governed by the authority. Use different nitrile gloves while sampling in different STPs.
- Use a mask, head cap, and shoe cover while sampling. Discard the gloves, mask, head cap and shoe cover after sampling with proper precaution and in a specified place governed by the authority.
- Use proper handling equipment while collecting the sludge. Do not use bare hands in the same way.

3.3. Collection Procedure

- Collection of the sludge samples should be done according to the 8-grab method.
- The moisture content of the sample must be observed and noted down using the moisture meter provided.
- Divide the entire area where the sludge is kept into a Z shape.
- Collect the first grab using a surface-sterilized trowel and note down the time.
- Similarly collect the remaining samples and place them inside the sterile container which has been premarked. Note down the time when the last grab is taken.
- Immediately seal the container and place parafilm for sealing it.
- The containers should be covered and placed on ice or refrigerated. (This is necessary whenever the interval between grab samples is longer than five minutes. The containers need to be transported to the laboratory as soon as possible.

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4. **Onsite Analysis parameters**
   - Date/ Time of collection
   - Name of STP
   - Compliance status of STP
   - Coordinates
   - Name of sample collector
   - Photograph of STP, sludge treatment area, and sludge drying area along with geotag.
   - Temperature at the time of collection.
   - Moisture content of the sludge sample.

5. **Storing & Transportation Procedure**

- The samples need to be transported in the sterile plastic containers provided to the team.
- The collector must ensure that the sampling bottle is properly marked as per the place from where it is being collected.
- Immediately after the collection is completed, the sampling bottle must be sealed with parafilm.
- The containers need to be placed inside the cool box containing polar packs.
- The collector must ensure that the samples are transported to the laboratory as soon as possible.
- Samples for microbial analysis will be immediately placed in 4°C refrigerator.
- Samples for physicochemical analysis will be placed in Polyhouse at room temperature.

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6. **Sample Collection Form**

General information	
Sample Identification code	
Name and Address of the Sampling Point	
Location of the sampling point (Latitude/longitude)	
Date (DD/MM/YY) and time (12 Hours Format) of collection	
Name of the sample collector	
Information regarding Sludge sample	
Type of sludge sample?(Processed/Raw)	
Physical appearance (Solid/Semi solid/ Dry Powder)	
Moisture of the collected sludge (Record by Soil meter)	
Temperature of the collected sample (Record by Soil meter)	
pH of the collected sludge (Record by Soil meter)	
Sunlight while collecting (Record by Soil meter)	

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7. **References**

1. EPA (1988). Sampling Procedures and Protocols for the National Sewage Sludge Survey.
2. Ben-David, E.A., Habibi, M., Haddad, E., Hasanin, M., Angel, D.L., Booth, A.M., Sabbah, I., 2021. Microplastic distributions in a domestic wastewater treatment plant: Removal efficiency, seasonal variation and influence of sampling technique. Sci. Total Environ. 752, 141880. http://dx.doi.org/ 10.1016/j.scitotenv.2020.141880

Annexure II

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Annexure II

Standard Testing Procedure for Physicochemical/ Microbiological analysis of sludge

Patanjali Organic Research Institute

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1. **Preparation, Review and Approval**
   This document has been prepared by the Expert Committee comprising of:

1.1. Physicochemical Parameters

Name	Designation	Function	Signature
Dr. Vedpriya Arya	Principle Investigator	Approved by	
Dr. Shalini Bhatt	Scientist B (Biochemistry)	Reviewed by	
Dr. Anamika Rana	Scientist B (Agriculture)	Prepared by	

1.2. Microbiological Parameters - QC

Name	Designation		Signature
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Dr. Priyanka Chaudhary	Scientist C (QC-Microbiology)	Reviewed by	
Shelly Singh	Assistant Scientist (QC-Microbiology)	Prepared by	

2. **Details of the Document**

Document Name:	**Standard Operating Procedure for recycling sludge into Bio-solids**
Document No.:	NMCG-SLUDGE/SOP/2024-2
Scope:	This document defines the STP to be followed for the physicochemical and microbiological analysis of sludge generated from wastewater treatment plants, industrial processes, or other relevant sources.
Effective Date:	06/09/2024
Review Date:	06/09/2027
Prepared and Reviewed by:	Name: Dr. Priyanka Chaudhary (Project Officer) Signature:
Approved By:	Name: Dr. Vedpriya Arya (Principal Investigator) Signature:

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3. Background of the SOP

The SOP for the **Recycling of Sludge into Biosolids** consists of two parts:

1. **General guidelines for laboratory operation and maintenance**
2. **Operation Manual**, dealing with the recommended standard analytical procedures

The Operation Manual describes the procedures to be followed for the analysis, treatment, and transformation of sewage sludge into biosolids within laboratory settings. This manual pertains to samples collected from sewage treatment plants (STPs) and outlines procedures for microbial, physicochemical, and heavy metal analysis, as well as post-treatment evaluation of biosolid quality.

This manual is structured as follows:

- **First**, it includes standard laboratory practices and procedures for ensuring within-laboratory analytical quality control, applicable during sludge analysis and biosolid assessment.
- **Next**, detailed protocols of each analytical test—microbiological, chemical, and physical—are presented to ensure reproducibility and scientific rigor.
- **Lastly**, the manual outlines the procedures for sample receipt, storage, work allocation, and transformation tracking, providing templates and formats for consistent documentation and traceability.

4. General Guidelines for Laboratory Operation and Maintenance

There are several general guidelines which laboratory staff should follow for laboratory maintenance:

• Keep the laboratory clean

This is the single most important thing you can do to keep laboratory equipment in good working order. Dirt and dust in the air, on the lab bench or on the floor will work their way into the equipment and affect sensitive parts. Clean the lab benches and sweep the floor daily. Do not bring food or drinks on the lab benches.

• Place dust covers on all analytical equipment when not in use

Despite best efforts to keep the laboratory as clean as possible, there will be some dust and dirt present. Protect sensitive analytical equipment with dust always covers when they are not in use. Dust covers should not be kept on dusty floor/platform while the instrument is in use.

• Designate a fixed location for each piece of analytical equipment. Most items of laboratory analytical equipment do not respond well to frequent transfers. Each piece of equipment should have a designated place in a clean, dry and stable location. You should avoid moving equipment or packing and unpacking items from storage.

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• Have a maintenance contract for each of analytical equipment. Even the best-cared-for equipment need periodic maintenance, either by lab staff or a specialized external service. The best way to keep laboratory analytical equipment functioning well for many years is to have regular servicing by an external qualified technician. An Annual Maintenance Contract (AMC) with the equipment supplier will cover regular maintenance checks by a technician as well as servicing when a specific problem occurs.

• Keep a maintenance logbook for each item of analytical equipment

1. List schedule for maintenance activities to be followed in the laboratory

2. List schedule for replacing equipment parts

3. Register all regular maintenance checks

4. Register all equipment problems and repairs

In this way the working history of each item will be available. The logbook should be readily available near the equipment item. The responsible person should sign the maintenance logbook when any maintenance activity is undertaken.

• Have equipment manual and troubleshooting list available for each item of analytical equipment

If there is trouble with an item of equipment, a designated person should try to identify the problem. Upkeep of each laboratory item should be the responsibility of one person. There should be a copy of the manual and a troubleshooting list kept together with the maintenance logbook, near the equipment item.

• Have a set of tools and maintenance equipment available in the laboratory Basic tools and equipment cleaning and maintenance supplies should be available in the laboratory. Items suggested including small brushes, screwdrivers, extra fuses, voltmeter, tweezers, etc.

• Don't try anything difficult If there is a serious problem with an item of equipment, the service contractor should be contacted. Opening a sensitive piece of equipment by unqualified person can make the problem worse. Make simple checks as outlined in the troubleshooting list, e.g. check power supply or equipment fuse. Do not open or dis-assemble equipment yourself.

4.1. Maintenance of equipment

In addition to the general maintenance suggestions made above, some suggestions for specific items are listed below, as to what can be done in the laboratory:

Air conditioner: Keep the air filter clean and dust free.

Glassware: All glassware should be cleaned on a regular basis as described in Section 2.1.2.

Distilled Water Apparatus: The distilled water apparatus for making high purity water needs regular control and maintenance. In the operation of water stills care should be taken to run the condenser cooling water whenever the still is in use. All stills are prone to scaling and accumulation of precipitated salts which, if not attended to, result in carry over of salts in distillate and will

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ultimately lead to overheating to cause damage to the heating elements. The scales should be periodically removed by dissolving in dilute solution of HCl.

In the case of ion exchange columns, a record should be kept of the volume of the product water and its EC value. The resin should be regenerated as per the supplier's instruction when the EC value exceeds the prescribed limit.

Desiccator: A desiccator is a special covered glass contained designed for storage of objects in a dry atmosphere. It contains a desiccant, which acts as a drying agent and can be heated to restore its drying powers. Airtight seal is obtained by a flat glass edge with acid free grease. The edge must be cleaned and greased periodically.

Deep freezer, icebox, and refrigerator: Periodically empty, defrost if applicable and thoroughly clean.

Balances: A few operation and maintenance procedures were listed in

These should be strictly followed to preserve the optimal operation of the balance.

Conductivity meter: Electrodes have a limited lifespan and will need replacement when the cell constant starts changing significantly, or the readings become erratic.

pH meter: The pH electrode needs to be rinsed thoroughly after each day of use to remove residuals that may accumulate on the probe, e.g. alkali build-up. The glass membrane electrode needs periodic filling with KCl reference solution. Proper storage is important. The pH meter can be permanently set up on the bench, with the electrode immersed in distilled water. Ion meter, probes & specific ion electrodes: The specific ion electrodes should be rinsed after each day of use to remove residuals that may accumulate. The electrodes may need periodic filling with reference solution. Proper storage is important. If the ion meter is used regularly, it can be permanently set-up on the bench, with the electrodes immersed in distilled water. It should be recognized that the electrodes have a limited lifespan and will need to be replaced every few years, as specified by the manufacturer. Cleaning and careful handling will prolong the lifespan. Many of the major equipment, such as, flame photometer, spectrophotometer, and gas.

Chromatograph, atomic absorption spectrophotometer, need to be maintained in accordance with the manufacturer's instructions. It is preferable to enter AMC for some of these, which should include an annual check.

4.2. Laboratory safety

All laboratory employees must make every effort to adhere to certain basic safety rules to protect themselves and their fellow workers. The sources of hazard in a laboratory are corrosive and poisonous chemicals, broken glass, explosion, fire, and electrical shock. Some common safety rules are given below. In case a health and safety programme has been developed for your laboratory, you should always follow it.

- Learn the locations of eye fountain, emergency shower, fire blanket and fire extinguisher.
- Eye protection must be always worn.

• In handling all chemicals, avoid contact with skin. In the event of such contact, immediately wash the affected area with copious amounts of water.

• Avoid working alone in a laboratory if the procedures to be conducted are hazardous.

• Do not drink, eat, or smoke in areas where laboratory chemicals are present. Do not drink from

Laboratory glassware.

• Do not store food or beverages in storage areas and refrigerators that are used for laboratory Operations.

• Always use a suction bulb to draw chemicals in a pipette. Never use the mouth to provide suction.

• Be extremely tentative in touching the objects that have been heated.

• Always fire polish the ends of freshly cut-glass tubing. Never attempt to force glass tubing through a hole in the stopper. Instead, make sure that both the tubing and the hole are thoroughly wet with soapy water and protect hands with towel or heavy gloves.

• Use fume hoods where toxic or noxious gases or fumes are likely to be evolved.

• Use care in testing for odours; use the hand to waft vapours above containers towards nose.

• In some locations it may not be permissible to flush heavy metals or poisonous substances down the drain. In case of such restrictions, alternative arrangements are required.

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5. Sample Analysis

5.1 Physicochemical Parameters

5.1.1. Determination of pH in sludge samples

Name of the Test	Determination of pH in sludge samples
Objective of the Test	To measure acidity/alkalinity of sludge and classify its chemical environment
Name of the Method Used	Electrometric (Glass Electrode) Method
Principle of the Method	Measurement of H^+ ion concentration using glass electrode vs reference electrode (potential difference proportional to pH).
Apparatus Required	pH meter with ATC, beakers, glass rod, balance.
Reagents Required	Buffer solutions (pH 4.0, 7.0, 10.0), KCl solution.
Methods	1. Add 20 g sludge sample in a beaker. 2. Add 40 ml distilled water (1:5 ratio). 3. Stir 30 min, allow settling. 4. Calibrate pH meter with buffers. 5. Measure pH of slurry supernatant.
Calculation	Direct instrument reading (±0.01).
Inference	pH < 6.5: Acidic; 6.5–8.5: Neutral; > 8.5: Alkaline.

5.1.2. Determination of Electrical Conductivity in sludge samples

Name of the Test	**Electrical Conductivity (EC) of sludge**
Objective of the Test	To estimate soluble salt concentration in sludge
Name of the Method Used	Conductivity Bridge Method
Principle of the Method	Conductivity proportional to dissolved salts; measured using cell constant × resistance.
Apparatus Required	Conductivity meter, beaker, balance.

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Reagents Required	0.01 M KCl standard, distilled water.
Methods	1. Weigh 20 g of sludge. 2. Add 40 ml distilled water, stir 30 min. 3. Filter or decant. 4. Measure EC at 25 °C.
Calculation	EC (dS/m) = Cell constant × meter reading.
Inference	< 0.8 dS/m: Normal; 0.8–1.6: Critical for sensitive plants; > 2.5: Saline.

5.1.3. Determination of Moisture

Name of the Test	**Determination of Total Solids, Moisture & Volatile Solids**
Objective of the Test	To estimate water content, dry matter, and organic fraction of sludge
Name of the Method Used	Gravimetric (Oven Drying & Ignition)
Principle of the Method	Drying at 105 °C removes water → Total Solids; ignition at 550 °C removes organic matter → Volatile Solids.
Apparatus Required	Crucibles, oven, muffle furnace, desiccator, balance.
Reagents Required	None (DI water for washing).
Methods	1. Weigh crucible/Petriplate + sample. 2. Dry at 105 °C to constant weight. 3. Ignite at 550 °C for 1 h. 4. Cool in desiccator, reweigh.
Calculation	% Moisture, % Total Solids, % Volatile Solids = (Weight loss / Initial wt.) × 100.
Inference	Higher VS % = higher organic content; indicates biodegradability.

5.1.4. Determination of Organic Nitrogen

Name of the Test	**Total Kjeldahl Nitrogen (TKN)**
Objective of the Test	To determine organic nitrogen and ammonium content in sludge
Name of the Method Used	Kjeldahl Digestion & Distillation

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Principle of the Method	Organic-N → NH_4^+ by acid digestion; NH_3 distilled and titrated.
Apparatus Required	Kjeldahl digestion/distillation unit, burette.
Reagents Required	$KMN0_4$ —Dissolve 3.2g of potassium permanganate in distilled water and make up the volume to one litre with distilled water; NaOH — Dissolve 25g of sodium hydroxide pellets in distilled water and make up the volume to one litre. 0.02 N H_2SO_4; Mixed Indicator — Dissolve 0.066g of methyl red and 0.099g of bromocresol green in 100m1 of ethanol.; Boric acid — Dissolve 25g of boric acid in one litre of distilled water and add 40m1 mixed indicator. Then adjust the pH to 4.5-5.0 by adding 2.5% NaOH.
Methods	1. Prepare the Kjeldahl assembly with one inlet tube in 0.32% $KMnO_4$ and the other in 2.5% NaOH. 2. Weigh 5 g sludge from each sample and transfer into the distillation tube without sticking to the sides. 3. Wash down adhering soil particles with distilled water. 4. Fix the tube in the distillation unit and moisten the sample with distilled water using the dilution key. 5. Pipette 25 mL of 2.5% boric acid into a conical flask and immerse the receiver end of the tube. 6. Add 25 mL $KMnO_4$ and 25 mL NaOH to the sample using the respective keys. 7. Switch on the heating unit and run the distillation for 6 minutes. 8. Distill ammonia gas from the sample and trap it in the boric acid receiver. 9. Remove the flask after 6 minutes of distillation. 10. Titrate the ammonium borate against 0.02 N H_2SO_4 and record the acid volume used. 11. Note the endpoint at the color change from bluish green to wine red.
Calculation	% N = (ml acid × N × 14) / sample wt. (g).
Inference	Indicates sludge N fertility; higher N supports soil amendment use.

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5.1.5. Determination of Total Phosphorus

Name of the Test	**Total Phosphorus**
Objective of the Test	To estimate total phosphorus in sludge
Name of the Method Used	Acid Digestion + Ascorbic Acid Colorimetry
Principle of the Method	Acid digestion converts all P → orthophosphate; reacts with molybdate + ascorbic acid to form blue complex measured at 880 nm.
Apparatus Required	Digestion block, spectrophotometer, volumetric flasks.
Reagents Required	Sodium bicarbonate, H_2SO_4 (5%), Darco G-60, Molybdate reagent, Distilled water.
Methods	1. Weigh 1 g sludge into a sample bottle. 2. Add 1 g Darco G-60. 3. Add 20 mL of 0.5 N $NaHCO_3$ (pH 8.5) to extract available phosphorus. 4. Shake the mixture vigorously for 30 minutes on a mechanical shaker. 5. Filter the suspension through Whatman No. 42 into a clean sample bottle. 6. Pipette 5 mL filtrate into a 25 mL volumetric flask. 7. Add 0.5 mL H_2SO_4, then 10 mL distilled water. 8. Add 4 mL freshly prepared indicator reagent and make up to 25 mL. 9. Leave undisturbed for 30 minutes to allow turbidity to develop. 10. Measure the blue color at 660 nm on a UV-Spectrophotometer after zeroing with a blank (without standard or soil extract).
Calculation	P (mg/kg) from calibration curve.
Inference	Indicates nutrient potential of sludge as P fertilizer.

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5.1.6. Determination of Potassium

Name of the Test	**Potassium**
Objective of the Test	To measure exchangeable and total K in sludge
Name of the Method Used	Acid Digestion + Flame Photometry/ICP-OES
Principle of the Method	Acid releases cations; measured by flame photometry or ICP-OES emission lines.
Apparatus Required	Digestion block, flame photometer/ICP-OES.
Reagents Required	1N Ammonium Acetate (NH_4OAc), pH 7.0, Standard Potassium Solution, Distilled Water
Methods	1. Weigh 5 g sludge into a clean 100 mL shaking bottle. 2. Add 25 mL of 1N ammonium acetate (pH 7.0). 3. Shake the mixture for 30 minutes on a mechanical shaker. 4. Filter the suspension through Whatman No. 42. 5. Collect the clear filtrate for potassium analysis. 6. Aspirate the filtrate into a flame photometer and record the potassium reading.
Calculation	ppm × dilution factor.
Inference	High K improves soil fertility.

5.1.7. Determination of Sulfur

Name of the Test	**Sulfate-Sulfur**
Objective of the Test	To measure available sulfate sulfur in sludge
Name of the Method Used	Turbidimetric ($BaSO_4$ Precipitation)
Principle of the Method	Sulfate reacts with $Ba^{2+} \rightarrow BaSO_4$ turbidity, measured at 420 nm.
Apparatus Required	Spectrophotometer, glassware.
Reagents Required	$BaCl_2$, gum acacia, $CaCl_2$ extractant.

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Methods	1. Shake 10 g sludge in 50 ml $CaCl_2$. 2. Filter; add $BaCl_2$ + gum acacia. 3. Read absorbance at 420 nm.
Calculation	SO_4-S from calibration curve × dilution factor.
Inference	Indicates sulfur fertility; very high values may cause odor issues (H_2S risk).

5.1.8. Determination of Organic Carbon

Name of the Test	**Determination of Available Organic Carbon in Sludge Samples**
Objective of the Test	To estimate the organic carbon content in sludge samples, which reflects soil/sludge fertility and organic matter status.
Name of the Method Used	Walkley and Black Wet Oxidation Method (Modified Titrimetric Method)
Principle of the Method	Organic carbon present in sludge is oxidized by excess potassium dichromate ($K_2Cr_2O_7$) in the presence of concentrated H_2SO_4. The unused dichromate is back-titrated with standard ferrous ammonium sulfate using diphenylamine indicator. The amount of dichromate reduced corresponds to the organic carbon content.
Apparatus Required	Weighing machine, 250 mL conical flask, burette, pipette, measuring cylinder, titration stand, beakers.
Reagents Required	1N Potassium dichromate ($K_2Cr_2O_7$) solution, Concentrated H_2SO_4, 0.5N Ferrous ammonium sulfate [$Fe(NH_4)_2(SO_4)_2$], Diphenylamine indicator, Sodium fluoride (NaF), Distilled water.
Methods	1. Weigh 2 g sludge into a 250 mL conical flask. 2. Add 10 mL of 1N $K_2Cr_2O_7$ solution. 3. Add 20 mL concentrated H_2SO_4, swirl for 1 min. 4. Allow mixture to stand for 30 min (oxidation). 5. Add 0.5 g NaF. 6. Dilute with 100 mL distilled water. 7. Add 10 drops diphenylamine indicator (solution turns violet). 8. Titrate against 0.5N ferrous ammonium sulfate until color changes from violet to bright green.
Calculation	% Organic Carbon = (Blank value−Sample titration value)×Normality of Fe(NH4)2(SO4)2×0.003×100Weight of sample(g)\dfrac{(Blank\ value - Sample\ titration\ value) \times Normality\ of\ $Fe(NH_4)_2(SO_4)_2$ \times 0.003 \times 100}{Weight\ of\ sample (g)} (Correction factor of 1.3 is often applied to account for incomplete oxidation).

Inference	Organic Carbon (%) – Soil/Sludge Rating: Below 0.40 → Low 0.40–0.75 → Medium Above 0.75 → High

5.1.9. Heavy Metal Analysis

Name of the Test	**Trace Metals (Zn, Cu, Fe, Mn) & Heavy Metals (Pb, Cd, Cr, Ni, etc.)**
Objective of the Test	To quantify micronutrients and toxic metals for biosolids safety assessment
Name of the Method Used	Acid Digestion + ICP-OES/AAS
Principle of the Method	Acid digestion releases metals; ICP-OES measures emission intensities proportional to concentration.
Apparatus Required	ICP-OES/AAS, digestion unit.
Reagents Required	Sludge sample, 0.005 M Diethylenetriaminepentaacetic acid (DTPA) solution.
Methods	1. Weigh 12.5 g sludge into a clean container. 2. Mix thoroughly with 25 mL DTPA reagent. 3. Place on a shaker at 89 rpm for 2 hours. 4. Filter the mixture through acid-washed, distilled water–washed Whatman No. 1 filter paper. 5. Collect the clear filtrate in a clean container. 6. Use the filtrate for further metal analysis.
Calculation	mg/kg = conc. × dilution / dry wt.
Inference	Compare with 40 CFR Part 503 limits; high heavy metals restrict land application.

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5.2. Microbiological Parameters

5.2.1. Mother Stock Preparation

Name of The Test	**Mother stock preparation**
Objective of the test	To prepare mother stock of sludge samples for dilution spreading
Name of the Method used	NA
Principle of the Method	To serially dilute sludge to obtain countable number of colonies
Apparatus required	Conical flask, culture tubes, micropipettes, distilled water, autoclave, laminar air flow chamber, non-absorbent cotton
Reagents required	None
Methods	**A.1. Preparation of mother stock of sludge** 10gm of sludge was taken from each of the samples and dissolved in 90ml of sterile 0.85% sterile saline in conical flasks of 250ml capacity. It was allowed to stir on a shaker at 150rpm for 2 hr to obtain a homogenized mixture. After this, the mixture was allowed to stand undisturbed for 30 min so that the sludge would settle down and a clear solution could be obtained. The clear supernatant was utilized for all tests related to microbial analysis. **A.2. Preparation of sludge dilutions** 1ml of the supernatant was taken and mixed well with 9ml of sterile distilled water to make 10^{-1} dilution. From the 10^{-1}, again 1ml was taken and mixed with 9ml of sterile distilled water to make 10^{-2} dilution. This was done till 10^{-6} dilution. For different types of media, dilution plating was done at different dilutions depending on the bacteria to be enumerated.
Calculation	NA
Inference	NA

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5.2.2. Total Aerobic Count

Name of The Test	**Aerobic Microbial count/Standard plate count**
Objective of the test	Microbial load count
Name of the Method used	Plate count agar (PCA) method
Principle of the Method	Plate count agar (PCA) is a general-purpose growth medium commonly used to assess "total" or "viable" bacterial growth of a sludge sample. The number of microorganisms per milliliter of sample is calculated from the number of colonies obtained on PCA plate from selected dilution. Poured plates are prepared using a specified culture medium and a specified quantity of the sample. The plates are aerobically incubated at two different temperatures i.e. 37°C for 24 hr and 20 – 22°C for 72 hr.
Apparatus required	Sampling bottle, sterile micropipettes, sterile petri plates, sterile micro pipette tips, and incubator.
Reagents required	70% ethanol, Plate count Agar (PCA), Buffered Peptone water (BPW),
Methods	A) Disinfect the surface of the bottle/pouch/cups containing sample with 70% ethanol. Thoroughly mix the sample by vigorous shaking to achieve uniform distribution. B) Aseptically inoculate 1ml of the water sample using sterile pipette into sterile petri plates in duplicate in two sets. The petri plates should be labeled with the sample number, date and any other desired information. C) Pour into each plate 15–18 mL of the molten sterilized PCA media (cooled to 44°C–47°C). Avoid pouring of molten medium directly onto the inoculum. Mix the media and inoculum by swirling gently clockwise and anti-clockwise so as to obtain homogenous distribution of inoculum in the medium. D) Allow to cool and solidify. In case, where in sample microorganism having spreading colonies is expected, add 4ml of overlay medium onto the surface of solidified plates. E) After complete solidification, invert the prepared plates and incubate one set at 37^0C for 24 hr and other set at 20 – 22°C for 72 hr. F) After specified incubation period, count all colonies including pinpoint colonies. Spreading colonies shall be considered as single colony. If less than one quarter of dish is overgrown by spreading, count the colonies on the unaffected part of the dish and calculate corresponding number in the entire dish. If more than one quarter is overgrown by spreading colonies discard the plate.

Calculation	Case 1: Plates having microbial count between 10 and 300cfu 2 N= Colonies Plate1 +ColoniesPlate2/ 2 Case2: Plates having microbial count less than 10cfu but at least 4. Calculate the results as given in Case 1. Case 3: If microbial load is from 3 to 1 then reporting of results shall be: "Microorganisms are present, but, less than 4 per mL" Case 4: When the test sample/plates contains no colonies then reporting of results shall be: "Less than 1 cfu/ml".
Inference	
References	1. IS 5402:2012 2. ISO 7218:1996 3. IS 14543:2004

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5.2.3. Enumeration of Coliform

Name of The Test	**Total coliform Count**
Objective of the test	Enumeration of Coliform
Name of the Method used	Most Probable Number
Principle of the Method	The most probable number (MPN) is a statistical method used to estimate the viable numbers of bacteria in a sample by inoculating broth in 10-fold dilutions and is based on the principle of extinction dilution. It is often used in estimating bacterial cells in water and food.
Apparatus required	Test tubes, Durhams tubes, Cotton
Reagents required	MacConkey Broth, BGLB broth
Methods	1. Take 5 tubes of double concentration and 10 tubes of single concentration for each sample of water to be examined. 2. Using a sterile pipette, add 10 mL of water to five tubes containing 10 mL of double-concentration medium. 3. Add 1 mL of water to five tubes containing 10 mL of single-strength medium and 0.1 mL of water to five tubes containing 10 mL of single-strength media. 4. All tubes should be incubated at 37°C for 24 hours. If no positive tubes develop, re-incubate for up to 48 hours. 5. Compare the number of tubes exhibiting a positive reaction against a standard chart and note the quantity of bacteria present in the sample. 6. For instance, a water sample with a result of 3–2–1 (3 10 mL positive, 2 1 mL positive, and 1 0.1 mL positive) has an MPN value of 17, indicating that the sample contains around 17 coliforms per 100 ml.
Calculation	Refer MPN table.
Inference	
References	(https://www.researchgate.net/publication/263770033_Evaluation_of_bacteriological_water_quality_Bangalore-_in_view_of_public_health)

5.2.4. Fecal Coliform Count- Confirmatory Test

Name of The Test	**Determine count of total and fecal coliform in sludge.**
Objective of the test	To determine the count of total coliform and fecal coliform in the sludge samples.
Name of the Method used	US EPA
Principle of the Method	To enumerate the presence or absence of coliforms from the different sludge samples, the dilutions were spread on MacConkey Agar media.
Apparatus required	Petri plates, Autoclave, Laminar Air flow chamber, Weighing balance, spatula, conical flask, non-absorbent cotton, brown paper, rubber band, aluminum foil, incubator, shaker, refrigerator
Reagents required	MacConkey Agar media with given below composition: Gelatin peptone: 17.00 gm/L HMC peptone: 3.00 gm/L Lactose monohydrate: 10 gm/L Sodium chloride: 5 gm/L Bile salts: 1.5 gm/L Neutral red: 0.03 gm/L Crystal violet: 0.001 gm/L Agar: 13.5 pH: 7.1±0.2
Methods	1. Dissolve the required quantity of media in distilled water. 2. Autoclave at 121°C, 15 lbs, for 15 minutes. 3. Cool to 50°C and pour into sterile Petri plates. 4. Spread 100 µL aliquots from raw, 10^{-2}, and 10^{-4} dilutions on the plates. 5. Incubate at 37°C for 2 days. 6. For fecal coliform counts, spread the same dilutions on EMB and Endo Agar.

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	7. Incubate at 37°C for 24 hours and record observations. 8. Gram stain single colonies to confirm Gram reaction.
Calculation	Cfu/ml = (Number of colonies * Dilution Factor)/Volume spread (in µl)
Inference	The colony count was noted down.

6.References

1. International Solid Waste Association. Working Group on Sewage & Waterworks Sludge. (1998). Sludge treatment and disposal: management approaches and experiences (No. 7). Office for official publications of the European communities.
2. Chen, H., Yan, S. H., Ye, Z. L., Meng, H. J., & Zhu, Y. G. (2012). Utilization of urban sewage sludge: Chinese perspectives. Environmental Science and Pollution Research, 19(5), 1454-1463.
3. Cieślik, B. M., Namieśnik, J., & Konieczka, P. (2015). Review of sewage sludge management: standards, regulations and analytical methods. Journal of cleaner production, 90, 1-15.
4. Herselman, J. E., & Snyman, H. G. (2009). Guidelines for the utilisation and disposal of wastewater sludge. Water Research Commission.

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Annexure III

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Annexure III

Standard Operating Procedure for recycling sludge into Bio solids

Patanjali Organic Research Institute

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1. Preparation, Review and Approval

This document has been prepared by the Expert Committee comprising of:

Name	Designation	Function	Signature
Dr. Sudesh Tiwari	Senior manager, PORI	Approved by	
Dr. Ajay Kumar Gautam	Scientist D (Agriculture)	Reviewed by	
Dr. Jaiprakash	Assistant Manager, PORI	Prepared by	

The SOPs were developed by a committee of experts and are being distributed to all team members and analysts of the current team for customization and acceptance. These are by no means all-inclusive or mandatory. A concerted attempt has been made to record all dimensions and operational features of typical processes and techniques used in the delivery of various aspects sampling. This document is about the lab. The SOPs that are pertinent to their settings and resources may be modified, adjusted, or adopted by the respective departments. The essential technical guidelines, STGs, and manuals that are stated in the SOPs must also be made available to the stakeholders in addition to providing them with training and familiarization with the SOPs.

2. Details of the Document

Document Name:	**Standard Operating Procedure for recycling sludge into Bio solids**
Document No.:	NMCG-SLUDGE/SOP/2024-3
Prepared By:	Name: Dr. Jaiprakash Signature:
Approved By:	Name: Dr. Vedpriya Arya (Principal Investigator) Signature:

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3. Details of the Experimental Procedures

3.1. Moisture Removal

Name of The Test	Moisture Reduction (Dewatering and Drying)
Objective of the test	Efficient removal of excess moisture from sludge to reduce volume, facilitate handling, and improve stabilization for further treatment or use.
Name of the Method used	Solar Drying; Addition of Absorbents
Principle of the Method	Solar drying utilizes solar radiation, ambient temperature, and natural airflow to promote evaporation of water content from sludge. Optional use of dry absorbents such as fly ash, sawdust, or biochar can enhance water removal and enrich the nutrient profile of the resulting biosolids.
Apparatus required	Drying beds (lined with sand/gravel)
	Rakes or shovels for turning sludge
	Protective gear (gloves, boots, masks)
	Containers for absorbent materials
	Weather monitoring tools (for sunlight/humidity tracking)
Reagents required	Fly ash, sawdust, or biochar
Methods	A) Spread thickened or dewatered sludge uniformly on drying beds under direct sunlight.
	B) Allow natural solar radiation and airflow to act on the sludge surface to evaporate moisture.
	C) Turn the sludge manually every 2–3 days to ensure uniform drying and prevent anaerobic conditions.
	D) If required, mix absorbents such as fly ash, sawdust, or biochar to accelerate drying and improve biosolid consistency.
	E) Allow drying to continue for 15–30 days depending on climatic conditions.
Calculation	Moisture content can be calculated by comparing initial and final weights:
	Moisture (%) = [(Initial weight - Dry weight) / Initial weight] × 100
Precautions	a. Avoid sludge overflow or runoff during rains; cover beds in wet conditions if possible.
	b. Monitor for foul odors indicating anaerobic conditions.

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	c. Avoid direct handling without PPE.
	d. Do not apply absorbents near water bodies or storm drains.
Inference	Effective moisture reduction enhances sludge manageability, reduces pathogen survival, and prepares sludge for further treatment or land application.
References	1. US EPA Guidelines for Biosolids Processing
	2. APHA (2017). Standard Methods for the Examination of Water and Wastewater

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3.2 Pathogen Removal

Name of The Test	**Pathogen Removal**
Objective of the test	Complete elimination of pathogenic microorganisms from sewage sludge
Name of the Method used	Thermal Optimization and Composting (Windrow or In-Vessel)
Principle of the Method	Pathogens in sludge are destroyed through the application of high temperature and aerobic decomposition processes:
	Optimization involves heating sludge at temperatures >600°C, which denatures microbial proteins and nucleic acids, ensuring complete destruction of pathogens. It also results in significant volume reduction of sludge.
	Composting is a biological process where microorganisms decompose organic matter in the sludge under aerobic conditions. Elevated temperatures (>55°C for at least 3 consecutive days) during composting eliminate most pathogens. It also stabilizes the sludge and reduces odor and vector attraction.
Apparatus required	Thermal chamber or furnace (for thermal method)
	Windrow turning equipment or in-vessel composting units
	Temperature probes/data loggers
	Autoclaved sampling tools
	Culture media and incubator for pathogen testing
	Personal protective equipment (PPE)
Reagents required	Culture media for pathogenic bacteria (e.g., XLD agar for Salmonella, DCA for Shigella, TCBS for Vibrio, CCA for E. coli), 70% ethanol or disinfectant for surface cleaning, Buffered Peptone Water (BPW) or other enrichment broths
Methods	Procedure:
	A) Heat optimization:
	1. Feed dewatered sludge into a high-temperature incinerator.
	2. Maintain operating temperatures >600°C.
	3. Collect dry sludge ash samples post-incineration under aseptic conditions.
	4. Inoculate sludge ash into selective media to confirm pathogen absence (Salmonella, Shigella, Vibrio, E. coli).
	5. Incubate as per microbial test protocols and observe for any growth.
	B) Composting:
	1. Pile sludge in windrows or load into an in-vessel composting system.
	2. Maintain aerobic conditions by regular turning and ventilation.
	3. Ensure internal temperatures remain >55°C for at least 3 consecutive days.
	4. Monitor temperature daily and compost for a total of 15–30 days.
	5. Collect final composted product and test in selective media for pathogen presence.
Calculation	Test for Pathogens= Present/absent per X mL of sample
Precautions	a. Handle pathogen culture media under aseptic and biosafety-compliant conditions.
	b. Prevent cross-contamination during sampling and processing.
	c. Use PPE and follow fire-safety procedures for thermal methods.

	d. Maintain compost pile moisture (~50–60%) for optimal microbial activity.
Inference	Successful thermal or composting treatment ensures pathogen-free biosolids suitable for reuse as fertilizer or soil conditioner per regulatory standards (e.g., US EPA Class A biosolids).
References	US EPA (1993). 40 CFR Part 503 – Standards for the Use or Disposal of Sewage Sludge
	APHA (2017). Standard Methods for the Examination of Water and Wastewater

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3.3 Heavy Metal and Organic Pollutant Elimination

Name of The Test	**Heavy Metal and Organic Pollutant Elimination**
Objective of the test	To remove, reduce, or stabilize heavy metals in sewage sludge
Name of the Method used	Chemical Stabilization and Bioleaching
Principle of the Method	Heavy metal elimination from sludge involves two primary approaches: • **Chemical Stabilization:** Involves the addition of chemical agents such as lime, phosphates, or iron salts that bind with heavy metals to form insoluble precipitates, reducing their mobility and bioavailability. • **Bioleaching:** Employs specific microorganisms or microbial biomass (e.g., *Thiobacillus ferrooxidans*, *Aspergillus niger*) to oxidize, solubilize, or bioaccumulate heavy metals from the sludge. This eco-friendly approach is especially effective at treating metals present in low concentrations.
Apparatus required	Reaction vessels or mixing tanks pH meter Magnetic stirrer or mechanical agitator Incubator (for bioleaching cultures) Personal protective equipment (gloves, lab coat, goggles) Microbial culture flasks Weighing balance
Reagents required	Calcium hydroxide (lime), Phosphates or ferric chloride (for chemical precipitation), Cultures of *Thiobacillus ferrooxidans*, *Aspergillus niger* (for bioleaching), Nutrient media for microbial growth (e.g., 9K medium, PDA), Distilled water
Methods	**A) For Chemical Stabilization:** 1. Prepare a uniform sludge slurry, in the ratio of 1:3 to 1:5 (lime: water). 2. Add stabilizing agents such as lime or iron salts under continuous mixing. 3. Adjust the pH to 8.5–10.5 for optimal precipitation. 4. Allow the reaction to continue for 1–2 hours. 5. Filter or settle the sludge and analyze supernatant for metal concentrations. **B) For Bioleaching:** 1. Inoculate sludge with selected microbial cultures in suitable bioreactors or flasks (5–20% (v/v) of the total sludge volume), with a cell density of ~10^6 to 10^8 CFU/mL or OD_{600} = 0.5–1.0. 2. Maintain conditions ideal for microbial growth (e.g., 28–30°C, pH 2.5–3.5 for acidophilic bacteria).

	3. Stir periodically and incubate for 5–10 days, depending on sludge type and metal load. 4. Monitor metal solubilization through regular sampling and analysis.
Calculation	ICP-MS for accurate quantification of metals like Cd, Pb, Cr, Zn, Ni, Cu, and Hg
Precautions	a. Handle all chemical reagents with proper PPE and under fume hoods. b. Maintain sterile conditions during bioleaching to avoid contamination. c. Monitor pH and temperature closely to ensure microbial viability. d. Ensure proper disposal of extracted metal residues and treated effluents.
Inference	Successful heavy metal elimination reduces ecological risk and enhances the potential for safe biosolid reuse in agriculture or landscaping.
References	1. Central Pollution Control Board (CPCB) Guidelines for Sludge Management 2. APHA (2017). Standard Methods for the Examination of Water and Wastewater

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3.4 Nutrient Enrichment

Name of The Test	Nutrient Enrichment
Objective of the test	To enhance the macronutrient profile—specifically nitrogen (N), phosphorus (P), and potassium (K)—of treated sludge, making the final biosolids more suitable for agricultural reuse as organic fertilizer or soil amendment.
Name of the Method used	Enrichment with Organic and Mineral Additives
Principle of the Method	The nutrient enrichment of sludge is achieved by incorporating specific organic and inorganic materials that boost the availability of primary nutrients: • **Nitrogen (N):** Neem cake is added to enhance nitrogen content. It also provides natural pesticidal properties and improves soil structure. • **Phosphorus (P):** Rock phosphate, a natural slow-release phosphorus source, is blended with the sludge. It is particularly effective in acidic conditions. • **Potassium (K):** Fly ash from sugarcane industries is used to increase potash content and also adds micronutrients.
Apparatus required	Mixing tools (manual or mechanical mixers) Weighing balance Containers for additives (neem cake, rock phosphate, fly ash) pH meter and EC meter PPE: gloves, masks, protective clothing
Reagents required	Neem cake (finely ground), Rock phosphate, Sugarcane fly ash (dry, sieved)
Methods	**Procedure:** 1. Air-dry the treated sludge to workable moisture content (~30–40%). 2. Add neem cake at 5–10% of dry sludge weight and mix uniformly. 3. Blend in rock phosphate at 2–5% of dry weight, depending on soil pH and targeted P levels. 4. Mix sugarcane fly ash at 3–7% to improve potash content. 5. Homogenize the mixture thoroughly and allow to stabilize for 7–10 days. 6. Analyze the enriched sludge for NPK values using standard nutrient testing protocols.
Calculation	-
Precautions	a. Ensure dry, well-sieved materials are used to ensure even distribution. b. Avoid overuse of fly ash, which may raise pH or contribute heavy metals. c. Use PPE to prevent inhalation or skin exposure to fine particulates. d. Monitor nutrient levels to prevent imbalance or phytotoxicity.
Inference	Nutrient-enriched biosolids provide enhanced fertility benefits when applied to soil and may serve as a sustainable alternative to synthetic fertilizers if regulatory standards are met.

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3.5. Preparation of Value Added Products

3.5.1. Jaivik PROM

Name of The Test	**Preparation of Value-Added Product- Jaivik PROM**
Objective of the test	To convert treated and dried sludge into high-quality, standardized organic fertilizer products by formulating nutrient-rich biosolids that meet FCO 1985 specifications
Name of the Method used	Nutrient Analysis, Formulation, and Granulation (Palletisation)
Principle of the Method	Dried sludge powder, after meeting safety and quality parameters, is repurposed as a key input material in organic fertilizer production. The process involves: **Nutrient Analysis:** Determines organic and inorganic nutrient content (TOC, N, P, K, pH, C: N ratio) to inform blend design. **Formulation:** Tailors the composition by blending sludge powder with other organic materials such as rock phosphate, press mud, neem cake, etc., as per FCO 1985 guidelines. **Palletisation:** Converts the homogenous blend into granulated fertilizer, ensuring uniformity, ease of handling, and efficient field application.
Apparatus required	Weighing balance Mixing and blending units Granulation/pelletisation machinery Dryers (optional) Nutrient testing instruments (TOC analyzer, Kjeldahl apparatus, Flame photometer) Coating tank (for microbial enhancement) Packaging and labeling units Safety gear (PPE)
Reagents required	Rock phosphate, Press mud, Poultry manure, Neem cake, Amino acids, Bentonite, Phosphate-solubilizing bacteria (1×10^9 CFU/ml)
Methods	**Procedure:** **Nutrient Analysis:** 1. Analyze dried sludge powder for: 2. Total Organic Carbon (≥14%) 3. Total Nitrogen (0.2–0.8%) 4. Total Phosphorus (0.2–1.0%)

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	5. Total Potash (0.4–0.7%) 6. pH ≥7 **Formulation:** 7. Blend sludge powder with additives to meet target NPK values. 8. Ensure compliance with FCO 1985 standards. **Granulation (Palletisation):** 9. Process the homogenized blend into granules or pellets. 10. Dry and cure the granules as per design specifications. **Product Enhancement:** 11. Coat granules with phosphate-solubilizing bacteria at 1×10^9 CFU/ml concentration to enhance phosphorus bioavailability. **Packaging:** 12. Pack the final product in labeled bags for market distribution.
Calculation	Analyze the final fertilizer for key parameters (on dry weight basis): TOC, TKN, Available P and K, pH, C:N Ratio, Bulk Density **FCO-Compliant Ranges for Patanjali Jaivik PROM:** Total Organic Carbon: ≥8–10% Total Nitrogen: ≥0.5–1% Total Phosphorus: ≥8–9% C:N Ratio: <20 pH: up to 8 Bulk Density: ≤1.6 g/cm³
Precautions	• Maintain cleanliness to avoid contamination during blending and packaging. • Use approved strains for microbial coating. • Ensure moisture content in final product is within limits to prevent spoilage. • Ensure compliance with legal labeling and nutrient content regulations.
Inference	Patanjali Jaivik PROM acts as an effective organic soil conditioner with bioenhancement properties for long-term fertility and crop productivity.
References	FCO 1985, CPCB Guidelines, FAO Organic Waste Utilization Manual

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3.5.2. Jaivik Khad

Name of The Test	Preparation of Value-Added Product- Jaivik Khad
Objective of the test	To convert treated and dried sludge into high-quality, standardized organic fertilizer products by formulating nutrient-rich biosolids that meet FCO 1985 specifications
Name of the Method used	Nutrient Analysis, Formulation, and Granulation (Palletisation)
Principle of the Method	The product is prepared through a controlled process that blends dry sludge with rock phosphate, press mud, poultry manure, and plant-based organic matter. The product is further enriched using beneficial microbes like Azotobacter, PSB, KMB, and Pseudomonas spp. This promotes nutrient availability and microbial soil health.
Apparatus required	Weighing balance
	Mixers and blenders
	Granulator/pelletizer
	Dryers (optional)
	Microbial culture equipment
	Quality control instruments (TOC analyzer, pH meter)
	Packaging and labeling setup
Reagents required	Dry sludge (68%), Rock phosphate, Press mud, Poultry manure, Herbal and vegetable waste, Azotobacter spp., PSB, KMB, Pseudomonas spp.
Methods	Procedure:
	1. Mix 68% dried sludge with remaining organic additives and homogenize.
	2. Inoculate the blend with microbial consortia under sterile or controlled conditions.
	3. Granulate the mixture for easy field application.
	4. Cure or dry the product under ambient or controlled drying.
	5. Analyze the final granules for standard nutrient composition.
	6. Package in compliance with organic product labeling norms.
Calculation	Final product quality must meet the following specifications:
	• Total Organic Carbon: 14–16%
	• Total Nitrogen: 0.5–1%
	• Total Phosphorus: 1–2%
	• Total Potash: 0.5–1.5%
	• C:N Ratio: <20

CONTENT

	• pH: ≤8.5
	• Bulk Density: <1 g/cm³
	• Total NPK: <3%
Precautions	• Maintain cleanliness to avoid contamination during blending and packaging.
	• Use approved strains for microbial coating.
	• Ensure moisture content in final product is within limits to prevent spoilage.
	• Ensure compliance with legal labeling and nutrient content regulations.
Inference	Patanjali Jaivik Khad acts as an effective organic soil conditioner with bioenhancement properties for long-term fertility and crop productivity.
References	FCO 1985, CPCB Guidelines, FAO Organic Waste Utilization Manual

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3.5.3 Jaivik Poshak

Name of The Test	Preparation of Value-Added Product Jaivik poshak
Objective of the test	To convert treated and dried sludge into high-quality, standardized organic fertilizer products by formulating nutrient-rich biosolids that meet FCO 1985 specifications
Name of the Method used	Nutrient Analysis, Formulation, and Granulation (Palletisation)
Principle of the Method	A nutrient-rich formulation consisting of 50% dried sludge is enhanced with humic acid, amino acids, seaweed extract, and mycorrhizal fungi to promote phosphorus solubilization and root growth. It's processed at controlled temperatures to retain microbial viability.
Apparatus required	Controlled heating unit
	Mixing and granulation machinery
	Spore count assessment tools
	pH meter, nutrient analyzers
	Mycorrhiza culture chambers
Reagents required	Dry sludge (50%), Humic acid, Amino acids, Sea grass, Natural minerals, Medicinal residues, Mycorrhizal spores
Methods	Procedure:
	1. Prepare a base mix with 50% sludge and other nutrient-rich additives.
	2. Process mixture through controlled heating for uniform drying and stability.
	3. Inoculate the cooled mixture with viable mycorrhizal spores.
	4. Granulate and cure the product.
	5. Confirm spore count and nutrient profile through lab testing.
	6. Store in moisture-free conditions and package with usage instructions.
Calculation	Product parameters must meet:
	• Spore count: ≥46
	• pH: ≤7.5
	• Confirm micronutrient balance and carbon content
Precautions	• Avoid over-processing that could reduce spore viability.
	• Use PPE to prevent exposure to bioaerosols or fine particulate matter.
	• Ensure quality control for consistent microbial count and nutrient levels.

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Inference	Jaivik Poshak improves plant root systems, enhances phosphorus uptake, and supports resilience under stress conditions.
References	FCO 1985, APHA, ICAR Biofertilizer Standards, CPCB Guidelines

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3.5.4. PORI Potash

Name of The Test	Preparation of Value-Added Product PORI Potash
Objective of the test	To convert treated and dried sludge into high-quality, standardized organic fertilizer products by formulating nutrient-rich biosolids that meet FCO 1985 specifications
Name of the Method used	Potash Recovery, Granulation, and Bioformulation
Principle of the Method	Molasses-derived potash is blended with fly ash, bentonite, and 5% dry sludge. The formulation is granulated and coated with potassium-mobilizing bacteria (KMB) to improve potassium bioavailability and promote sustainable nutrient delivery.
Apparatus required	Mixing unit and granulator
	Dryers and coolers
	Coating chamber
	Microbial inoculation system
	Analytical instruments (for moisture, K_2O content, CFU count)
Reagents required	Dry sludge (5%), Molasses-based potash, Fly ash, Bentonite, Potassium-mobilizing bacteria (KMB), Distilled water
Methods	Procedure:
	1. Blend molasses-based potash with fly ash, bentonite, and 5% dry sludge.
	2. Process the mixture into granules.
	3. Dry the granules to achieve moisture balance.
	4. Coat the granules with a microbial suspension of KMB.
	5. Conduct quality checks for potash content, moisture, and microbial load.
	6. Package in labeled, moisture-resistant bags.
Calculation	Ensure the product meets:
	• Potash (K_2O): 14.5–16.2%
	• Moisture content: ≤5%
	• Bulk Density: ~1.2–1.5 g/cm³
	• KMB count: ≥1 × 10^8 CFU/g
	• pH: Neutral to slightly alkaline
Precautions	• Ensure uniform microbial distribution during coating.
	• Avoid contamination during formulation and packaging.
	• Monitor product for viability loss during storage.
Inference	PORI Potash enhances potassium uptake, stimulates chlorophyll synthesis, supports robust crop growth, and contributes to improved soil health. It is suitable for sustainable and conventional farming.
References	FCO 1985, US EPA Biosolids Standards, CPCB Guidelines, ICAR Biofertilizer Manual

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3.5.5 Dharti ka Chowkidar

Name of The Test	Preparation of Value-Added Product - Dharti Ka Chowkidar (DKC)
Objective of the test	To convert treated and dried sludge into high-quality, standardized organic fertilizer products by formulating nutrient-rich biosolids that meet FCO 1985 specifications
Name of the Method used	Nutrient Analysis, Formulation, and Granulation (Palletisation)
Principle of the Method	Using PROM-based technology, this product blends 24% dry sludge with press mud, poultry manure, and herbal components, then granulates and coats with neem oil, Trichoderma spp., and Pseudomonas fluorescens. The final product delivers improved nutrient levels and biocontrol benefits.
Apparatus required	Mixing unit and pelletizer
	Dryers and coolers
	Microbial coating chamber
	Biocontrol inoculation setup
	Analytical instruments for CFU count, pH, TOC
Reagents required	Dry sludge (24%), Rock phosphate, Press mud, Poultry manure, Herbal residues, Neem oil (1500 ppm), Trichoderma spp. (2×10^6 CFU), Pseudomonas fluorescens (2×10^8 CFU)
Methods	Procedure:
	1. Mix raw materials including 24% dried sludge.
	2. Homogenize and process into granules through granulation unit.
	3. Dry and prepare granules for coating.
	4. Coat granules with neem oil and microbial suspension containing Trichoderma and Pseudomonas spp.
	5. Test microbial load and nutrient profile of final product.
	6. Package in moisture-proof, labeled bags.
Calculation	Ensure the product meets:
	• Total Organic Carbon: ≥10%
	• Total Nitrogen: ≥1%
	• Total Phosphorus: 8–9%
	• C:N Ratio: <20
	• pH: up to 8
	• Bulk Density: <1.6 g/cm³
	• Trichoderma: $\geq 2 \times 10^6$ CFU
	• Pseudomonas: $\geq 2 \times 10^8$ CFU
Precautions	• Ensure uniform microbial distribution during coating.
	• Avoid contamination during formulation and packaging.
	• Monitor product for viability loss during storage.
Inference	DKC provides nutrient enrichment, biological pest resistance, and improved soil conditioning for both organic and conventional farming.

References	FCO 1985, US EPA Biosolids Standards, CPCB Guidelines, ICAR Biofertilizer Manual

4. References

Mandal, P., Chaturvedi, M. K., Bassin, J. K., Vaidya, A. N., & Gupta, R. K. (2014). Qualitative assessment of municipal solid waste compost by indexing method. International Journal of Recycling of Organic Waste in Agriculture, 3(4), 133-139.

National Research Council, Division on Earth, Board on Environmental Studies, Committee on Toxicants, & Pathogens in Biosolids Applied to Land. (2002). Biosolids applied to land: advancing standards and practices. National Academies Press.

Gupta, P. P., Bankar, N. J., Mishra, V. H., Sanghavi, S., Badge, A. K., & Badge, A. (2023). The efficient disposal of biomedical waste is critical to public health: Insights from the central pollution control board guidelines in India. Cureus, 15(10).

Saxena, A. K., Kumar, M., Chakdar, H., Rajawat, M. V. S., Dubey, S. C., & Sharma, T. R. (2021). ICAR Technologies: Biofertilizers for Sustainable Crop Production. Indian Council of Agricultural Research, New Delhi.

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Annexure IV Farmers Consent -Form

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

	1. INFORMATION OF FARMER AND FAMILIY	
a)	Name of Farmer	Sachin saini
b)	Gender	male
c)	Aadhar Number	206718668307
d)	Village	Ahmadpur Gnant
e)	District and Pin-code	Haridwar, 249402
f)	State	Uttarakhand
g)	Total No. of Family Members	05
h)	Contact No.	9720151030
	2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION	
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	40 brgha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Rice (60 days)
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	tubewell
h)	Detail of Livestock (name/number)	02 (cows)
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	1 bigha (0.60 Acre)
m)	Previous Crop in the Experimental Field	Sugar cane
n)	Next Crop in the Experimental Field	Rice (60days) (1509)
o)	Fertilizer detail to be used in Field Trial/Trials	Jaivik khad

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Aakash Saini
b)	Gender	MALE
c)	Aadhar Number	492419699854
d)	Village	Jaswawala
e)	District and Pin-code	Haridwar - 247667
f)	State	Uttarakhand
g)	Total No. of Family Members	06+1 ⇒ 7
h)	Contact No.	8006856209
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Ag
b)	Total Agriculturally Cultivable Land	15 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Lady Finger / Bhindi / Okra
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Tube well
h)	Detail of Livestock (name/number)	2
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.30 Acre (0.5 Bigha)
m)	Previous Crop in the Experimental Field	Onion
n)	Next Crop in the Experimental Field	Lady Finger / Bhindi / Okra
o)	Fertilizer detail to be used in Field Trial/Trials	DKC (Dharti ka chowkidar)

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Mangeram Saini
b)	Gender	Male
c)	Aadhar Number	6211 8446 4072
d)	Village	Sherpur
e)	District and Pin-code	Haridwar - 247 663
f)	State	Uttarakhand
g)	Total No. of Family Members	11
h)	Contact No.	9719146194
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	25 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full Time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Sugarcane
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Tube well
h)	Detail of Livestock (name/number)	
i)	Awareness about soil testing and organic farming and their related Government Schemes	Yes
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.60 Acre (1 Bigha)
m)	Previous Crop in the Experimental Field	wheat
n)	Next Crop in the Experimental Field	Sugarcane
o)	Fertilizer detail to be used in Field Trial/Trials	PROM (Jaivik Prom)

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

मांगेराम सैनी

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	YUGVEER SINGH
b)	Gender	MALE
c)	Aadhar Number	7092 0485 9162
d)	Village	BHOGPUR
e)	District and Pin-code	HARIDWAR 247663
f)	State	Uttraknand
g)	Total No. of Family Members	06
h)	Contact No.	9758008756
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	40 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time.
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Organic.
e)	Crops under Cultivation	Sugar Cane.
f)	Ever used Ganga sludge directly or any of its products in the field	Yes.
g)	Mode of Irrigation	Tubewell.
h)	Detail of Livestock (name/number)	4 (Cow)
i)	Awareness about soil testing and organic farming and their related Government Schemes	Yes.
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No.
k)	Participation in any Government Scheme	Yes.
l)	Total Area allotted for Field trials	1. Bigha (0.60 Acre)
m)	Previous Crop in the Experimental Field	Sugar Cane.
n)	Next Crop in the Experimental Field	Sugar Cane.
o)	Fertilizer detail to be used in Field Trial/Trials	Jaivik Promo.

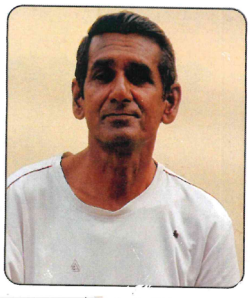
1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Yasveer Singh
b)	Gender	Male
c)	Aadhar Number	4275 1947 4031
d)	Village	Bhogpur
e)	District and Pin-code	Haridwar - 247663
f)	State	Uttara Khand -
g)	Total No. of Family Members	6
h)	Contact No.	9758024588
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	9 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time, Commercial
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Sugar Cane
f)	Ever used Ganga sludge directly or any of its products in the field	Yes
g)	Mode of Irrigation	Tube well
h)	Detail of Livestock (name/number)	2 (Cow)
i)	Awareness about soil testing and organic farming and their related Government Schemes	Yes, Namami Gange
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	Yes, Namami Gange
l)	Total Area allotted for Field trials	½ Bigha (0.30 Acre)
m)	Previous Crop in the Experimental Field	Mustard
n)	Next Crop in the Experimental Field	Sugarcane
o)	Fertilizer detail to be used in Field Trial/Trials	Jaivik Khad.

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

यशवीर सिंह

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Dhani Ram
b)	Gender	Male
c)	Aadhar Number	532566768837
d)	Village	Bhogpur
e)	District and Pin-code	Haridwar, 247663
f)	State	Uttarakhand
g)	Total No. of Family Members	10
h)	Contact No.	9758556280
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	22 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time, commercial
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Traditional
e)	Crops under Cultivation	Sugar cane
f)	Ever used Ganga sludge directly or any of its products in the field	Yes, Namami Gange
g)	Mode of Irrigation	Tube well
h)	Detail of Livestock (name/number)	4, (Buffalo)
i)	Awareness about soil testing and organic farming and their related Government Schemes	Yes, Namami Gange
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	Yes, Namami Gange
l)	Total Area allotted for Field trials	1 Bigha (0.68 Acre)
m)	Previous Crop in the Experimental Field	Sugar Cane
n)	Next Crop in the Experimental Field	Sugarcane
o)	Fertilizer detail to be used in Field Trial/Trials	Jaivik Khad.

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Dhani Ram
Signature/Thumb impression of the Respondent

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PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Sonu Kumar
b)	Gender	Male
c)	Aadhar Number	859278773071
d)	Village	Bhogpur
e)	District and Pin-code	Haridwar, 247663
f)	State	Uttarakhand
g)	Total No. of Family Members	7
h)	Contact No.	9012229191
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	8 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Part-time, commercial
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Sugarcane
f)	Ever used Ganga sludge directly or any of its products in the field	Yes, Namami Gange
g)	Mode of Irrigation	Tube well
h)	Detail of Livestock (name/number)	2
i)	Awareness about soil testing and organic farming and their related Government Schemes	Yes, Namami Gange
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	Yes
l)	Total Area allotted for Field trials	½ Bigha (0.30 Acre)
m)	Previous Crop in the Experimental Field	Sugar Cane
n)	Next Crop in the Experimental Field	Sugar Cane
o)	Fertilizer detail to be used in Field Trial/Trials	Jaivik Prom

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Sonukumar

Signature/Thumb impression of the Respondent

Aantam

Signature of the Enumerator

Signature of the Project Head

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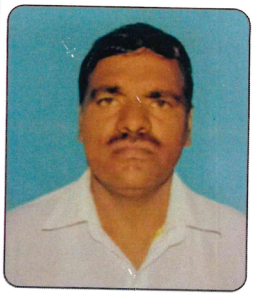

PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Tilak Raj
b)	Gender	Male
c)	Aadhar Number	5316 6049 9204
d)	Village	Tilak Puri
e)	District and Pin-code	Haridwar, 247663
f)	State	Uttarakhand
g)	Total No. of Family Members	6
h)	Contact No.	9719582163
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	25 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time, Commercial
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Organic
e)	Crops under Cultivation	Sugar Cane
f)	Ever used Ganga sludge directly or any of its products in the field	Yes, Namami Grange
g)	Mode of Irrigation	Tube well
h)	Detail of Livestock (name/number)	7 (cow, Buffalo)
i)	Awareness about soil testing and organic farming and their related Government Schemes	Yes, Namami Grange
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	Yes, Namami Grange
l)	Total Area allotted for Field trials	1 Bigha (0.60 Acre)
m)	Previous Crop in the Experimental Field	Paddy (Dhan)
n)	Next Crop in the Experimental Field	Sugarcane
o)	Fertilizer detail to be used in Field Trial/Trials	Puri Potash.

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Tilak Raj

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

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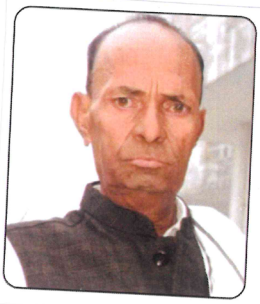


PROFORMA

	1. INFORMATION OF FARMER AND FAMILIY	
a)	Name of Farmer	Suresh Kumar
b)	Gender	Male
c)	Aadhar Number	9638 1439 2496
d)	Village	Bhogpur
e)	District and Pin-code	Haridwar, 247663
f)	State	Uttarakhand
g)	Total No. of Family Members	4
h)	Contact No.	9719517797
	2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION	
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	8 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full-time, Commercial
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Sugar cane
f)	Ever used Ganga sludge directly or any of its products in the field	Yes
g)	Mode of Irrigation	Tubewell
h)	Detail of Livestock (name/number)	1 (cow)
i)	Awareness about soil testing and organic farming and their related Government Schemes	Yes
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	Yes, Namami Gange
l)	Total Area allotted for Field trials	½ Bigha (0.30 Acre)
m)	Previous Crop in the Experimental Field	Sugar Mustard
n)	Next Crop in the Experimental Field	Sugar Cane
o)	Fertilizer detail to be used in Field Trial/Trials	DKC (Bharti Ka chowkidar)

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

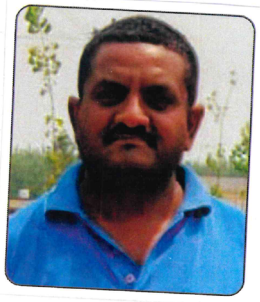
सूरज कुमार

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Harsh Kumar
b)	Gender	Male
c)	Aadhar Number	713728 777709
d)	Village	Manubans
e)	District and Pin-code	Haridwar, 247667
f)	State	Uttarakhand.
g)	Total No. of Family Members	6
h)	Contact No.	9719474111
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	10 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full Time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Sugarcane
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Tube well
h)	Detail of Livestock (name/number)	3
i)	Awareness about soil testing and organic farming and their related Government Schemes	Yes
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	1 Bigha (0.60 Acre)
m)	Previous Crop in the Experimental Field	Sugarcane
n)	Next Crop in the Experimental Field	Sugarcane
o)	Fertilizer detail to be used in Field Trial/Trials	Pori Potash

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Harsh

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Mahepal
b)	Gender	Male
c)	Aadhar Number	763055357910
d)	Village	Sahadpur Sikrodha.
e)	District and Pin-code	Haridwar, 247667
f)	State	Uttarakhand.
g)	Total No. of Family Members	6
h)	Contact No.	7500768574, 9027298715
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	15 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Brinjal
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Tube well
h)	Detail of Livestock (name/number)	4
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	1 Bigha (0.60 Acre)
m)	Previous Crop in the Experimental Field	Cabbage
n)	Next Crop in the Experimental Field	Brinjal
o)	Fertilizer detail to be used in Field Trial/Trials	Jaivik Khad

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Munna Lal
b)	Gender	Male
c)	Aadhar Number	931776066266
d)	Village	Ibrahimpur Masahi
e)	District and Pin-code	Haridwar, 247667
f)	State	Uttarakhand
g)	Total No. of Family Members	6
h)	Contact No.	9012010725, 8006239344, 7351420503
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	17 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Organic / Integrated.
e)	Crops under Cultivation	Menthol
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Tube well
h)	Detail of Livestock (name/number)	3
i)	Awareness about soil testing and organic farming and their related Government Schemes	Yes
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	½ Bigha (0.30 Acre)
m)	Previous Crop in the Experimental Field	Wheat
n)	Next Crop in the Experimental Field	Menthol
o)	Fertilizer detail to be used in Field Trial/Trials	Jaivik Prem 50 kg

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

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PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Ramkumar
b)	Gender	Male
c)	Aadhar Number	8 80 5824 2690 169
d)	Village	Sohalpur, Sikradha
e)	District and Pin-code	Haridwar, 247667
f)	State	Uttarakhand
g)	Total No. of Family Members	5
h)	Contact No.	9761168924, 9758054029
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	9 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Part-time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Brinjal
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Tubewell
h)	Detail of Livestock (name/number)	2
i)	Awareness about soil testing and organic farming and their related Government Schemes	Yes
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.60 Acre (1 Bigha)
m)	Previous Crop in the Experimental Field	Wheat
n)	Next Crop in the Experimental Field	Brinjal
o)	Fertilizer detail to be used in Field Trial/Trials	Jaivik Khad

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Madanpal
b)	Gender	Mall
c)	Aadhar Number	364031918630
d)	Village	Bhagpur
e)	District and Pin-code	Haridwar - 247663
f)	State	Uttarakhand
g)	Total No. of Family Members	05
h)	Contact No.	9758953587, 9675355750
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	15 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Sugarcane
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Tube well
h)	Detail of Livestock (name/number)	3
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.60 acre (1 Bigha)
m)	Previous Crop in the Experimental Field	Wheat
n)	Next Crop in the Experimental Field	Sugarcane
o)	Fertilizer detail to be used in Field Trial/Trials	Pori Potash

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Ram Singh
b)	Gender	Male
c)	Aadhar Number	222775477035
d)	Village	Daulatpur - 249402
e)	District and Pin-code	Haridwar
f)	State	Uttaraknand
g)	Total No. of Family Members	4
h)	Contact No.	9917265031
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	2 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	organic
e)	Crops under Cultivation	Black Uraam
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Tube well
h)	Detail of Livestock (name/number)	No
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.60 Acre (1 Bigha)
m)	Previous Crop in the Experimental Field	wheat
n)	Next Crop in the Experimental Field	Black Uraam
o)	Fertilizer detail to be used in Field Trial/Trials	Jaivik khad

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Dhyan Singh
b)	Gender	Male
c)	Aadhar Number	425842206200
d)	Village	Daulatpur, 249402
e)	District and Pin-code	Haridwar
f)	State	Uttarakhand
g)	Total No. of Family Members	6
h)	Contact No.	7464807074
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	4 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Organic
e)	Crops under Cultivation	Lady Finger / Bhindi / Okra
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Tube well
h)	Detail of Livestock (name/number)	1 Buffalow
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.60 Acre (1 Bigha)
m)	Previous Crop in the Experimental Field	Brinjal
n)	Next Crop in the Experimental Field	Lady Finger / Bhindi / Okra
o)	Fertilizer detail to be used in Field Trial/Trials	Pori-Potash

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

ध्यान सिंह

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Balram
b)	Gender	Male
c)	Aadhar Number	411869344944
d)	Village	Daulatpur, 249402
e)	District and Pin-code	Haridwar
f)	State	Uttarakhand
g)	Total No. of Family Members	3
h)	Contact No.	8077979194.
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	3 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Organic
e)	Crops under Cultivation	Lobiya (cowpea)
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Tube well
h)	Detail of Livestock (name/number)	No
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.60 Acre (1 Bigha)
m)	Previous Crop in the Experimental Field	Wheat
n)	Next Crop in the Experimental Field	Lobiya (cowpea)
o)	Fertilizer detail to be used in Field Trial/Trials	DKC (Dhani ka chowkidar)

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

बलराम

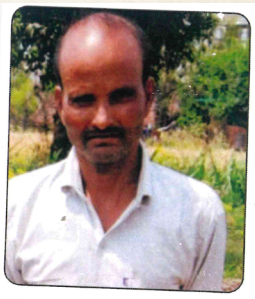
Signature/Thumb impression of the Respondent

Afsantan

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF)	Patanjali Organic Research Institute (PORI)	National Mission for Clean Ganga (NMCG)



PROFORMA

	1. INFORMATION OF FARMER AND FAMILIY	
a)	Name of Farmer	Kunwar Singh
b)	Gender	Male
c)	Aadhar Number	221200039001
d)	Village	Resham Majri Grant
e)	District and Pin-code	Dehradun - 248140
f)	State	Uttarakhand
g)	Total No. of Family Members	4
h)	Contact No.	7351349848
	2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION	
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	30 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Basil (Tulsi)
f)	Ever used Ganga sludge directly or any of its products in the field	NO
g)	Mode of Irrigation	Canal
h)	Detail of Livestock (name/number)	No
i)	Awareness about soil testing and organic farming and their related Government Schemes	Yes
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	1 Bigha (0.60 Acre)
m)	Previous Crop in the Experimental Field	Dill (Soya)
n)	Next Crop in the Experimental Field	Basil (Tulsi)
o)	Fertilizer detail to be used in Field Trial/Trials	DKC (Dharti ka chowkidar)

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Devender Singh
b)	Gender	Male
c)	Aadhar Number	950425587622
d)	Village	Resham Majri Grant
e)	District and Pin-code	Dehradun - 248140
f)	State	Uttarkhand
g)	Total No. of Family Members	6
h)	Contact No.	9758727662
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	14 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full Time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Lady Finger / Bhindi / okra
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Canal
h)	Detail of Livestock (name/number)	2
i)	Awareness about soil testing and organic farming and their related Government Schemes	Yes
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	½ Bigha (0.30 Acre)
m)	Previous Crop in the Experimental Field	Sugarcane
n)	Next Crop in the Experimental Field	Lady Finger / Bhindi / okra
o)	Fertilizer detail to be used in Field Trial/Trials	Jaivik Kheti

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

देवेन्द्र सिंह

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Yaspal Singh
b)	Gender	Male
c)	Aadhar Number	3936 53 54 2729
d)	Village	Reshan Majri Grant
e)	District and Pin-code	Dehradun - 248140
f)	State	Uttarakhand
g)	Total No. of Family Members	4
h)	Contact No.	9758 122 830
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agricultural
b)	Total Agriculturally Cultivable Land	40 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Cholai (Amaranth)
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Canal
h)	Detail of Livestock (name/number)	2
i)	Awareness about soil testing and organic farming and their related Government Schemes	Yes
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	½ Bigha (0.30 Acre)
m)	Previous Crop in the Experimental Field	Wheat
n)	Next Crop in the Experimental Field	½ Bigha Cholai (Amaranth)
o)	Fertilizer detail to be used in Field Trial/Trials	Jaivik Khad

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

YASHPAL SINGH

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Chaitan
b)	Gender	Male
c)	Aadhar Number	7165 7308 1776
d)	Village	Resham Nagar Grant
e)	District and Pin-code	Dehradun - 248140
f)	State	Uttarakhand
g)	Total No. of Family Members	04
h)	Contact No.	9528086048
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	30 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Mint
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Canal
h)	Detail of Livestock (name/number)	No
i)	Awareness about soil testing and organic farming and their related Government Schemes	yes
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.60 Acre (1 Bigha)
m)	Previous Crop in the Experimental Field	Coriander
n)	Next Crop in the Experimental Field	Mint
o)	Fertilizer detail to be used in Field Trial/Trials	DKC (Dharti ka chowkidar)

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

चैतन्य

Signature/Thumb impression of the Respondent

Chaitan

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF)	Patanjali Organic Research Institute (PORI)	National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Nikhil Kumar
b)	Gender	Male
c)	Aadhar Number	201820334067
d)	Village	Resham Majri Grant
e)	District and Pin-code	Dehradun - 248140
f)	State	Uttarakhand
g)	Total No. of Family Members	6
h)	Contact No.	9761419006
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	14 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Cholai (Amaranth)
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Canal
h)	Detail of Livestock (name/number)	No
i)	Awareness about soil testing and organic farming and their related Government Schemes	yes
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.30 Acre (0.5 Bigha)
m)	Previous Crop in the Experimental Field	Sugarcane
n)	Next Crop in the Experimental Field	Cholai (Amaranth)
o)	Fertilizer detail to be used in Field Trial/Trials	DKC (Dharti ka Chowkidar)

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Nikhil Kumar
Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Satypal Singh
b)	Gender	Male
c)	Aadhar Number	509135165854
d)	Village	Resham Majri Uttar
e)	District and Pin-code	Dehradun, 248140
f)	State	Uttarakhand
g)	Total No. of Family Members	5
h)	Contact No.	9690266833
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	20 Bigh
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Lady finger / Bhindi / okra
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Canal
h)	Detail of Livestock (name/number)	2 cow
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.60 Acre (1 Bigha)
m)	Previous Crop in the Experimental Field	Spinach
n)	Next Crop in the Experimental Field	Lady Finger / Bhindi / okra
o)	Fertilizer detail to be used in Field Trial/Trials	DAP (Dharti ka chowkidar)

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

21/2/16

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

	1. INFORMATION OF FARMER AND FAMILIY	
a)	Name of Farmer	Hritik Kumar
b)	Gender	Male
c)	Aadhar Number	2000 7853 3308
d)	Village	Resham Majri Grant
e)	District and Pin-code	Dehradun -248140
f)	State	Uttaraknand
g)	Total No. of Family Members	5
h)	Contact No.	9548096811
	2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION	
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	20 Digha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Bitter Gourd (Karela)
f)	Ever used Ganga sludge directly or any of its products in the field	NO
g)	Mode of Irrigation	Canal
h)	Detail of Livestock (name/number)	2 Cow
i)	Awareness about soil testing and organic farming and their related Government Schemes	Yes
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.60 Acre (1 Bigha)
m)	Previous Crop in the Experimental Field	
n)	Next Crop in the Experimental Field	Bitter Gourd (Karela)
o)	Fertilizer detail to be used in Field Trial/Trials	Jaivik Khad

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Hritik

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Kuldeep Singh Saini
b)	Gender	Male
c)	Aadhar Number	8642 8303 7428
d)	Village	Bheema wala ,
e)	District and Pin-code	Dehradun , 248198
f)	State	Uttarkhand
g)	Total No. of Family Members	4+2 = 6
h)	Contact No.	9319193953
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture + Horticulture
b)	Total Agriculturally Cultivable Land	20 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Lady Finger / Bhindi / Okra
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Tube well
h)	Detail of Livestock (name/number)	2 Buffallo , 4 cow
i)	Awareness about soil testing and organic farming and their related Government Schemes	Yes
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.30 Acre (0.5 Bigha)
m)	Previous Crop in the Experimental Field	Cabbage
n)	Next Crop in the Experimental Field	Lady Finger / Bhindi / Okra
o)	Fertilizer detail to be used in Field Trial/Trials	DKC ('Dharti Ka chowkidar')

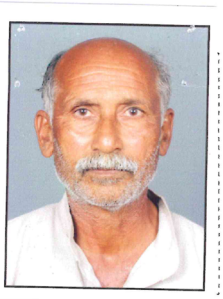
1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF)	Patanjali Organic Research Institute (PORI)	National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Tara chand Saini
b)	Gender	Male
c)	Aadhar Number	2486 8348 5051
d)	Village	Jassowala ,
e)	District and Pin-code	Dehradun , 248142
f)	State	Uttarakhand
g)	Total No. of Family Members	5
h)	Contact No.	9634969118
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	15 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Cucumber
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Tube well
h)	Detail of Livestock (name/number)	3
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.30 Acre (0.5 Bigha)
m)	Previous Crop in the Experimental Field	Cauliflower
n)	Next Crop in the Experimental Field	Cucumber
o)	Fertilizer detail to be used in Field Trial/Trials	DKC (Dharti Ka Chowkidar)

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Sachin kumar
b)	Gender	male
c)	Aadhar Number	938773177556
d)	Village	Jassowala
e)	District and Pin-code	Dehradun 248142
f)	State	Uttarakhand
g)	Total No. of Family Members	04
h)	Contact No.	7060796758
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	22 Bigha.
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Sugarcane
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Tube well
h)	Detail of Livestock (name/number)	3 Cow
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.60 Acre (1 Bigha)
m)	Previous Crop in the Experimental Field	Sugarcane
n)	Next Crop in the Experimental Field	Sugarcane
o)	Fertilizer detail to be used in Field Trial/Trials	Pori Potash

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Sachin

Signature/Thumb impression of the Respondent

Akantar

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Ramesh chand
b)	Gender	Male
c)	Aadhar Number	2346 3057 7305
d)	Village	Parteetpur
e)	District and Pin-code	Dheradun - 248142
f)	State	Uttarakhand
g)	Total No. of Family Members	11
h)	Contact No.	97205 17 808
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	60 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Sugar cane
f)	Ever used Ganga sludge directly or any of its products in the field	NO
g)	Mode of Irrigation	Tube well
h)	Detail of Livestock (name/number)	2 cow, 2 Buffalo (4)
i)	Awareness about soil testing and organic farming and their related Government Schemes	NO
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	NO
k)	Participation in any Government Scheme	NO
l)	Total Area allotted for Field trials	0.60 Acre (1 Bigha)
m)	Previous Crop in the Experimental Field	Barley (Sorgham)
n)	Next Crop in the Experimental Field	Sugar Cane
o)	Fertilizer detail to be used in Field Trial/Trials	Pori Potash

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

रमेश चन्द

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Rajendra Singh
b)	Gender	Male
c)	Aadhar Number	4841461728 77
d)	Village	Goodrich T- Estate (Jamnipur)
e)	District and Pin-code	Dehradun, 248198
f)	State	Uttarakhand
g)	Total No. of Family Members	5
h)	Contact No.	9536271818
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	16 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Lady Finger / Bhindi / Okra
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Tube well
h)	Detail of Livestock (name/number)	2 cow
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.60 acre (1 Bigha)
m)	Previous Crop in the Experimental Field	Cabbage
n)	Next Crop in the Experimental Field	Laddy Finger / Bhindi / Okra
o)	Fertilizer detail to be used in Field Trial/Trials	Jaivik Khad

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF)	Patanjali Organic Research Institute (PORI)	National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Ashish Kumar
b)	Gender	Male
c)	Aadhar Number	5410 860 18632
d)	Village	Goodrich T-Estate (Jamnipur)
e)	District and Pin-code	Dehradun, 248198
f)	State	Uttarakhand
g)	Total No. of Family Members	5
h)	Contact No.	9410379770
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	16 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Lady Finger / Bhindi / Okra
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Tube well
h)	Detail of Livestock (name/number)	3
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.60 Acre (1 Bigha)
m)	Previous Crop in the Experimental Field	Spinach
n)	Next Crop in the Experimental Field	Lady Finger / Bhindi / Okra
o)	Fertilizer detail to be used in Field Trial/Trials	Jaivik Prom

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Ashish Kumar

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Shubham
b)	Gender	Male
c)	Aadhar Number	2187 0479 4106
d)	Village	Goodrich T-Estate, Jamnipur
e)	District and Pin-code	Dehradun, 248198
f)	State	Uttarakhand
g)	Total No. of Family Members	6
h)	Contact No.	89369881144
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	10 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Lady Finger / Bhindi / Okra
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	River (cannal)
h)	Detail of Livestock (name/number)	2 cow, 1 Buffallo
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.60 Acre (1 Bigha)
m)	Previous Crop in the Experimental Field	cabbage
n)	Next Crop in the Experimental Field	Lady Finger / Bhindi / Okra
o)	Fertilizer detail to be used in Field Trial/Trials	Jaivik Khad.

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Jitender Singh
b)	Gender	Male
c)	Aadhar Number	721323625063
d)	Village	Jassowala,
e)	District and Pin-code	Dehradun, 248142
f)	State	Uttarakhand
g)	Total No. of Family Members	6
h)	Contact No.	9758901201
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	10 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full Time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Sugarcane
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Tube well
h)	Detail of Livestock (name/number)	2 Buffallo
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No.
l)	Total Area allotted for Field trials	0.60 Acre (1 Bigha)
m)	Previous Crop in the Experimental Field	Sugarcane
n)	Next Crop in the Experimental Field	Sugar Cane
o)	Fertilizer detail to be used in Field Trial/Trials	Pori Potash

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

J. Singh

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Aryan Saini
b)	Gender	Male
c)	Aadhar Number	6612 9955 5797
d)	Village	Jassiwala
e)	District and Pin-code	Dehradun - 248142
f)	State	Uttarakhand
g)	Total No. of Family Members	5
h)	Contact No.	8171 9805 68
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	15 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Part-time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Cucumber
f)	Ever used Ganga sludge directly or any of its products in the field	NO
g)	Mode of Irrigation	Tube well
h)	Detail of Livestock (name/number)	3
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	NO
k)	Participation in any Government Scheme	NO
l)	Total Area allotted for Field trials	0.30 Acre (0.5 Bigha)
m)	Previous Crop in the Experimental Field	Cabbage
n)	Next Crop in the Experimental Field	Cucumber
o)	Fertilizer detail to be used in Field Trial/Trials	Pori-Potash

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Aryan

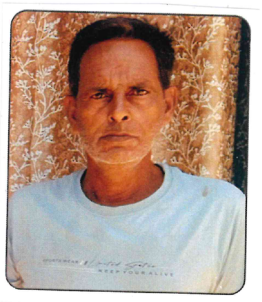
Signature/Thumb impression of the Respondent

Amitav

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Rishi Pal
b)	Gender	Male
c)	Aadhar Number	5222 0993 7217
d)	Village	Jassowala, 248142
e)	District and Pin-code	Dehradun
f)	State	Uttarakhand
g)	Total No. of Family Members	5
h)	Contact No.	9719220025
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	20 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full Time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated.
e)	Crops under Cultivation	Sweet Corn
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Tube well
h)	Detail of Livestock (name/number)	1 Cow, 1 Buffalo
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.60 Acre (1 Bigha)
m)	Previous Crop in the Experimental Field	Cauliflower
n)	Next Crop in the Experimental Field	Sweet Corn
o)	Fertilizer detail to be used in Field Trial/Trials	Jaivik Khad

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

ऋषिपाल

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Chatar Singh
b)	Gender	Male
c)	Aadhar Number	9752 0911 6478
d)	Village	Sehwari
e)	District and Pin-code	Uttarkashi - 249171
f)	State	Uttarkhand
g)	Total No. of Family Members	27
h)	Contact No.	9389248355
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	3 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Tomato
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Pond
h)	Detail of Livestock (name/number)	3 Buffallo, 20 Goat
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.30 Acre (0.5 Bigha)
m)	Previous Crop in the Experimental Field	Tomato
n)	Next Crop in the Experimental Field	Tomato
o)	Fertilizer detail to be used in Field Trial/Trials	Potash (Pori-Potash)

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF)	Patanjali Organic Research Institute (PORI)	National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Inder Singh
b)	Gender	Male
c)	Aadhar Number	2455 7554 4818
d)	Village	Diyari
e)	District and Pin-code	Uttarkhasi, 249171
f)	State	Uttarakhand
g)	Total No. of Family Members	6
h)	Contact No.	7818827375
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	16 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated.
e)	Crops under Cultivation	Tomato
f)	Ever used Ganga sludge directly or any of its products in the field	No.
g)	Mode of Irrigation	Pond
h)	Detail of Livestock (name/number)	1 Buffallo, 2 Goat
i)	Awareness about soil testing and organic farming and their related Government Schemes	NO
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	NO
k)	Participation in any Government Scheme	NO
l)	Total Area allotted for Field trials	0.30 Acre (0.5 Bigha)
m)	Previous Crop in the Experimental Field	Arbi
n)	Next Crop in the Experimental Field	Tomato
o)	Fertilizer detail to be used in Field Trial/Trials	Potash (Pori-Potash)

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Bhagtu Lal
b)	Gender	Mall
c)	Aadhar Number	3678 7032 0819
d)	Village	Satwari
e)	District and Pin-code	Uttarkhashi, 249171
f)	State	Uttarakhand
g)	Total No. of Family Members	5
h)	Contact No.	9389052320
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	10 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	हिमली मिर्च
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Pond
h)	Detail of Livestock (name/number)	–
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.60 Acre (1 Bigha)
m)	Previous Crop in the Experimental Field	Pea
n)	Next Crop in the Experimental Field	हिमली मिर्च
o)	Fertilizer detail to be used in Field Trial/Trials	Jaivik Prom

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

भगतु लाल

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF)	Patanjali Organic Research Institute (PORI)	National Mission for Clean Ganga (NMCG)



PROFORMA

	1. INFORMATION OF FARMER AND FAMILIY	
a)	Name of Farmer	Gulabu Singh
b)	Gender	Male
c)	Aadhar Number	631070023143
d)	Village	Setuwri
e)	District and Pin-code	Uttarkashi - 249171
f)	State	Uttarakhand
g)	Total No. of Family Members	7
h)	Contact No.	9258098126
	2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION	
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	6 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Tomato
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Pond
h)	Detail of Livestock (name/number)	4
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.30 Acre (0.5 Bigha)
m)	Previous Crop in the Experimental Field	Pea
n)	Next Crop in the Experimental Field	Tomato
o)	Fertilizer detail to be used in Field Trial/Trials	Jaivik Prem

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Dinesh Panwar
b)	Gender	Male
c)	Aadhar Number	2922 4653 7883
d)	Village	Rikhaun
e)	District and Pin-code	Uttarkashi – 249171
f)	State	Uttarakhand
g)	Total No. of Family Members	7
h)	Contact No.	9456 7434 48
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	20 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Tomato
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	5 Pond
h)	Detail of Livestock (name/number)	5
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.60 Acre (1 Bigha)
m)	Previous Crop in the Experimental Field	Pea
n)	Next Crop in the Experimental Field	Tomato
o)	Fertilizer detail to be used in Field Trial/Trials	Jaivik Khad (40 kg)

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF)	Patanjali Organic Research Institute (PORI)	National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Pyar Singh
b)	Gender	Male
c)	Aadhar Number	399452273832
d)	Village	Rikhaun
e)	District and Pin-code	Uttarkashi - 249171
f)	State	Uttaraknand
g)	Total No. of Family Members	45
h)	Contact No.	8218774923
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	20 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Tomato
f)	Ever used Ganga sludge directly or any of its products in the field	NO
g)	Mode of Irrigation	Pond
h)	Detail of Livestock (name/number)	10
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.60 Acre (1 Bigha)
m)	Previous Crop in the Experimental Field	Bean
n)	Next Crop in the Experimental Field	Tomato
o)	Fertilizer detail to be used in Field Trial/Trials	PKC (Dharti ka chowkidar)

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Meena Devi
b)	Gender	Female
c)	Aadhar Number	3177 9587 9410
d)	Village	Rikhaun
e)	District and Pin-code	Uttarkashi - 249171
f)	State	Uttarakhand
g)	Total No. of Family Members	6
h)	Contact No.	9411139490
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	12 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Sweet corn
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Pond
h)	Detail of Livestock (name/number)	6
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.60 Acre (1 Bigha)
m)	Previous Crop in the Experimental Field	Onion
n)	Next Crop in the Experimental Field	Sweet corn
o)	Fertilizer detail to be used in Field Trial/Trials	Jaivik Khad

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

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PROFORMA

	1. INFORMATION OF FARMER AND FAMILIY	
a)	Name of Farmer	Mahipal Singh
b)	Gender	Male
c)	Aadhar Number	7523 0458 3665
d)	Village	Bhut gaon (Dawarika puri)
e)	District and Pin-code	Tehri-Garhwal - 249186
f)	State	Uttarakhand
g)	Total No. of Family Members	7
h)	Contact No.	9997138409
	2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION	
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	20 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full Time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Capsicum
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Pond
h)	Detail of Livestock (name/number)	5
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.60 Acre (1 Bigha)
m)	Previous Crop in the Experimental Field	Rice
n)	Next Crop in the Experimental Field	Capsicum
o)	Fertilizer detail to be used in Field Trial/Trials	Jaivikkhad

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Signature/Thumb impression of the Respondent

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PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Surbeer Singh
b)	Gender	Male
c)	Aadhar Number	920517321331
d)	Village	Bhut gaon (Dwarikapuri)
e)	District and Pin-code	Tehri-garhwal, 279186
f)	State	Uttarakhand
g)	Total No. of Family Members	6
h)	Contact No.	7055153457
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	9 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Capsicum
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Pond
h)	Detail of Livestock (name/number)	4
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.60 Acre (1 Bigha)
m)	Previous Crop in the Experimental Field	Rice
n)	Next Crop in the Experimental Field	Capsicum
o)	Fertilizer detail to be used in Field Trial/Trials	Jaivik khad

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

सुरबीर

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Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Rajendra Singh
b)	Gender	male
c)	Aadhar Number	7711 4075 3037
d)	Village	Bhet Gaon (Dwarikapuri)
e)	District and Pin-code	Tehri Garhwal - 279186
f)	State	Uttarakhand
g)	Total No. of Family Members	8
h)	Contact No.	7579463558
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	33 Agriculture
b)	Total Agriculturally Cultivable Land	20 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Capsicum
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	
h)	Detail of Livestock (name/number)	2 Bullock 20 goat 4 Cow
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.30 Acre (0.5 Bigha)
m)	Previous Crop in the Experimental Field	Rice
n)	Next Crop in the Experimental Field	Capsicum
o)	Fertilizer detail to be used in Field Trial/Trials	DKC (Dharti Ka Chowkidar)

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

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PROFORMA

	1. INFORMATION OF FARMER AND FAMILIY	
a)	Name of Farmer	Jasveer Singh
b)	Gender	Male
c)	Aadhar Number	7845 3765 3184
d)	Village	Bhat gaon (Dharikagun.)
e)	District and Pin-code	Tehri - Garhwal - 279186
f)	State	Uttarkhand
g)	Total No. of Family Members	8
h)	Contact No.	9389958217
	2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION	
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	9 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	capsicum
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Pond
h)	Detail of Livestock (name/number)	6
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	NO
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.20 Acre (0.5 Bigha)
m)	Previous Crop in the Experimental Field	Rice
n)	Next Crop in the Experimental Field	Capsicum
o)	Fertilizer detail to be used in Field Trial/Trials	Potash (Pasi - Potash)

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

जसवीर

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head



Patanjali Research Foundation (PRF)	Patanjali Organic Research Institute (PORI)	National Mission for Clean Ganga (NMCG)

PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Jaspal Chauhan
b)	Gender	Male
c)	Aadhar Number	832174033834
d)	Village	Bhat gaon (Dwarikapuri)
e)	District and Pin-code	Tehri-Garhwal - 279186
f)	State	Uttarakhand
g)	Total No. of Family Members	7
h)	Contact No.	8433262973
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	10 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Tomato
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Pond
h)	Detail of Livestock (name/number)	3 cow
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.30 Acre (0.5 Bigha)
m)	Previous Crop in the Experimental Field	Rice
n)	Next Crop in the Experimental Field	Tomato
o)	Fertilizer detail to be used in Field Trial/Trials	Pori-Potash

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

जसपाल

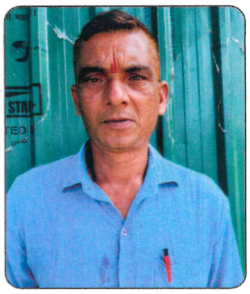
Signature/Thumb impression of the Respondent

Afaitan

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF) | Patanjali Organic Research Institute (PORI) | National Mission for Clean Ganga (NMCG)



PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Anand Singh
b)	Gender	Male
c)	Aadhar Number	4966 32 87 8725
d)	Village	Mala
e)	District and Pin-code	Pauri Garhwal - 249304
f)	State	Uttarakhand
g)	Total No. of Family Members	5
h)	Contact No.	9027267519
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	6 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Lady Finger / Bhindi / Okra
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Rainfall Field
h)	Detail of Livestock (name/number)	2
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.30 (0.5 Bigha)
m)	Previous Crop in the Experimental Field	Wheat
n)	Next Crop in the Experimental Field	Lady Finger / Bhindi / Okra
o)	Fertilizer detail to be used in Field Trial/Trials	Jaivik Khad

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2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

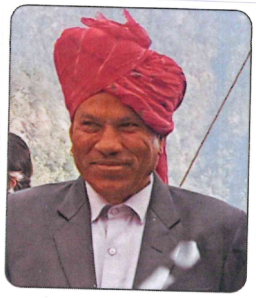
Anand Singh

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Patanjali Research Foundation (PRF)	Patanjali Organic Research Institute (PORI)	National Mission for Clean Ganga (NMCG)



PROFORMA

	1. INFORMATION OF FARMER AND FAMILIY	
a)	Name of Farmer	Akbeer Singh.
b)	Gender	Male
c)	Aadhar Number	7938 6800 5469
d)	Village	Mala
e)	District and Pin-code	Pauri - Uttarkhand - 249304
f)	State	Uttarakhand
g)	Total No. of Family Members	3
h)	Contact No.	6397617771
	2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION	
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	5 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Lady Finger / Bhindi / Okra
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Rainfall Field
h)	Detail of Livestock (name/number)	2
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.30 Acre (0.5 Bigha)
m)	Previous Crop in the Experimental Field	Wheat
n)	Next Crop in the Experimental Field	Lady Finger / Bhindi / Okra
o)	Fertilizer detail to be used in Field Trial/Trials	Jaivik Khad.

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

अकबीर सिंह

Signature/Thumb impression of the Respondent

Signature of the Enumerator

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PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Babbar Singh
b)	Gender	Male
c)	Aadhar Number	753349630513
d)	Village	Mala
e)	District and Pin-code	Pauri - Garhwal - 249304
f)	State	Uttarakhand
g)	Total No. of Family Members	5
h)	Contact No.	6398221014
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	5 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Lady Finger / Bhindi / Okra
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Rainfall Field
h)	Detail of Livestock (name/number)	3
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.30 Acre (0.5 Bigha)
m)	Previous Crop in the Experimental Field	wheat
n)	Next Crop in the Experimental Field	Lady Finger / Bhindi / Okra
o)	Fertilizer detail to be used in Field Trial/Trials	DKC (Dharti Ka Chowkidar)

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

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Patanjali Research Foundation (PRF)	Patanjali Organic Research Institute (PORI)	National Mission for Clean Ganga (NMCG)



PROFORMA

	1. INFORMATION OF FARMER AND FAMILIY	
a)	Name of Farmer	Rajpal
b)	Gender	Male
c)	Aadhar Number	9831 1595 8300
d)	Village	Mala -
e)	District and Pin-code	Pauri - Garhwal - 249304
f)	State	Uttarakhand
g)	Total No. of Family Members	5
h)	Contact No.	9910 74 34 58
	2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION	
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	4 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full Time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	गेहूँ दाल
f)	Ever used Ganga sludge directly or any of its products in the field	NO
g)	Mode of Irrigation	Rainfall field
h)	Detail of Livestock (name/number)	3
i)	Awareness about soil testing and organic farming and their related Government Schemes	NO
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	NO
k)	Participation in any Government Scheme	NO
l)	Total Area allotted for Field trials	0.30 Acre (0.5 Bigha)
m)	Previous Crop in the Experimental Field	Potato
n)	Next Crop in the Experimental Field	गेहूँ दाल
o)	Fertilizer detail to be used in Field Trial/Trials	Pori Potash

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2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

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Signature of the Project Head

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PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Vikram Singh Negi
b)	Gender	Male
c)	Aadhar Number	6111 4953 0204
d)	Village	Mala
e)	District and Pin-code	Pauri - Garhwal - 249304
f)	State	Uttarakhand
g)	Total No. of Family Members	3
h)	Contact No.	9718920180
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	5 Bigha
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Capsicum
f)	Ever used Ganga sludge directly or any of its products in the field	No
g)	Mode of Irrigation	Rainfall Field-
h)	Detail of Livestock (name/number)	1
i)	Awareness about soil testing and organic farming and their related Government Schemes	No
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	No
k)	Participation in any Government Scheme	No
l)	Total Area allotted for Field trials	0.30 Acre (0.5 Bigha)
m)	Previous Crop in the Experimental Field	Spinach
n)	Next Crop in the Experimental Field	Capsicum
o)	Fertilizer detail to be used in Field Trial/Trials	Jaivik Prom

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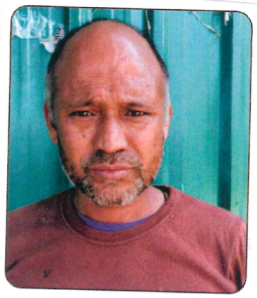
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head



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PROFORMA

1. INFORMATION OF FARMER AND FAMILIY		
a)	Name of Farmer	Hukam Singh Negi
b)	Gender	Male
c)	Aadhar Number	3459 5008 7182
d)	Village	Hala .
e)	District and Pin-code	Pauri - Garhwal , 249304
f)	State	uHarkhand
g)	Total No. of Family Members	4
h)	Contact No.	9027953768
2. AGRICULTURE AND SOCIO-CULTURAL INFORMATION		
a)	Livelihood Practices	Agriculture
b)	Total Agriculturally Cultivable Land	3 Bighe,
c)	Agricultural Practices (full-time or part-time, commercial, etc.)	Full time
d)	Types of farming (Traditional/Organic/ Inorganic/Integrated)	Integrated
e)	Crops under Cultivation	Onion
f)	Ever used Ganga sludge directly or any of its products in the field	NO
g)	Mode of Irrigation	Rainfall
h)	Detail of Livestock (name/number)	1
i)	Awareness about soil testing and organic farming and their related Government Schemes	NO
j)	Use of Social platforms for Marketing and Selling of Agricultural Products	NO
k)	Participation in any Government Scheme	NO
l)	Total Area allotted for Field trials	0.30 Acre (0.5 Bigha)
m)	Previous Crop in the Experimental Field	Spadodo .
n)	Next Crop in the Experimental Field	Onion
o)	Fertilizer detail to be used in Field Trial/Trials	Jaivik Khad

1. I declare that the above information is correct as per my knowledge.
2. It is further declared that I am working with Patanjali Organizations (PRF and PORI) and the National Mission for Clean Ganga (NMCG) for agriculture field trials based on Ganaga Sludge-based Organic fertilizers. I will not use any inorganic agriculture product (fertilizers and pesticides, etc.) in the trial field crop/ crops during the experimentation.

हुकम सिंह

Signature/Thumb impression of the Respondent

Signature of the Enumerator

Signature of the Project Head

Annexure V Final List of farmers information (District-wise)

LIST OF FARMERS AND THEIR DETAILED INFORMATION
(DISTRICT - HARIDWAR)

Sr. No.	Name	Address with Aadhar Number and Mobile Number	Field Area With Khasra No.	Crop	Previous Crop	Irrigation Mode	Manure Selected
1.	Sachin Saini	Village- Ahmedpur Grant Aadhar No.- 806718668307 Mob. No.- 9720151030	Area- 0.60 Acre (1 Bigha) Khasra No. 1045	Rice (60 Days)	Sugarcane	Tubewell	Jaivik Khad
2.	Aakash Saini	Village- Jaswawala Aadhar No.- 492419699854 Mob. No.- 8006856209	Area- 0.30 Acre (0.5 Bigha) Khasra No. 00096	Bhindi/ Lady Finger/ Okra	Onion	Tubewell	Dharti Ka Chowkidar (DKC)
3.	Mangeram Saini	Village- Sherpur Aadhar No.- 621184464072 Mob. No.- 9719146194	Area- 0.60 Acre (1 Bigha) Khasra No.120	Sugarcane	Wheat	Tubewell	Jaivik Prom
4.	Yugveer Singh	Village- Bhogpur Aadhar No.- 709204859162 Mob. No.- 9758087561	Area- 0.30 Acre (0.5 Bigha) Khasra No.1064	Sugar cane	Sugar Cane	Tubewell	Jaivik Prom
5.	Yasveer Singh	Village- Bhogpur Aadhar No.- 427519474031 Mob. No- 9758024538	Area-0.30 Acre (0.5 Bigha) Khasra No.400 अ	Sugarcane	Mustard	Tubewell	Jaivik Khad
6.	Dhani Ram	Village- Bhogpur Aadhar No.- 552566766837 Mob. No.- 9758556280	Area- 0.60 Acre (1 Bigha) Khasra No. 584	Sugarcane	Sugarcane	Tubewell	Jaivik Khad
7.	Sonu Kumar	Village- Bhogpur Aadhar No.-855278773071 Mob. No.- 9012229191	Area-0.30 Acre (0.5 Bigha) Khasra No. 400	Sugarcane	Sugarcane	Tubewell	Jaivik Prom
8.	Tilak Raj	Village- Tilakpuri Aadhar No.- 531660499204 Mob. No.- 9719582163	Area- 0.60 Acre (1 Bigha) Khasra No. 1648	Sugarcane	Paddy	Tubewell	Natural Pori Potash
9.	Suresh Kumar	Village- Bhogpur Aadhar No.- 963814392496 Mob. No.- 9719517797	Area- 0.30 Acre (0.5 Bigha) Khasra No. 365	Sugarcane	Mustard	Tubewell	Dharti Ka Chowkidar (DKC)
10.	Harsh Kumar	Village- Manu bans Aadhar No.-713728777709 Mob. No.- 9719474111	Area-0.60 Acre (1 Bigha) Khasra no. 97	Sugarcane	Sugarcane	Tubewell	Natural Pori Potash
11.	Mahepal	Village- Sohalpur Sikrodha Aadhar No.- 763055357910 Mob. No.- 9027298715	Area- 0.60 Acre (1 Bigha) Khasra No.	Brinjal	Cabbage	Tubewell	Jaivik Khad
12.	Munna Lal	Village- Ibrahimpur Masahi Aadhar No.- 931776066266 Mob- 7351420503	Area- 0.30 Acre (0.5 Bigha) Khasra No. 199	Menthol	Wheat	Tubewell	Jaivik Prom
13.	Ram Kumar	Village- Sohalpur Sikrodha Aadhar No.- 805842690169 Mob. No.- 9758054029	Area- 0.60 Acre (1 Bigha) Khasra No.	Brinjal	Wheat	Tubewell	Jaivik Khad

Sr. No.	Name	Address with Aadhar Number and Mobile Number	Field Area With Khasra No.	Crop	Previous Crop	Irrigation Mode	Manure Selected
14.	Madan Pal	Village- Bhogpur Aadhar no.- 364031918630 Mob. No.- 9758953587	Area- 0.60 Acre (1 Bigha) Khasra No. 269	Sugarcane	Wheat	Tubewell	Natural Pori Potash
15.	Ram Singh	Village- Daulatpur Aadhar No.- 222775477035 Mob. No.- 9917265031	Area- 0.60 Acre (1 Bigha) Khasra No.	Black Gram (Urad)	Wheat	Tubewell	Jaivik Khad
16.	Dhyan Singh	Village- Daulatpur Aadhar No.- 425842206200 Mob. No.- 7464807074	Area- 0.60 Acre (1 Bigha) Khasra No.	Bhindi/Lady Finger/Okra	Brinjal	Tubewell	Natural Pori Potash
17.	Balram	Village- Daulatpur Aadhar No.- 411069344944 Mob. No.- 8077979194	Area- 0.60 Acre (1 Bigha) Khasra No.	Cowpea (Lobiya)	Wheat	Tubewell	Dharti Ka Chowkidar (DKC)

LIST OF FARMERS AND THEIR DETAILED INFORMATION (DISTRICT - DEHRADUN)

Sr. No.	Name	Address with Aadhar Number and Mobile Number	Field Area With Khasra No.	Crop	Previous Crop	Irrigation Mode	Manure Selected
1.	Kunwar Singh	Village- Resham Majri Grant Aadhar No.- 221200039001 Mob. No.- 7351349848	Area- 0.60 Acre (1 Bigha) Khasra No. 4938	Basil (Tulsi)	Dill (Soya)	Canal	Dharti Ka Chowkidar (DKC)
2.	Devender Singh	Village- Resham Majri Grant Aadhar No.- 950425587622 Mob. No.- 9758727662	Area- 0.30 Acre (0.5 Bigha) Khasra No.	Bhindi/Lady Finger/Okra	Sugarcane	Canal	Jaivik Khad
3.	Yaspal Singh	Village- Resham Majri Grant Aadhar No.- 393653542729 Mob. No.- 9758122830	Area- 0.30 Acre (0.5 Bigha) Khasra No. 357 ख	Amaranth (Cholai)	Wheat	Canal	Jaivik Khad
4.	Chaitan	Village- Resham Majri Grant Aadhar No.- 716573081776 Mob. No.- 9528086048	Area-0.60 Acre (1 Bigha) Khasra No. 4937	Mint	Coriander	Canal	Dharti Ka Chowkidar (DKC)
5.	Nikhil Kumar	Village- Resham Majri Grant Aadhar No.- 201820334067 Mob. No.- 9761419006	Area- 0.30 Acre (0.5 Bigha) Khasra No.	Amaranth (Cholai)	Sugarcane	Canal	Dharti Ka Chowkidar (DKC)
6.	Satypal Singh	Village- Resham Majri Grant Aadhar No.-509135165854 Mob. No.-9690266833	Area- 0.60 Acre (1 Bigha) Khasra No.1386	Bhindi/ Lady Finger/ Okra	Spinach	Canal	Dharti Ka Chowkidar (DKC)
7.	Hritik Kumar	Village- Resham Majri Grant Aadhar No.- 200078533308 Mob. No.- 9548096811	Area- 0.60 Acre (1 Bigha) Khasra No.1386	Bitter Gourd (Karela)	Spinach	Canal	Jaivik Khad
8.	Kuldeep Saini	Village- Bheemawala Aadhar No.- 864283037428 Mob.No.- 9319193953	Area- 0.30 Acre (0.5 Bigha) Khasra No.	Bhindi/Lady Finger/Okra	Cabbage	Tubewell	Dharti Ka Chowkidar (DKC)
9.	Tara Chand Saini	Village- Jassowala Aadhar No.- 248683485051 Mob. No.- 9634969118	Area- 0.30 Acre (0.5 Bigha) Khasra No. 320	Cucumber	Cauliflower	Tubewell	Dharti Ka Chowkidar (DKC)

Sr. No.	Name	Address with Aadhar Number and Mobile Number	Field Area With Khasra No.	Crop	Previous Crop	Irrigation Mode	Manure Selected
10.	Sachin Saini	Village- Jassowala Aadhar no- 938773177556 Mob. No.- 7060796758	Area-0.60 Acre (1 Bigha) Khasra No.289	Sugarcane	Sugarcane	Tubewell	Natural Pori Potash
11.	Ramesh Chand	Village- Parteetpur Aadhar No.- 234630577305 Mob. 9720517808	Area- 0.60 Acre (1 Bigha) Khasra No.512	Sugarcane	Barley (Sorghum)	Tubewell	Natural Pori Potash
12.	Rajender Singh	Village- Jamnipur (Goodrich T-State) Aadhar No.- 484146172877 Mob. No.- 9536271818	Area- 0.60 Acre (1 Bigha) Khasra No.	Bhindi/ Lady Finger/ Okra	Cabbage	Tube well	Jaivik Khad
13.	Ashish Kumar	Village- Jamnipur (Goodrich T-State) Aadhar No.- 541086018632 Mob. No.- 9410379770	Area- 0.60 Acre (1 Bigha) Khasra No.	Bhindi/ Lady Finger/ Okra	Spinach	Tubewell	Jaivik Prom
14.	Shubham	Village- Jamnipur (Goodrich T-State) Aadhar No.- 218704794106 Mob. No.- 8936988144	Area- 0.60 Acre (1 Bigha) Khasra No.	Bhindi/ Lady Finger/ Okra	Cabbage	Tubewell	Jaivik Khad
15.	Jitender Singh	Village- Jassowala Aadhar No.- 721323625063 Mob.No.- 9758901201	Area- 0.60 Acre (1 Bigha) Khasra No. 644	Sugarcane	Sugarcane	Tubewell	Natural Pori Potash
16.	Aryan Saini	Village- Jassowala Aadhar No.- 661299555797 Mob. No.- 8171980568	Area- 0.30 Acre (0.5 Bigha) Khasra No. 320	Cucumber	Cabbage	Tubewell	Natural Pori Potash
17.	Rishi Pal	Village- Jassowala Aadhar No.- 22209937217 Mob.No.- 9719220025	Area- 0.60 Acre (1 Bigha) Khasra No.	Sweet Corn	Cauliflower	Tubewell	Jaivik Khad

LIST OF FARMERS AND THEIR DETAILED INFORMATION
(DISTRICT - UTTARKASHI)

Sr. No.	Name	Address with Aadhar Number and Mobile Number	Field Area With Khasra No.	Crop	Previous Crop	Irrigation Mode	Manure Selected
1	Chatar Singh	Village- Setwari Aadhar No.- 975209116478 Mob. No.- 9389248355	Area- 0.30 Acre (0.5 Bigha) Khasra No. 1258,1262	Tomato	Rajma	Pond	Natural Pori Potash
2	Inder Singh	Village- Diyari Aadhar No.- 245575544818 Mob. No.- 7818827375	Area- 0.30 Acre (0.5 Bigha) Khasra No.	Tomato	Arbi	Pond	Natural Pori Potash
3	Bhagtu Lal	Village- Setwari Aadhar No.- 367870320819 Mob. No.- 9389052320	Area- 0.60 Acre (1 Bigha) Khasra No.133	Capsicum	Pea	Pond	Jaivik Prom
4	Gulabu Singh	Village- Setwari Aadhar No.- 631070023143 Mob. No.- 9258098126	Area- 0.30 Acre (0.5 Bigha) Khasra No.132	Tomato	Pea	Pond	Jaivik Prom

Sr. No.	Name	Address with Aadhar Number and Mobile Number	Field Area With Khasra No.	Crop	Previous Crop	Irrigation Mode	Manure Selected
5	Dinesh Panwar	Village- Rikhaun Aadhar No.- 292246537883 Mob. No.- 9456743448	Area- 0.60 Acre (1 Bigha) Khasra No.1761	Tomato	Pea	Pond	Jaivik Khad
6	Pyar Singh	Village- Rikhaun Aadhar No.- 399452273832 Mob. No.- 8218774723	Area- 0.60 Acre (1 Bigha) Khasra No.213	Tomato	Beans	Pond	Dharti Ka Chowkidar (DKC)
7	Meena Devi	Village- Rikhaun Aadhar No.- 317795879410 Mob. No.- 9411139490	Area- 0.60 Acre (1 Bigha) Khasra No.214	Sweet Corn	Onion	Pond	Jaivik Khad

LIST OF FARMERS AND THEIR DETAILED INFORMATION
(DISTRICT - TEHRI GARHWAL)

Sr. No.	Name	Address with Aadhar Number and Mobile Number	Field Area With Khasra No.	Crop	Previous Crop	Irrigation Mode	Manure Selected
1.	Mahipal Singh	Village- Bhut Gaon (Dwarikapuri) Aadhar No.- 752304583665 Mob. No.- 9997138409	Area- 0.60 Acre (1 Bigha) Khasra No.	Capsicum	Rice	Pond	Jaivik Khad
2.	Surbeer Singh	Village- Bhut Gaon (Dwarikapuri) Aadhar No.- 920517321331 Mob. No.- 7055153457	Area- 0.60 Acre (1 Bigha) Khasra No.	Capsicum	Rice	Pond	Jaivik Khad
3.	Rajender Singh	Village- Bhut Gaon (Dwarikapuri) Aadhar No.- 771140753037 Mob. No.- 7579465558	Area- 0.30 Acre (0.5 Bigha) Khasra No.	Capsicum	Rice	Pond	Dharti Ka Chowkidar (DKC)
4.	Jasveer Singh	Village- Bhut Gaon (Dwarikapuri) Aadhar No.- 784537653184 Mob. No.- 9389958217	Area- 0.30 Acre (0.5 Bigha) Khasra No.	Capsicum	Rice	Pond	Natural Pori Potash
5.	Jaspal Chauhan	Village- Bhut Gaon (Dwarikapuri) Aadhar No.- 832174033834 Mob. No.- 8433262973	Area- 0.30 Acre (0.5 Bigha) Khasra No.	Tomato	Rice	Pond	Natural Pori Potash

LIST OF FARMERS AND THEIR DETAILED INFORMATION
(DISTRICT - PAURI GARHWAL)

Sr. No.	Name	Address with Aadhar Number and Mobile Number	Field Area With Khasra No.	Crop	Previous Crop	Irrigation Mode	Manure Selected
1.	Anand Singh	Village- Mala Aadhar No.- 496632878725 Mob. No.- 9027267519	Area- 0.30 Acre (0.5 Bigha) Khasra No.4129	Bhindi/ Lady Finger/ Okra	Wheat	Rainfall Field	Jaivik Khad
2.	Akbeer Singh	Village- Mala Aadhar No.- 793868005469 Mob. No.- 6397617771	Area- 0.30 Acre (0.5 Bigha) Khasra No.4129	Bhindi/ Lady Finger/ Okra	Wheat	Rainfall Field	Jaivik Khad
3.	Gabbar Singh	Village- Mala Aadhar No.- 753349630513 Mob. No.- 6398221014	Area- 0.30 Acre (0.5 Bigha) Khasra No.4129	Bhindi/ Lady Finger/ Okra	Wheat	Rainfall Field	Dharti Ka Chowkidar (DKC)
4.	Rajpal	Village- Mala Aadhar No.- 983115958300 Mob. No.- 9910743458	Area- 0.30 Acre (0.5 Bigha) Khasra No.4145	Cholai (Amaranth)	Potato	Rainfall Field	Natural Pori Potash
5.	Vikram Singh Negi	Village- Mala Aadhar No.- 611149530204 Mob. No.- 9718920180	Area- 0.30 Acre (0.5 Bigha) Khasra No.4145	Capsicum	Spinach	Rainfall Field	Jaivik Prom
6.	Hukum Singh Negi	Village- Mala Aadhar No.- 345950087182 Mob. No.- 9027953768	Area- 0.30 Acre (0.5 Bigha) Khasra No.4145	Onion	Potato	Rainfall Field	Jaivik Khad

Annexure VI DKD CERTIFICATE



BHARUWA AGRI SCIENCE

Reg. No. NMCG/PORI/001

Hands-on Training on

Dharti ka Doctor

Soil Testing Kit

Certificate

This is to certify that Ms./Mr. Sachin Saini *S/O-D/O.* Surendra Singh

Village/District Ahmedpur,Haridwar *has successfully completed the hands-on training on Dharti Ka Doctor Soil Testing Kit on* 16-4-2025

Dr. Acharya Balkrishna
Co-founder,
Patanjali Institutes

Dr. Vedpriya Arya
Scientist-E & Head
Patanjali Research Foundation

Dr. Ajay K. Gautam
Scientist
Patanjali Research Foundation

Scan this QR code to see certificates distributed to farmers on DKD Soil Testing training.

Annexure VII DKD Kit - Soil Health Cards (with recommendations)



Dharti ka Doctor
Soil Health Report

Sample No	DKD0000293050800000000165202	**State**	Uttarakhand
Sample date	28/06/2025	**District**	Dehradun
Farmer name	KUNWAR SINGH	**City**	Doiwala
Father name	DHULI CHAND	**Block**	Doiwala
Khasra Number	4938	**Village name**	Resham majri
Farm size	0.60 Acre	**Pin code**	248140
Mobile Number	7351349848	**Soil color**	Black
Gender	Male	**Soil type**	Clay soil
Current crop Name	Tulsi	**Season**	Kharif
Previous Crop Name	Dill (Soya)	**Drainage type**	Rapid
Irrigation Source	Canal	**Soil depth**	30cm
Test type	6Test	**Electricty Connection**	No
Preferred Report Language	English	**GPS Location**	30.148706,78.156999
		Status	Server





Boundary Area:729.7041 square meters



pH **Slightly Acidic**	Ec **Salt Free**
Organic Carbon **Medium**	Available Nitrogen **Low**
Available Phosphorus **Very High**	Available Potassium **Medium**

Sample Number (Barcode) : NMCGD001

Fertilizer Recommendations

According to the soil health card, fertilizer recommendations tailored to the specific area have been provided for each mentioned crop.

Organic Farming 100%

Fertilizer	Wheat	Sugarcane	Paddy	Mustard	Potato	Gram
F.Y.M (quintal)	4.80	4.80	4.80	4.80	4.80	4.80
RP (quintal)	0.60	0.60	0.60	0.60	0.60	0.60
P.S.B. (ml)	300.00	300.00	300.00	300.00	300.00	300.00
K.M.B. (ml)	300.00	300.00	300.00	300.00	300.00	300.00

Chemical 100%

Fertilizer	Wheat	Sugarcane	Paddy	Mustard	Potato	Gram
Urea (kg)	178.00	178.00	139.00	144.00	210.00	15.00
D.A.P. (kg)	40.00	40.00	40.00	27.00	55.00	27.00
M.O.P (kg)	49.00	62.00	49.00	49.00	98.00	25.00
SSP. (kg)	50.00	50.00	50.00	34.00	67.00	34.00

Organic 75% - Chemical 25%

Fertilizer	Wheat	Sugarcane	Paddy	Mustard	Potato	Gram
Urea (kg)	133.50	133.50	104.25	108.00	157.50	11.25
D.A.P. (kg)	30.00	30.00	30.00	20.25	41.25	20.25
M.O.P (kg)	36.75	46.50	36.75	36.75	74.25	18.75
SSP. (kg)	37.50	37.50	37.50	25.50	50.25	25.50
Organic/bio fertilizer						
F.Y.M. (quintal)	1.20	1.20	1.20	1.20	1.20	1.20
RP (quintal)	0.15	0.15	0.15	0.15	0.15	0.15
P.S.B. (ml)	75.00	75.00	75.00	75.00	75.00	75.00
K.M.B. (ml)	75.00	75.00	75.00	75.00	75.00	75.00

Organic 50% - Chemical 50%

Fertilizer	Wheat	Sugarcane	Paddy	Mustard	Potato	Gram
Urea (kg)	89.00	89.00	69.50	72.00	105.00	7.50
D.A.P. (kg)	20.00	20.00	20.00	13.50	27.50	13.50
M.O.P (kg)	24.50	31.00	24.50	24.50	49.50	12.50
SSP. (kg)	25.00	25.00	25.00	17.00	33.50	17.00
Organic/bio fertilizer						
F.Y.M. (quintal)	2.40	2.40	2.40	2.40	2.40	2.40
RP (quintal)	0.30	0.30	0.30	0.30	0.30	0.30
P.S.B. (ml)	150.00	150.00	150.00	150.00	150.00	150.00
K.M.B. (ml)	150.00	150.00	150.00	150.00	150.00	150.00

Organic 25% - Chemical 75%

Fertilizer	Wheat	Sugarcane	Paddy	Mustard	Potato	Gram
Urea (kg)	44.50	44.50	34.75	36.00	52.50	3.75
D.A.P. (kg)	10.00	10.00	10.00	6.75	13.75	6.75
M.O.P (kg)	12.25	15.50	12.25	12.25	24.75	6.25
SSP. (kg)	12.50	12.50	12.50	8.50	16.75	8.50
Organic/bio fertilizer						
F.Y.M. (quintal)	3.60	3.60	3.60	3.60	3.60	3.60
RP (quintal)	0.45	0.45	0.45	0.45	0.45	0.45
P.S.B. (ml)	225.00	225.00	225.00	225.00	225.00	225.00
K.M.B. (ml)	225.00	225.00	225.00	225.00	225.00	225.00

Micro Fertilizer

Fertilizer	Wheat	Sugarcane	Paddy	Mustard	Potato	Gram
Zinc Sulphate (kg)	N/A	N/A	N/A	N/A	N/A	N/A
Ferrous Sulphate (kg)	N/A	N/A	N/A	N/A	N/A	N/A
Manganese Sulphate (kg)	N/A	N/A	N/A	N/A	N/A	N/A
Borax (kg)	N/A	N/A	N/A	N/A	N/A	N/A
Dust Sulphur–90% (kg)	N/A	N/A	N/A	N/A	N/A	N/A
Copper Sulphate (kg)	N/A	N/A	N/A	N/A	N/A	N/A

Authorized Signatory

Note: N/A (No application required)

Package of practices for seed selection, fertilizer and agricultural management under favorable weather conditions.

General Recommendations:

1. When adopting organic farming, the farmer is advised to use organic fertilizers which supply phosphorus and potassium to the crops. However, the authenticity of these materials should be checked before they are used in the field.
2. If single super phosphate (SSP) is not available when adopting chemical farming, then increase the amount of DAP to 1/3 of the recommended amount of SSP and reduce the amount of urea nitrogen to 1/3 of the recommended amount of SSP.
3. N (Urea) Usage: Apply 1/2 part of Nitrogen at the time of sowing of the crop, remaining half should be given 20-25 days after sowing (with first irrigation) in all crops except sugarcane. In sugarcane crop, 1/2 nitrogen is applied at the time of sowing and the remaining 1/2 part in two parts, after 60-70 days and 105-115 days of ploughing, respectively.

Note:

- Soil test report results may vary according to cropping pattern in the field.
- The soil test report is as per the soil sampling procedure adopted and cannot be produced in judicial cases as it does not have any legal validity.
- This DKD machine was validated by CSSRI-ICAR (Karnal).
- In this machine, available nitrogen is determine as an ammoniacal form.

Contact

Bharuwa Agri Science Pvt. Ltd. Agriculture Research Campus, Maal Prakarti, Maharishi Dayanand Near Shantershah Village, Bahadrabad, Haridwar- 249405, UK (India)
www.soilhealthcard.org info@soilhealthcard.org

Scan this QR code to see Soil Health Cards with recommendations generated through DKD Kit.

Annexure VIII DKD Machine -Soil Health Cards (with recommendations)

Soil Health Card

Farmer Details

Farmer name : Sachin Saini

Father/Husband name : X

Address : Ahmedpur,Bahadrabad,Bahadrabad, Haridwar, Uttarakhand, 249407

Current crops : Rice

Sample date : 24/07/2025

Mobile number : 9720151030

Soil type :

Drainage type : Rapid

Electricity connection : No

Soil Sample Details

Sample number (Barcode) : NMCGH001

Survey/Khasra/Dag number and area : 1046, (0.60 Acre)

Irrigation source : Tube well

Previous crops : Sugarcane

Khasra location (G.P.S) : 29.9036071, 77.9973103

Soil color : Brown

Season :

Soil depth : 15 cm

Soil Test Results

Soil Test Name	Unit	Result		
Potential of Hydrogen (pH)	---	8.17	Moderately Alkaline	
Electrical Conductivity (EC)	ds/m	0.52	Salt Free	
Organic Carbon (OC)	%	0.61	Medium	
Available Nitrogen (N)	Kg/ha	165.58	Low	
Available Phosphorus (P)	Kg/ha	35.88	High	
Available Potassium (K)	Kg/ha	69.96	Low	
Sulphur (S)	ppm	80.64	Sufficient	
Boron (B)	ppm	5.11	Sufficient	
Zinc (Zn)	ppm	2.50	Sufficient	
Copper (Cu)	ppm	1.40	Sufficient	
Iron (Fe)	ppm	27.10	Sufficient	
Manganese (Mn)	ppm	7.59	Sufficient	

Very Low, Low, Deficient, Acid Sulphate, Strongly Acidic, Highly Acidic, Strongly Alkaline, Moderately Saline, Highly Saline

Medium, Moderately Acidic, Moderately Alkaline, Slightly Saline

High, Very High, Sufficient, Neutral, Slightly Acidic, Salt Free

Sample Number (Barcode) : NMCGH001

Fertilizer Recommendations

According to the soil health card, fertilizer recommendations tailored to the specific area have been provided for each mentioned crop.

Organic Farming 100%

Fertilizer	Wheat	Sugarcane	Paddy	Mustard	Potato	Gram
F.Y.M (quintal)	4.80	4.80	4.80	4.80	4.80	4.80
RP (quintal)	0.60	0.60	0.60	0.60	0.60	0.60
P.S.B. (ml)	300.00	300.00	300.00	300.00	300.00	300.00
K.M.B. (ml)	300.00	300.00	300.00	300.00	300.00	300.00

Chemical 100%

Fertilizer	Wheat	Sugarcane	Paddy	Mustard	Potato	Gram
Urea (kg)	178.00	178.00	139.00	144.00	210.00	15.00
D.A.P. (kg)	40.00	40.00	40.00	27.00	55.00	27.00
M.O.P (kg)	49.00	62.00	49.00	49.00	98.00	25.00
SSP. (kg)	50.00	50.00	50.00	34.00	67.00	34.00

Organic 75% - Chemical 25%

Fertilizer	Wheat	Sugarcane	Paddy	Mustard	Potato	Gram
Urea (kg)	133.50	133.50	104.25	108.00	157.50	11.25
D.A.P. (kg)	30.00	30.00	30.00	20.25	41.25	20.25
M.O.P (kg)	36.75	46.50	36.75	36.75	74.25	18.75
SSP. (kg)	37.50	37.50	37.50	25.50	50.25	25.50
Organic/bio fertilizer						
F.Y.M. (quintal)	1.20	1.20	1.20	1.20	1.20	1.20
RP (quintal)	0.15	0.15	0.15	0.15	0.15	0.15
P.S.B. (ml)	75.00	75.00	75.00	75.00	75.00	75.00
K.M.B. (ml)	75.00	75.00	75.00	75.00	75.00	75.00

Organic 50% - Chemical 50%

Fertilizer	Wheat	Sugarcane	Paddy	Mustard	Potato	Gram
Urea (kg)	89.00	89.00	69.50	72.00	105.00	7.50
D.A.P. (kg)	20.00	20.00	20.00	13.50	27.50	13.50
M.O.P (kg)	24.50	31.00	24.50	24.50	49.50	12.50
SSP. (kg)	25.00	25.00	25.00	17.00	33.50	17.00
Organic/bio fertilizer						
F.Y.M. (quintal)	2.40	2.40	2.40	2.40	2.40	2.40
RP (quintal)	0.30	0.30	0.30	0.30	0.30	0.30
P.S.B. (ml)	150.00	150.00	150.00	150.00	150.00	150.00
K.M.B. (ml)	150.00	150.00	150.00	150.00	150.00	150.00

Organic 25% - Chemical 75%

Fertilizer	Wheat	Sugarcane	Paddy	Mustard	Potato	Gram
Urea (kg)	44.50	44.50	34.75	36.00	52.50	3.75
D.A.P. (kg)	10.00	10.00	10.00	6.75	13.75	6.75
M.O.P (kg)	12.25	15.50	12.25	12.25	24.75	6.25
SSP. (kg)	12.50	12.50	12.50	8.50	16.75	8.50
Organic/bio fertilizer						
F.Y.M. (quintal)	3.60	3.60	3.60	3.60	3.60	3.60
RP (quintal)	0.45	0.45	0.45	0.45	0.45	0.45
P.S.B. (ml)	225.00	225.00	225.00	225.00	225.00	225.00
K.M.B. (ml)	225.00	225.00	225.00	225.00	225.00	225.00

Micro Fertilizer

Fertilizer	Wheat	Sugarcane	Paddy	Mustard	Potato	Gram
Zinc Sulphate (kg)	N/A	N/A	N/A	N/A	N/A	N/A
Ferrous Sulphate (kg)	N/A	N/A	N/A	N/A	N/A	N/A
Manganese Sulphate (kg)	N/A	N/A	N/A	N/A	N/A	N/A
Borax (kg)	N/A	N/A	N/A	N/A	N/A	N/A
Dust Sulphur–90% (kg)	N/A	N/A	N/A	N/A	N/A	N/A
Copper Sulphate (kg)	N/A	N/A	N/A	N/A	N/A	N/A

Authorized Signatory

Note: N/A (No application required)

Package of practices for seed selection, fertilizer and agricultural management under favorable weather conditions.

General Recommendations:

1. When adopting organic farming, the farmer is advised to use organic fertilizers which supply phosphorus and potassium to the crops. However, the authenticity of these materials should be checked before they are used in the field.
2. If single super phosphate (SSP) is not available when adopting chemical farming, then increase the amount of DAP to 1/3 of the recommended amount of SSP and reduce the amount of urea nitrogen to 1/3 of the recommended amount of SSP.
3. N (Urea) Usage: Apply 1/2 part of Nitrogen at the time of sowing of the crop, remaining half should be given 20–25 days after sowing (with first irrigation) In all crops except sugarcane. In sugarcane crop, 1/2 nitrogen is applied at the time of sowing and the remaining 1/2 part in two parts, after 60–70 days and 105–115 days of ploughing, respectively.

Note:

- Soil test report results may vary according to cropping pattern in the field.
- The soil test report is as per the soil sampling procedure adopted and cannot be produced in judicial cases as it does not have any legal validity.
- This DKD machine was validated by CSSRI-ICAR (Karnal).
- In this machine, available nitrogen is determine as an ammoniacal form.

Contact

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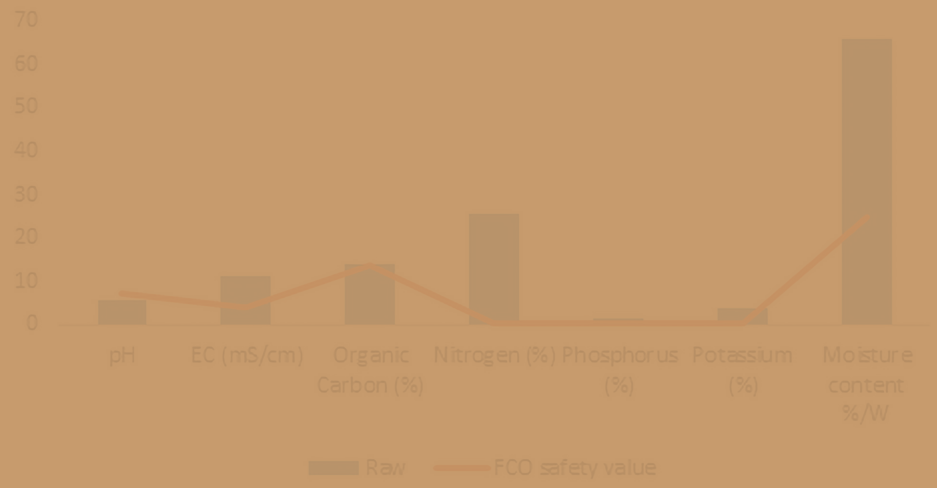
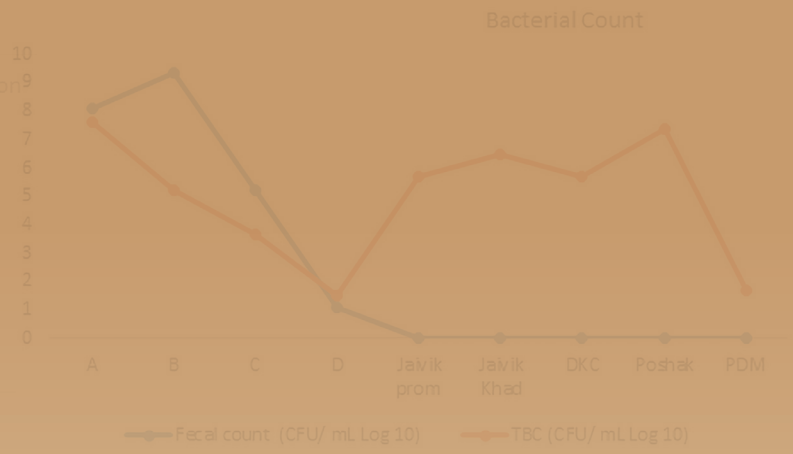
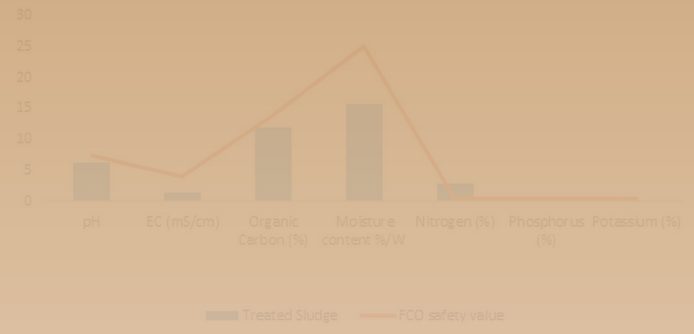
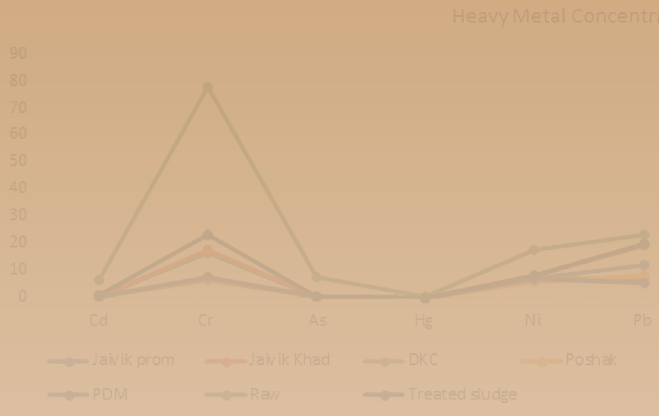
Scan this QR code to see Soil Health Cards with recommendations generated through DKD Machine.











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National Mission for Clean Ganga
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