REPORT

Advancing Nutrient Circularity through a Hub and Spoke Model in Kerala

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Technology and Governance Support Forum

TAGS

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Introduction

Project Background

The global challenge of waste management and nutrient loss is a critical issue affecting countries particularly in the global south. The unsustainable disposal of organic materials not only contributes to environmental degradation but also wastes valuable nutrients essential for soil fertility and plant growth. This study sets out to propose a solution to the pressing problems of waste management and loss of soil nutrient quality through the concept of nutrient circularity.

The organic waste crisis in the state of Kerala, India is inextricably linked to the flow of nutrients from the soil in the form of agricultural resources from rural to urban areas. The circularity of nutrient movement between urban and rural areas can be restored by recovering nutrients from solid waste in urban areas and transporting the same to rural areas, thus effectively closing the nutrient cycle. However, challenges, such as the economic costs of recovering and utilising nutrients (Cobo et al., 2019) and the incompatibility of urban sanitation practices with large-scale material recovery and recycling (Ordonez et al., 2015) to hinder this process. To address these barriers and to overcome implementation and upscaling challenges, political and administrative will is imperative.

In this context, Kerala's expertise and experience in decentralised planning exhibits great potential in solving this problem by engaging local governments in waste management and nutrient recovery programs. However, local governments, owing to their short terms and limited capacity, tend to look for immediate solutions. To aid the local government in realising this idea of nutrient circularity, it is essential to have a roadmap for LSGIs so that they can make informed decisions about the various links in the nutrient cycle. In this report, we present a hub and spoke nutrient recovery model for Alappuzha town and neighbouring cluster of villages located in Alappuzha legislative constituency. By mapping the different stakeholders from different institutions involved in nutrient supply and nutrient demand, and understanding their perspectives on the potential for such a model in the context of Alappuzha, we offer recommendations for the establishment and sustainable execution of the model in the district.

Hub and Spoke model

This study for addressing the crisis of waste management and nutrient loss revolves around the concept of nutrient circularity. This term underscores the efficient utilisation and recycling of organic nutrients through composting processes, ensuring that organic materials return to the soil as valuable alteration rather than being wasted. Various studies have indicated the success of nutrient circularity in enhancing soil fertility and reducing dependency on chemical fertilisers (Chiew et al., 2015). This approach not only addresses environmental concerns but also promotes a sustainable agricultural ecosystem where resources are utilised ideally.

The operationalization of this proposal is structured around the hub and spoke model (Figure 1), a framework proven effective in resource distribution across industries. In agriculture, this model facilitates the dissemination of farming knowledge, seeds, fertilisers, and equipment, enhancing productivity and sustainability. Central hubs serve as repositories of resources, ensuring timely access to essential agricultural inputs for rural communities. By optimising logistics and minimising costs, the hub and spoke model ensures timely access to essential nutrients and supports agricultural sustainability. This model's application in agriculture optimises supply chain logistics, reduces transportation costs, and improves input accessibility, thereby promoting agricultural development and rural empowerment (Sriram, 2015 and Nigussie et al., 2015).

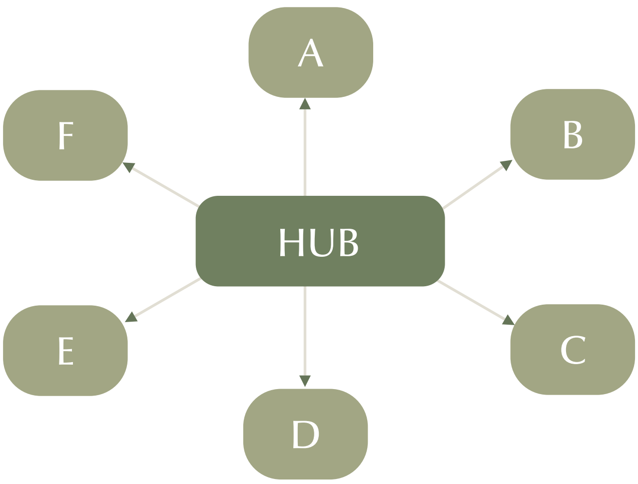


Figure 1 Hub and Spoke Model Diagram

Report Scope and Structure

The scope of this report pertains to the identification of challenges and analysis of potential of the Hub and Spoke model for efficient compost distribution, focusing on Alappuzha Municipality as the hub area and nearby panchayats as the spoke areas. The report is arranged into four main chapters. The first chapter serves as the introduction and is divided into three sections. The first section, Project Background, provides an overview of the project's study area, its objectives, and the primary question it seeks to address; the second introduces the Hub and Spoke Model, and finally, the third section details how the report is organized and outlines its content.

The second chapter, Methodology, explains the research methods used in this study. It begins with an overview of Alappuzha region's geographical and socio-economic context in the Hub Area. The Research Methods section details the approach undertaken to identify existing data and gaps, data collection methods, and criteria employed for selecting spoke areas, mapping stakeholders, and institutions.

The third chapter presents the findings of the study, divided into sections on the hub area and spoke areas. For the hub area- it provides an analysis of the current status of organic waste management, compost quality, and utilization, and the challenges of the existing waste management system. For the spoke areas, it examines agricultural practices, the status of agricultural inputs, and the potential scope for the use of waste-derived compost. This extensive analysis aims to highlight the strengths and weaknesses of the current system and identify opportunities for improvement.

The final chapter Concluding Remarks and Recommendations offers strategic recommendations based on the findings of the study. It provides targeted recommendations for the hub area and the main spoke areas, aimed at improving the efficiency and effectiveness of the Hub and Spoke model. The chapter also discusses the broader implications of the model for transitioning to a resilient circular bioeconomy, emphasising its potential to enhance community resilience and environmental sustainability.

Methodology

Hub area - Regional setting of Alappuzha

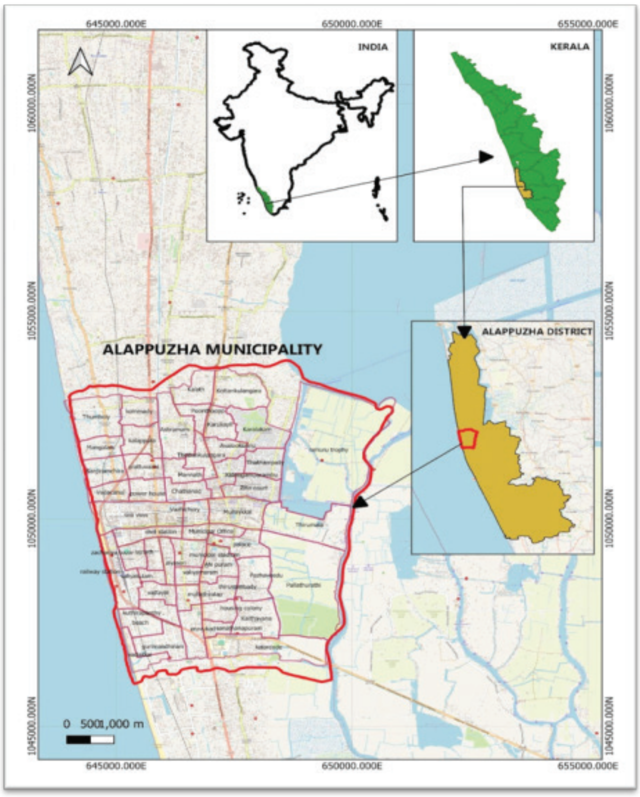


Figure 2 Location map of Alappuzha

Alappuzha Municipality is situated in the Ambalappuzha Taluk of Alappuzha district, occupying an area of 46.77 square kilometres in the state of Kerala, India. It encompasses several villages, including Pazhaveedu, Mullakkal, Vadacanal, Vazhichery, and Pallathurathi (Figure 2). Due to the presence of picturesque backwaters and serene beaches, the municipality attracts tourists from various parts of the world, making it a famous tourist spot and a key focus of local developmental efforts.

Administratively, Alappuzha Municipality comprises 52 wards, each playing a crucial role in local governance and administration. Beyond tourism, the municipality manages essential services such as water supply, sanitation, and infrastructure development.

Alappuzha Municipality serves as an ideal hub area for organic waste management due to its in place infrastructure in aerobic composting. Currently, the municipality operates 436 aerobic bins, which processes 8 to 10 tonnes of organic waste daily. An estimated one-third of the food waste processed by each aerobic bin—roughly 1500 kg—is turned into compost. This positions Alappuzha as a potential producer of organic compost in the region.

Research Methods

The methodology for assessing the viability of optimising organic compost distribution through a hub and spoke model involves several stages, as illustrated in Figure 3. The first part of the exercise was identifying a spoke area for this particular study. By identifying a single spoke area, we can direct our focus on understanding the challenges and barriers for utilising MSW derived compost from the hub area. Next, spoke area selection is based on criteria such as agricultural land area, crop diversity, soil texture, and the population of farmers. Different types of agricultural crop data (such as farmers population, soil texture etc) was collected from respective Krishi Bhavan of Aryad, Mannanchery, Mararikulam North, Mararikulam South, and Kanjikuzhy. After analysis of the data, spoke area was identified for further study.

The next step was identification and mapping of key stakeholders from the Hub and Spoke area. Stakeholder identification and mapping involves identifying all relevant parties, including farmers, government officials, and compost producers. A detailed questionnaire is prepared to gather insights from stakeholders, followed by interviews and focus group discussions (FGDs) to collect in-depth qualitative data. The findings from these discussions are then transcribed and documented. Finally, recommendations are formulated based on the analysis of the collected data and stakeholder inputs, aiming to optimise compost distribution and enhance agricultural productivity and sustainability through the hub and spoke model.

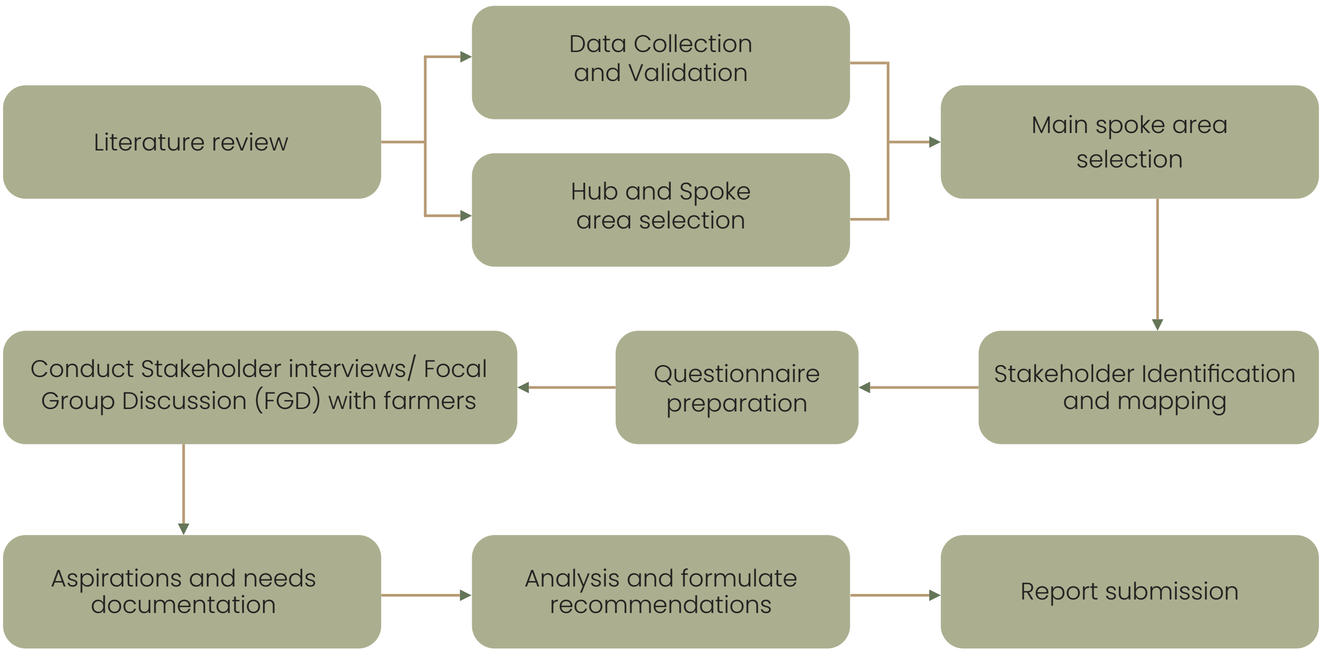


Figure 3 Methodology flowchart

Data discrepancies and data validation

The initial review identified discrepancies between data collected from the Kerala State Economics and Statistics Department and various Krishibhavans, confirmed through examination of their collection methods and records. These inconsistencies stem from differences in data aggregation levels and reporting standards. The state department provides macro-level data, while Krishibhavans offer detailed, localised information.

Additional data gaps were observed in several critical areas. Firstly, there were inconsistencies in crop diversity records, which varied significantly between different sources. Soil texture data was also incomplete, with some areas lacking updated information on soil composition and quality. Furthermore, there was a lack of comprehensive data on organic farming practices, including the extent and methods of organic cultivation in the selected panchayats. Inconsistent or outdated records from different sources highlighted the need for more synchronised and up-to-date data collection. For instance, some records were found to be outdated or not reflective of the current agricultural practices and land use patterns. Additionally, the data on compost demand and usage patterns was fragmented, with varying figures reported by different agencies.

To address these gaps, a comprehensive validation process was conducted, involving cross-referencing data points and field visits. This process confirmed that while Krishi Bhavan data is more detailed, it sometimes lacks the broader context provided by state-level reports. It also underscored the need for more frequent updates and a unified data collection methodology to ensure accuracy and reliability.

Questionnaire Preparation

Five sets of questionnaires included as appendices, were prepared for interviews at the hub and spoke areas. Two of these are for the hub area: one for officials at Alappuzha Municipality and the other for sanitation workers. Three are for the spoke area: one for officials at spoke area, another for some main farmers engaged in organic farming, and the third for farmers who already produce compost from their food and agricultural waste and use it in their farming. An additional questionnaire was prepared for the focal group discussion (FGD) with farmers. All these questionnaires are designed to capture the perspectives of stakeholders.

- Hub Area Questionnaire: Aimed at understanding the current challenges in compost production at Alappuzha Municipality, their future plans, and aspirations for using compost in agriculture.

- Spoke Area Questionnaire: Aimed at understanding the aspirations and needs of using municipal compost in agriculture at the spoke area, and their compost demand and the reasons behind it.

Spoke area selection

Identifying spoke areas involves analysing parameters like soil texture, crop diversity, vegetable cultivation area, farmers' population, and agricultural land area. Panchayats with larger agricultural land areas, diverse crops, suitable soil textures, significant vegetable cultivation, and a high population of farmers are ideal candidates. These criteria ensure that resources are allocated efficiently to areas with the highest demand for organic compost (Abebe Nigussie et al., 2015). The selection of specific panchayats (shown in Fig.4) to act as demanded spoke areas for compost is thus a strategic process influenced by various factors aimed at optimising resource allocation and enhancing agricultural output.

For the selection of the spoke area, a thorough analysis of several parameters is essential. These parameters include agricultural land area extent, crop diversity, soil texture, total population, agriculture-dependent population, and the rate of practising organic cultivation (Abebe Nigussie et al., 2015; Van Tuijl, E.,et al., 2018). Through the evaluation of these factors across various panchayats, it is possible to pinpoint the regions with the most significant potential demand for organic compost.

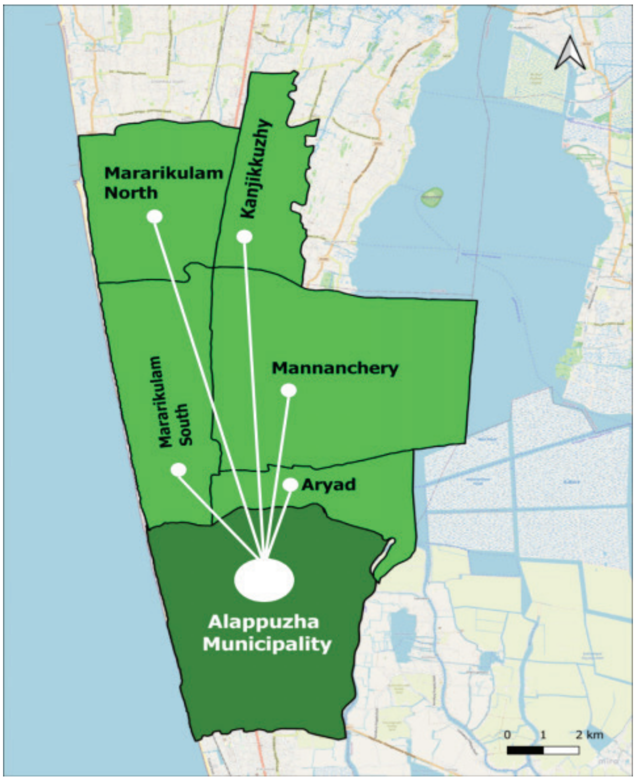


Figure 4 Hub and spoke study area map

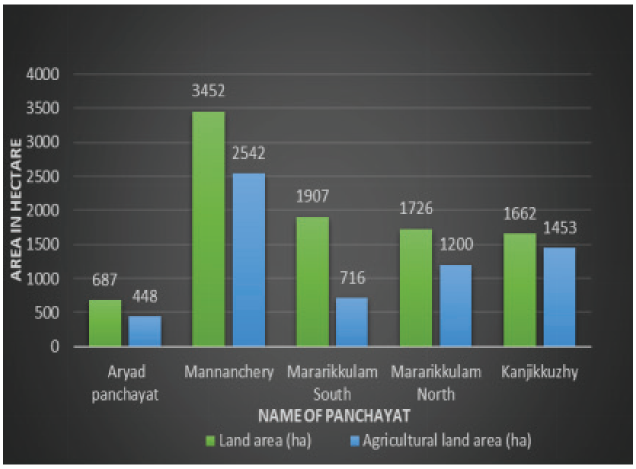


Figure 5 Panchayat wise agricultural land area (Source: Krishibhavan)

Understanding the agricultural land area helps in assessing the potential demand for compost as a soil amendment and fertiliser. Panchayats with larger agricultural land areas are likely to require more compost to maintain soil fertility and support crop growth. The panchayat wise agricultural land area corresponding to its total land area is shown through the bar graph in Figure 5. Based on information sourced from Krishi Bhavan, Mannanchery is noted for its expansive agricultural land,constituting approximately 74% of its total land area.

Following closely is Kanjikkuzhy, which reports extensive organic farming practices. Mararikulam North also holds a noteworthy position in agricultural activity. However, in Aryad Panchayat, despite its relatively smaller size, agriculture plays a significant role, with approximately 65% of its total area dedicated to agricultural land. Aryad Panchayat stands out for its vibrant vegetable cultivation, showcasing a pivotal role in the agricultural sector.

The main livelihoods of the residents offer valuable insights into the agricultural methods and the significance of farming within the local economy. Panchayats where agriculture serves as the primary occupation are expected to exhibit greater demand for compost.

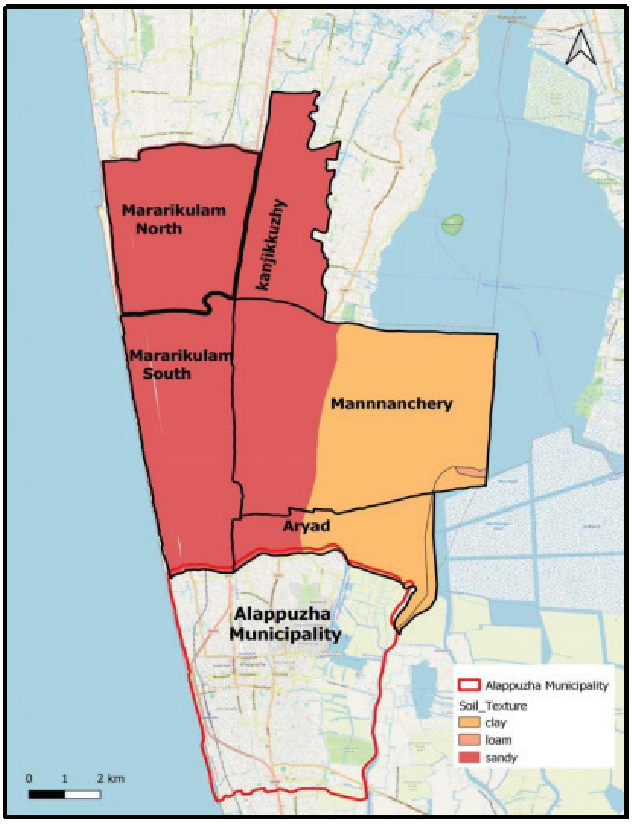


Figure 6 Soil texture map of spoke areas (Source: Krishibhavan)

Assessing soil texture holds immense importance as it directly impacts various aspects of agriculture. Sandy soil, in particular, plays a distinct role due to its unique characteristics compared to other soil textures. Sandy soil tends to have larger particles, which facilitate excellent drainage, allowing water to move through quickly. While this can lead to challenges with water retention, its loose structure enables roots to penetrate easily, aiding in root development. However, sandy soil typically has lower nutrient-holding capacity, necessitating more frequent addition of fertilisers. Despite these considerations, understanding soil texture, Figure 6 Soil texture map of spoke areas (Source: Krishibhavan)

including the sandy nature, is critical for optimising water management, drainage, and nutrient availability, ultimately enhancing agricultural productivity. Panchayats like Mararikulam North, Mararikulam South, and Kanjikuzhy predominantly feature sandy soil, whereas Mannanchery and Aryad panchayats exhibit a blend of sandy and clayey soil types. Additionally, Aryad boasts a small area with loamy soil, as depicted in Figure 6.

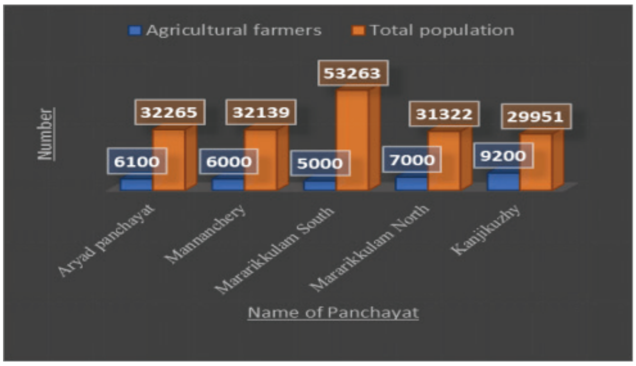


Figure 7 Panchayat wise farmers count versus population (Source: Census Report 2011)

The number of farmers engaged in agriculture is a significant parameter when selecting spoke areas as it aids in customising compost supply initiatives to precisely address the needs of the local farming communities, ensuring effective support and sustainable agricultural practices. Figure 7 shows the number of farmers involved in agriculture across panchayats around Alappuzha. Kanjikuzhy panchayat stands out with a significant proportion of its population engaged in agriculture, accounting for 30% of the total populace. In Mannanchery panchayat, although there are 6000 farmers, their numbers fluctuate annually due to their varying interests, many being seasonal workers rather than solely dependent on farming. Many among them are retired government employees, leading to diverse interests. Conversely, in the Kanjikuzhy panchayat, out of 9200 farmers, a significant majority are fully reliant on farming as their primary occupation. They engage in diverse cultivation activities, supported by numerous state and central government schemes facilitated through their respective Krishibhavans, aiming to enhance their yield. Following behind are Mararikulam North, Aryad, and Mannanchery panchayats, occupying the second, third, and fourth positions respectively in terms of agricultural farmer representation.

Considering crop diversity is paramount in agricultural planning, especially when evaluating compost demand in different spoke areas. Each crop has unique nutrient requirements, and a diverse range of crops necessitates a varied compost composition to meet these needs

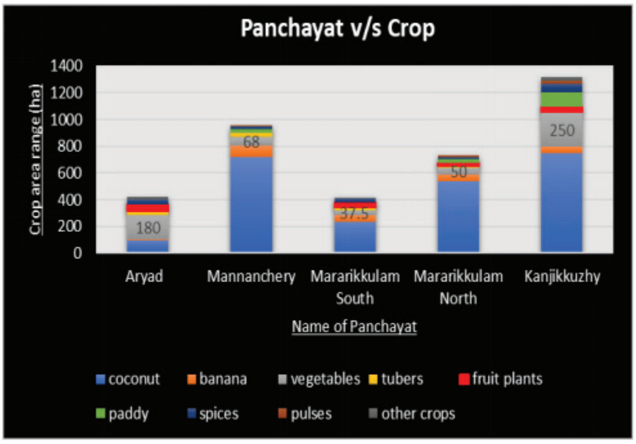
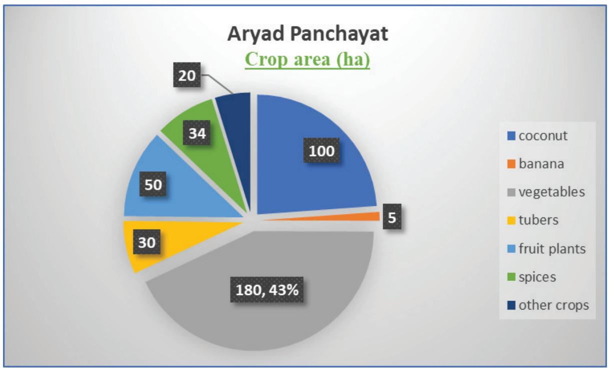
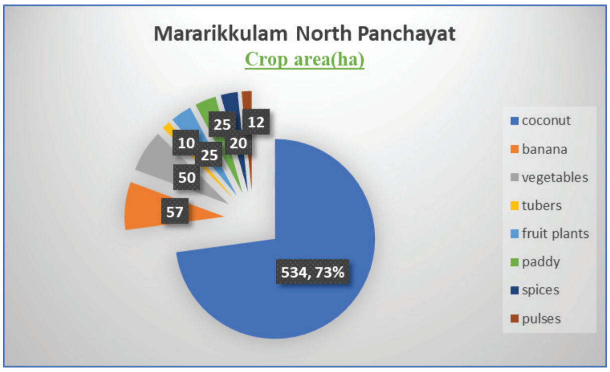


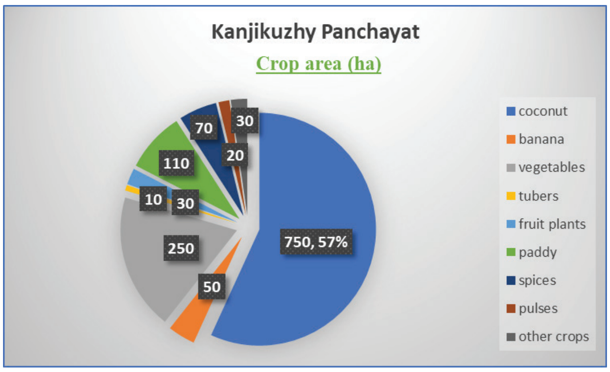
Figure8 Crop diversity in Panchayats

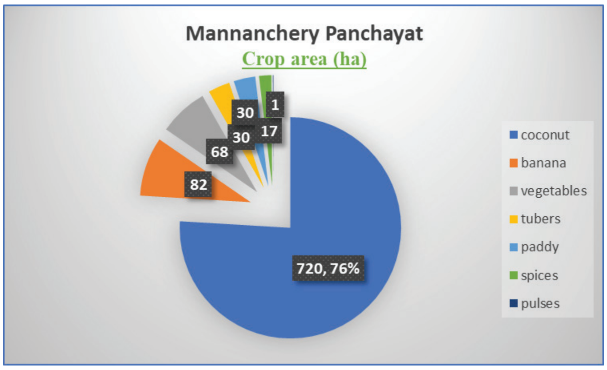
effectively. For instance, coconut and fruit plants may require different nutrient compared to vegetables or tubers. By strategically selecting spoke areas based on crop diversity, agricultural planners can ensure that compost production aligns with the nutrient demands of the crops cultivated in each region. This approach optimises soil health, enhances crop yields, and promotes sustainable agricultural practices across a broad spectrum of crops.

Analysing the agricultural data for the five spoke areas reveals significant variations in land area, agricultural land distribution, and crop cultivation (Fig.8). Kanjikkuzhy and Mannanchery exhibit significant agricultural activity, with varying proportions of land area. Crop-wise, coconut cultivation is prominent across all areas, with Mannanchery leading in coconut cultivation. Banana, vegetables, spices, tubers, fruit plants, paddy, spices and pulses are among the other crops cultivated across these regions. When selecting spoke areas, considering the significance of vegetable cultivation within agriculture is crucial, particularly in relation to compost demand. Vegetable cultivation often requires nutrient-rich soil, making compost a vital resource to enhance soil fertility and productivity. Therefore, assessing the demand for compost in areas with a strong focus on vegetable cultivation is essential for effective agricultural planning and resource allocation.









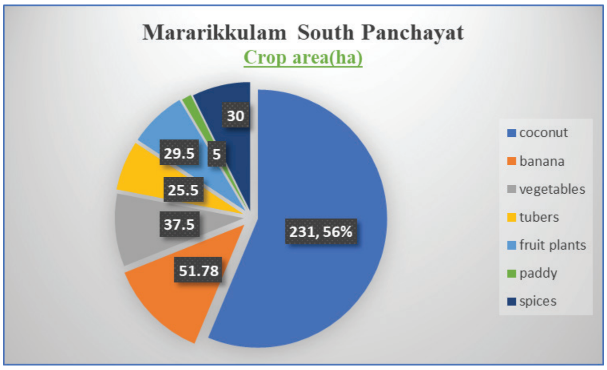


Figure 9 Pie charts showing panchayat wise crop data (Source: Krishi Bhavan)

From the figure 9; Kanjikuzhy Panchayat stands out with the highest vegetable cultivation at 250 hectares, indicating a significant reliance on compost for agricultural productivity. Aryad panchayat holds second position at 180 hectares. While Mannanchery follows with 68 hectares and the other panchayats, Mararikulam South and Mararikulam North show comparatively lower levels of vegetable cultivation. This analysis suggests that areas with higher vegetable cultivation, such as Aryad and Kanjikkuzhy Panchayat, may exhibit a greater demand for compost to support their agricultural activities.

Observing the areas with a higher prevalence of organic farming sheds light on the importance of identifying potential demand for organic compost. Among the panchayats, Kanjikuzhy stands out with a notable engagement in organic farming compared to others.

This inclination receives considerable support from both the panchayats and other local bodies, marking a positive endorsement of the system. Overall, the selection of these panchayats as demand areas for compost supply is a comprehensive process that considers multiple factors to ensure efficient resource allocation and support sustainable agricultural practices.

The criteria ranking method involves assigning numerical rankings to criteria based on its potential values. Each criterion is assessed and given a rank after a proper classification, typically on a scale from 1 to 4 or 1 to 5, with lower numbers indicating low demanded area. These ranks are then used to evaluate options or alternatives. In selecting a primary spoke area, the total ranks obtained for each option are calculated by summing up the ranks assigned to each criterion. The option with the highest total rank is typically chosen as the most suitable and having high potential to compost demand. The chart is given below in figure 10 and the classification is shown in Appendix A.

Name of Panchayat	Total Land	Agricultural land	Agricultural percentage	vegitable cultivation	Vegitable cultivation	Sand texture	Demand potential
Aryad	1	1	4	3	3	2	14
Mannanchery	4	4	4	3	2	1	18
Mararikulam North	4	2	2	2	1	3	14
Mararikulam South	2	1	2	2	2	3	12
Kanjikuzhy	3	3	3	4	4	3	20

Criteria Conditions: Ok, Good, Very good, Excellent

Demand Potential: Low, Average, High, Very high

Figure 10 Criteria ranking chart

potential values. Each criterion is assessed and given a rank after a proper classification, typically on a scale from 1 to 4 or 1 to 5, with lower numbers indicating low demanded area. These ranks are then used to evaluate options or alternatives. In selecting a primary spoke area, the total ranks obtained for each option are calculated by summing up the ranks assigned to each criterion. The option with the highest total rank is typically chosen as the most suitable and having high potential to compost demand. The chart is given below in figure 10 and the classification is shown in Appendix A.

Following the ranking procedure, Kanjikuzhy panchayat emerges as the primary spoke area, with a demand potential ranking of 20, categorising it as an area with high demand for organic compost application. Criteria wise ranked map is shown in Fig. 11 below. Mararikulam South has low demand of compost with the total rank, 12.

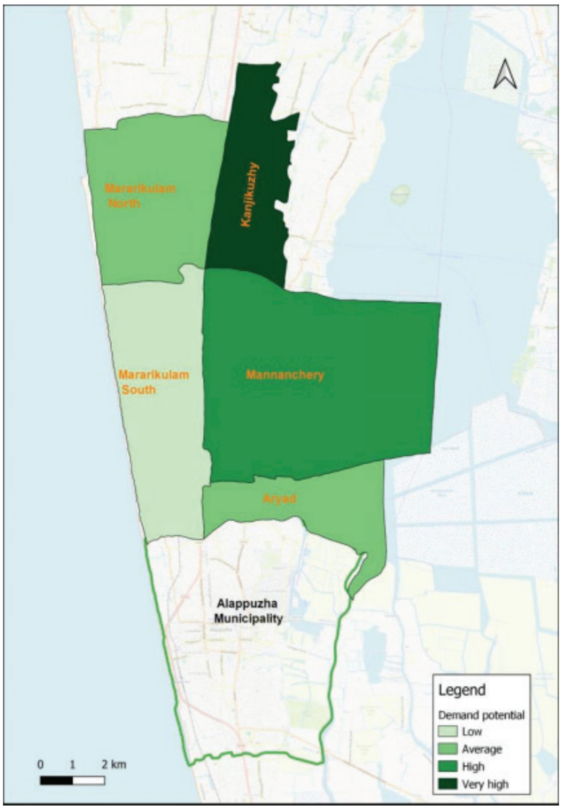


Figure 11 Ranked map of demand potential

Kanjikuzhy panchayat: Spoke area

Kanjikuzhy Gram Panchayat spanning over 1662 hectares (shown in Fig. 12) lies within Cherthala taluk, Alappuzha district,. Due to its unique geographical characteristics, the soil is predominantly dry, posing significant challenges for cultivating food grains

and vegetables. Unlike many other panchayats, Kanjikuzhy lacks access to rivers or coastal areas. Despite these geographical limitations, the majority of its residents rely on agriculture, animal husbandry, and the coir industry for their livelihoods.

Figure 12 Area map of Kanjikuzhy Gram panchayat

Another aspect of the panchayath which makes it an ideal spoke area, is the success of the panchayath in organic farming. Kanjikuzhy panchayat stands out due to the significant involvement of its population in organic farming (shown in Fig.13), with approximately 90% of its residents actively practising organic agricultural practices. This level of engagement sets it apart from other panchayats where such practices might not be as widespread or deeply rooted. The active participation and support of the local body with the residents to promote organic farming is revealed through this statement of the kanjikuzhy panchayat president.

"If any family is unable to do cultivation, they can handover their land to the panchayat. The panchayat will conduct the cultivation there with the help of the kudumbashree members. the harvested crops will be given to the family concerned"

Further, various organisations, such as Gandhi Smaraka Seva Kendram and Krishi Bhavan, have played pivotal roles in promoting organic farming and providing support to farmers in Kanjikuzhy. Non-profit organisations like Gandhi Smaraka Seva Kendram have played a crucial role in introducing best agricultural practices through awareness campaigns, model farm setups, and bio-lab facilities. The Government of Kerala has actively supported organic farming initiatives in Kanjikuzhy, as evidenced by initiatives like the agricultural study tour to Israel organised for select farmers. The collaborative efforts between these organisations, coupled with the proactive involvement of the local government, showcase a supportive ecosystem conducive to agricultural development. This support has fostered a group of individuals who practice innovative and experimental farming. Farmers Sujith SP, Asha Shaiju and Subhakesan, have received awards and recognition for their contributions to organic farming, innovative farming methods and a willingness to experiment. This spirit of innovation and experimentation is indicative of a community deeply committed to agricultural advancement, making Kanjikkuzhy an ideal candidate for further exploration and collaboration.

Figure 13 News clips of articles regarding organic farming at Kanjikuzhy

Despite challenges such as high labour costs and pest infestations, farmers in Kanjikuzhy have found economic viability in organic farming by finding avenues for selling their produce, both through local shops and direct sales to consumers. The profitability of organic produce, as evidenced by Subhakesan's sales figures and profit margins, further underscores the potential for sustainable agricultural practices in the region. The success of Kanjikuzhy's organic farming initiatives can be attributed in part to strong community collaboration and collective action. Initiatives like the formation of farmers' collectives and cooperative clusters for seed supply and vegetable sales demonstrate a shared commitment to mutual support and empowerment. Kanjikkuzhy's robust organic farming ecosystem, characterised by widespread community participation, innovation, institutional support, economic viability, makes it a compelling choice for further investigation and collaboration as a main spoke area.

Stakeholder and institutions identification and mapping

Stakeholders involved in the organic compost production process at Alappuzha Municipality and those involved in agricultural activities at Kanjikuzhy Panchayat are identified. Their roles and responsibilities within the compost production and utilisation processes are also mapped to understand their involvement and influence.

Hub area- Alappuzha Municipality

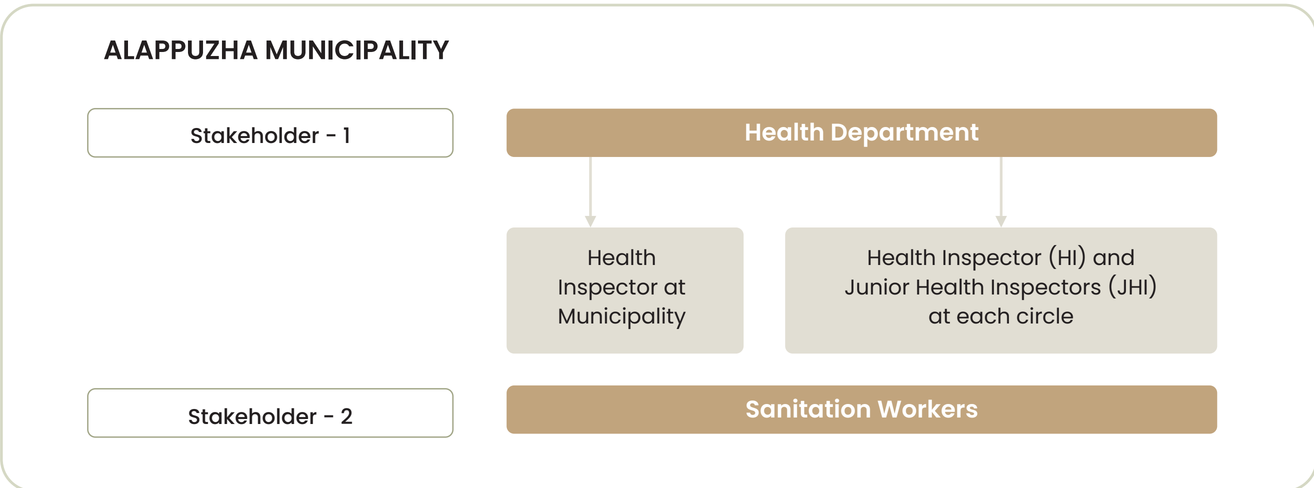


Figure 14 Stakeholders chart at hub area

In the context of organic compost production at the Alappuzha Municipality, under the health department, the roles of each stakeholder are shown in Figure 14. In the organic compost production process facilitated by the use of aerobic bins stationed throughout the Hub Area in Alappuzha Municipality, several stakeholders contribute to its successful implementation. At the forefront is the Health Department, which has the mandate of formulating policies and regulations governing organic compost production and waste disposal, and monitoring and evaluating the process to ensure compliance with established standards. The Health Inspectors at both the municipal level and within each circle are involved in coordinating activities, enforcing compliance, and allocating necessary resources for compost production. Specifically, the Junior Health Inspectors (JHIs) are instrumental in facilitating the day-to-day operations. They are responsible for arranging machinery, providing assistance to sanitation workers, managing filled bins, assigning roles to workers as per ward requirements, and procuring raw materials essential for composting. Additionally, sanitation workers actively engage in waste collection, composting activities, bin monitoring, and site maintenance, ensuring a smooth and efficient process. Through collaboration and diligent execution of their respective roles, these stakeholders contribute to the municipality's efforts in sustainable waste management and organic compost production.

Spoke Area - Kanjikuzhy Panchayat

In the spoke area of Kanjikuzhy Panchayat, various stakeholders (shown in Figure 15) play crucial roles in supporting agricultural practices. Krishibhavan in the panchayat is an important institution under the Department of Agriculture, whose mandate is to support local farmers and promote sustainable agricultural practices. It provides a range of services, including agricultural extension, implementation of government schemes, and distribution of inputs like seeds and fertilisers. Krishibhavan is also responsible for regular testing of soil to understand the status of nutrient deficiency and crop diseases. To remediate the same, they are mandated to offer pest and disease management assistance, and organise training sessions to enhance farmers' knowledge and skills. By acting as a liaison between the government and the farming community, Krishibhavan plays a crucial role in improving agricultural productivity and rural livelihoods within the panchayat. Agricultural Officers (AO) or Implementing Officer oversee the implementation of agricultural policies and programs and are supported by the Senior Agriculture Assistant.

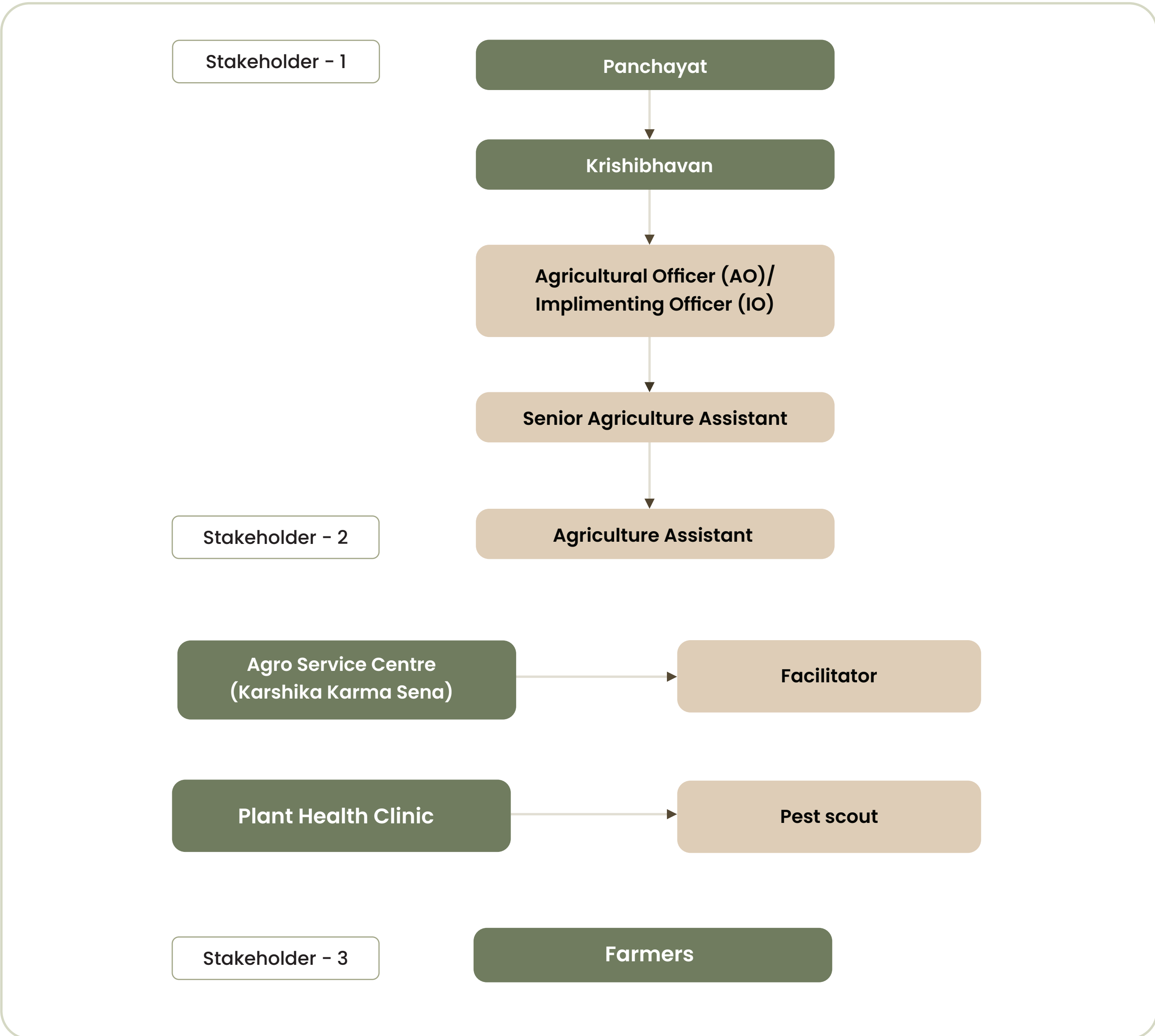


Figure 15 Stakeholders chart at spoke area

Agriculture Assistants and the Agro Service Centre (Karshika Karma Sena) provide on-ground support, technical assistance and facilitate access to agricultural resources. When farmers report plant diseases, pest scout at the plant health clinic examine the plants to diagnose issues and recommends remedies, either independently or with the assistance of an Agricultural Officer. The clinic operates every Friday, where farmers report plant health issues and receive necessary treatments from the Bio Pharmacy

Key Stakeholder Interviews

Key stakeholder interviews were conducted with identified participants using structured questionnaires. The interviews aimed to gather insights into the stakeholders' perspectives, challenges, and requirements related to the viability of the hub and spoke model for organic compost circulation.

Hub Area - Alappuzha Municipality

Figure 16 Interviews with officials at Alappuzha Municipality

The key stakeholders interviewed in the hub area were the Health Inspector at Alappuzha Municipality and Junior Health Inspectors from North I, North II, Central, South I, and South II circles (Figure 16) and the sanitation workers (Figure 17). Discussions focused on understanding challenges faced in municipal composting using aerobic bins and perspectives on utilising municipal compost in agriculture. Experienced sanitation workers involved in aerobic bin composting were interviewed to capture their insights and operational challenges in monitoring and managing the composting process.

Figure 17 Interviews with sanitation workers

Spoke Area - Kanjikuzhy Panchayat

Interviews were conducted with key officials (Figure 18) including the Agriculture Officer (AO), Senior Agricultural Assistant (SAA), Agricultural Assistants (AA), and Pest Scouts at Kanjikuzhy Krishi Bhavan. The discussions aimed to understand their perspectives on organic compost demand, agricultural practices, and the integration of compost into farming.

Figure 18 Interviews with officials at Kanjikuzhy Krishi Bhavan

Interviews with small to large-scale organic farmers (Figure 19), including state award winners in organic farming, were conducted to explore their aspirations, needs, and challenges regarding the use of organic compost in agriculture.

Figure 19 Interviews with farmers at Kanjikuzhy panchayat

Focus group discussions

Figure 20 Focal Group Discussion (FGD) with farmers

A Focus Group Discussion (FGD) (Figure 20), was conducted to gather collective insights and perspectives from key stakeholders engaged in agriculture within the Kanjikuzhy Panchayat. The FGD involved seven farmers of varying scales of cultivation, held at the Kanjikuzhy Grama Panchayat hall on June 7th, 2024. The FGD participants included seven key farmers actively engaged in cultivation across different scales, ranging from small to large-scale operations.

The FGD aimed to understand farmers' perspectives on the utilization of organic compost in agriculture, assess their compost demand and current usage of fertilizers, conditioners, and pesticides, and identify collective challenges and requirements related to integrating organic compost into farming practices. The insights from all the data collection activities, including the key stakeholder interviews and FGD, are presented in the next chapter.

Findings

This chapter presents the findings obtained from the comprehensive stakeholder engagements conducted through interviews and focal group discussions (FGDs) at both the hub and spoke areas. At the hub area, which includes Alappuzha Municipality, the discussions primarily focused on identifying the challenges associated with aerobic bin composting and the limitations that exist in the effective production of municipal compost. The insights from the officials and sanitation workers highlight the operational difficulties and quality concerns that need to be addressed to enhance the composting process and its outputs.

In the spoke area the focus was on understanding the aspirations and needs of farmers regarding the use of organic compost in their agricultural practices. Through interviews with key officials at Krishi Bhavan and interactions with both medium and large-scale organic farmers, as well as the FGD with a diverse group of farmers, we gathered detailed information on their requirements, expectations, and the current usage patterns of compost, fertilisers, conditioners, and pesticides. This chapter systematically presents these findings, offering a comprehensive view of the stakeholder perspectives at both the hub and spoke areas, and lays the groundwork for developing targeted interventions and improvements in the organic composting system.

Hub area

Status of Organic Waste Management

The organic waste management system in Alappuzha Municipality is largely centred around aerobic composting, with varying levels of success and ongoing challenges. The municipality has implemented biobins extensively in residential areas, which has helped reduce waste collection volumes in some regions. However, in more populated town centres, communal aerobic bins often face overloading issues, particularly with food waste, which disrupts the composting process. This results in the formation of leachate and odour, further aggravated by limited space for expansion. These factors present significant obstacles to maintaining an efficient waste management system.

Quality control of the compost produced is a critical concern. Laboratory tests have indicated nutrient deficiencies in the compost, and the monitoring of key parameters like pH, temperature, and moisture content is inconsistent. This lack of consistency contributes to the poor quality of the compost, making it less suitable for direct agricultural use. To address these issues, the municipality is exploring ways to improve compost quality, such as incorporating powdered dry leaves into the composting process. Collaborations with agricultural institutions are also being sought to enhance the nutrient content of the compost, which could increase its applicability as an organic fertiliser.

Despite these issues, there have been some successes. For instance, some sanitation workers have managed to use municipal compost effectively for vegetable cultivation. Notably, Hameelath Beevi, a sanitation worker at the Allissery unit, has been cultivating vegetables using municipal compost on the premises of the collectorate land (shown in Fig. 21). Her efforts have yielded a significant crop, and she has been recognized with several awards from the municipality, including district and state-level awards for her contributions to sanitation and waste management.

കലക്ടറേറ്റിലെ കൃഷിപാഠം

Figure 21: News article about Hameelath Beevi's cultivation using municipal compost

Challenges

Several challenges continue to impede the efficient operation of the organic waste management system in Alappuzha Municipality. One of the most significant problems is the improper segregation of food waste, which results in a compost product of insufficient quality for agricultural use. The high volume of waste, particularly during peak disposal periods, overwhelms the municipality's composting infrastructure, leading to interruptions in the composting process. The municipality has 37 aerobic composting units with a total of 436 aerobic bins. However, only 23 of these units are functional, collectively handling close to 8-10 tonnes of organic waste daily. Furthermore, the lack of adequate facilities to manage leachate and prevent odour formation further complicates the situation.

The composting process itself faces delays due to these challenges, often requiring interventions to restart or maintain operations. The quality of the compost is further compromised by inconsistent monitoring of pH, temperature, and moisture content during the composting process. As a result, the compost is often not suitable for direct use in agriculture, particularly due to its high heat content. This has limited its application, though some successes have been achieved in using it as a soil conditioner in certain agricultural areas, particularly where it is applied away from direct plant roots to avoid damaging crops.

In terms of infrastructure, the municipality's composting facilities are in need of significant upgrades. The addition of more composting bins, improved segregation machinery, and better leachate management systems are all necessary to enhance the efficiency of the waste management process. According to municipality officials, plans are in place to acquire equipment such as conveyor belts, bailing machines, and sieves to streamline the composting workflow and improve the quality of the compost produced.

In terms of quality test results (shown in Fig. 22 & attached in Appendix), conducted at the Kerala Agricultural University (KAU), several parameters have been measured and compared to the FCA (Fertilizer Control Act) specifications that is adopted as standard specification by KAU. The obtained results are as follows,

Sl. No.	Parameter	Observed Value	Standard Value (FCA)
1	pH (1:5)	**5.66**	6.5-7.5
2	Electrical Conductivity (EC 1:10)	6.27 dS/m	< 4.0 dS/m
3	Moisture Content	29%	15 – 25%
4	Organic Carbon (O.C)	37.70%	> 12%
5	Nitrogen (N)	0.84%	> 0.8%
6	C/N Ratio	44.88:1	20:1
7	Phosphorus (P)	1.39%	> 0.4%
8	Potassium (K)	1.23%	> 0.4%
9	Bulk Density	0.39 Mg/m^3	< 1.0 g/cm^3
10	Particle Size (passing 4.0mm sieve)	76.40%	> 90% passing through sieve
11	Sulphur (mg/ kg)	1857.14	Not specified
12	Calcium (mg/kg)	119400	Not specified
13	Nickel (mg/kg)	24.58	50 maximum
14	Cadmium (mg/kg)	NIL	5 Maximum
15	Chromium (mg/kg)	54.82	50 Maximum
16	Lead (mg/kg)	5.89	100 Maximum
13	Magnesium (mg/kg)	2895	Not specified
14	Total Bacterial Count	5×10^8 cfu/ml	Not specified
15	Total Fungal Count	5×10^6 cfu/ml	Not specified
16	Total Actinomycete Count	7×10^6 cfu/ml	Not specified
17	E. coli	Not Detected	Absent
18	Coliforms	Not Detected	Absent
19	Staphylococcus sp.	9×10^5 cfu/ml	Not specified
20	Salmonella sp.	Not Detected	Absent
21	Shigella sp.	Not Detected	Absent

Fig. 22. Test Result of Municipal compost

The test results from the compost quality analysis highlight several areas that need attention and improvement, alongside some positive findings. The Electrical Conductivity (EC) value of 6.27 dS/m exceeds the standard of 4.0 dS/m, indicating excessive salt content in the compost. This could be due to the saline water in Alappuzha or the type of food waste used, potentially increasing soil salinity and negatively affecting plant growth by limiting water uptake and disrupting soil microorganisms. Sensitive plants may suffer from stunted growth, potentially degrading soil quality. To mitigate this, salinity should be reduced through leaching or by diluting the compost with low-salt materials. The moisture content is observed at 29%, higher than the optimal 15-25%, which can inhibit aeration, slow decomposition, cause foul odors, and create conditions that promote pathogen growth. This indicates inefficient composting, likely due to anaerobic conditions, and calls for closer management of moisture levels to avoid these issues.

On a positive note, the nitrogen content at 0.84% meets standard requirements, but the C/N ratio of 44.88:1 is too high compared to the ideal 20:1, suggesting incomplete decomposition and delayed nutrient release. Additional nitrogen, through urea or other enrichments, is recommended to balance the C/N ratio, improving compost efficiency. The pH level, slightly acidic at 5.66, falls below the ideal range of 6.5-7.5, which can reduce microbial activity and limit nutrient availability. Additionally, it could increase the solubility of toxic metals, which might harm plants and soil organisms. Adjusting the pH is crucial to enhance compost quality for agricultural use. The chromium content at 54.82 mg/kg exceeds the recommended maximum of 50 mg/kg, posing risks of soil and water contamination. High chromium levels can interfere with nutrient absorption and stunt plant growth, leading to long-term soil health concerns.

Despite these challenges, there are some positive aspects. The presence of beneficial actinomycetes is a good sign, indicating healthy microbial activity, which helps in breaking down organic matter effectively. The adequate nitrogen content is also a positive factor, essential for plant growth and soil fertility. However, the presence of Staphylococcus sp., which should be absent in compost, raises concerns, as it may cause skin rashes and other health risks if handled improperly. Furthermore addressing high EC and moisture content adds complexity to the composting process, requiring careful monitoring and adjustments. Similarly, lowering the C/N ratio involves precise nitrogen addition, which must be managed to avoid over-enrichment and ammonia buildup. Balancing pH and mitigating chromium toxicity further complicates the process, potentially requiring additional amendments or leaching techniques. Nonetheless, with proper management, these issues can be resolved to produce high-quality compost that benefits soil health and agricultural productivity.

In addition, some workers handling municipal compost have reported cases of eye redness and irritation, while others have experienced blister formation on their skin. These symptoms suggest a need for careful handling protocols and personal protective equipment (PPE) to protect workers from potential allergens, irritants, or harmful microorganisms present in compost materials. Implementing safety guidelines and providing proper training on PPE use (e.g., gloves, goggles, and masks) could significantly reduce these health risks.

Spoke Area

Data collection in the spoke area was conducted through interviews, focus group discussions (FGDs) with farmers, and consultations with Krishi Bhavan officials. Key farmers from the Kanjikuzhy area shared insights into their agricultural practices, challenges, and the overall farming landscape. Agriculture serves as the primary source of income for these farmers, supplemented by support from Krishi Bhavan and the Panchayat, highlighting the connection between agricultural and institutional efforts in this region.

Status of Agricultural practices and Agricultural inputs

Farmers in the Kanjikuzhy region cultivate a variety of crops, including vegetables like lady's finger, spinach, beans, and cucumber, as well as paddy, watermelon, and flowers such as sunflowers. They use diverse farming techniques, including mulching and open-field methods, and they generally prefer hybrid seeds obtained from local shops. To enhance soil fertility and minimise pest infestations, they commonly practise crop rotation and intercropping.

The predominant soil type in this area is quicksand, characterised by low water retention capacity. This condition requires frequent watering and careful nutrient management to ensure optimal plant growth and yield. To improve soil structure and increase water retention, farmers add organic matter as a soil amendment. Bore wells are the main source of irrigation, and many farmers utilise drip irrigation systems. Additionally, rainwater harvesting techniques are employed to supplement irrigation needs during dry periods.

Plant disease management involves coordination with Krishi Bhavan officials, including pest scouts and agricultural assistants, who help diagnose and treat common issues. Weekly plant health clinics (shown in Figure 23) are organised to address these issues, promoting integrated pest management (IPM) techniques to minimise reliance on chemical pesticides.

Fig. 23: Plant Health clinic

Figure 24: Changes in soil fertility before and after using compost

Figure 25: Inoculum used for compost production

As agricultural inputs, farmers use a mix of chemical fertilisers (such as NPK and Triple 19) and organic alternatives like cow dung, poultry waste, and compost. Due to the rising costs of traditional fertilizers, some farmers have started producing their own compost using agricultural waste, vegetable waste, dry leaves, and inoculum (shown in Figures 24 and 25). Occasionally, they employ foliar feeding techniques to provide nutrients directly to plant leaves. Organic fertilisers such as poultry manure, ashes, cow dung, bone meal powder, neem leaves, and liquid preparations are mixed and applied at the base of plants, sometimes covered with sand to enhance nutrient absorption.

Challenges

Farmers in the Kanjikuzhy area encounter several significant challenges that impact both their agricultural practices and the effective use of inputs. A major concern is water scarcity, which adversely affects crop yields and irrigation methods. Additionally, soil nutrient deficiencies pose substantial hurdles, undermining crop health and productivity. The high costs associated with fertilisers, whether chemical or organic, remain a barrier that complicates efforts to boost agricultural output. Furthermore, the low water retention capacity of the soil limits the effective application of certain fertilisers, hindering crop growth.

Transitioning from chemical to organic fertilisers comes with its own set of challenges. While organic options are viewed as beneficial for long-term soil health, their higher initial costs and slower effects deter their usage. Institutions such as Krishi Bhavan (figure 26) and schemes such as BPKP (Bharatiya Prakritik Krishi Paddhati) and PKVY (Paramparagat Krishi Vikas) Yojana play an essential role in addressing these challenges by promoting the use of organic compost through training programs. However, lack of proper marketing channels and apprehensions about compost quality hinders the adoption of municipal compost as a cost-effective alternative to traditional fertilisers.

Figure 26: Kanjikuzhy Krishi Bhavan

Scope for Waste-Derived Compost

Fig. 27: Vegetable cultivation using self-made compost using vegetable wastes by a farmer, Sanu in his field (Inside: Image of prepared compost)

In the Kanjikuzhy area, farmers utilise a variety of organic materials, including organic waste, cow dung, bone meal powder, and dry leaves, for compost preparation (shown in Figures 27, 28 and 29). This compost is typically applied bi-monthly or through specific techniques, such as layering with sand, to enhance soil fertility, moisture retention, and overall plant health. Vermicomposting is also gaining popularity among farmers as an efficient method for producing high-quality compost, which further contributes to sustainable agricultural practices in the region.

Fig.28: Vegetable cultivation using self- made compost using dry leaves compost

Fig.29: Two types of compost made by farmer, Subhakesan using dry leaves and liquid compost using bone meal powder, neemcake powder and cow dung powder

Interviews with farmers in Kanjikuzhy revealed that they are increasingly interested in cost-effective and high-quality compost with transparent ingredient proportions to ensure reliability and effectiveness. They are open to experimenting with municipal compost, provided it meets their nutrient requirements and aligns with their agricultural needs. Further they recognize compost as a valuable resource for enhancing soil fertility, improving soil structure, moisture retention, and overall crop health while reducing dependence on costly chemical fertilizers. However, consistent quality and freedom from contaminants such as glass and wood powder are critical to gaining farmers' trust and encouraging widespread adoption.

Scope of Forward Linkage for Compost distribution from hub area

- Case study on Utilisation of municipal compost in precision farming at Devaswom Krishiyidam, Kanjikuzhy

Fig. 30. Collected municipal compost

To objectively analyse the scope of forward linkage of compost, municipal compost generated using aerobic units in Hub area was transported to farmer Jyothish's farm in Kanjikuzhy for agricultural use (figure 30). He intended to apply the compost to a 1-acre plot planted with chrysanthemum. Farmer Jyothish incorporated municipal compost into his fields (Figure 31 and Figure 32) as part of an open mulching system, utilising its benefits for moisture retention and weed reduction. However, he has raised concerns about the quality of the compost, particularly regarding the significant plastic contamination that necessitates manual removal before application. Despite the fertility advantages that the compost offers, this contamination increases labour and effort for farmers like Jyothish.

Jyothish elaborated on his mulching process, which involves layering municipal compost with organic materials such as poultry waste, bone meal powder, fodder crop powder, dry fish powder, and lime powder, applied two weeks prior. This method not only conserves water but also enhances soil health. Municipal compost serves as the foundational layer, contributing carbon to the soil and improving its structure and moisture retention, thus functioning effectively as both a soil conditioner and fertiliser. Furthermore, the addition of various additives helps create a balanced nutrient profile to optimise crop growth. However, the persistent plastic residues in the compost collected from Alappuzha Municipality poses a significant challenge, undermining soil quality and necessitating additional efforts for remediation.

Fig.31 Direct application of collected Compost on field

Fig. 32 First Mulching incorporating Municipal compost in farmland

The main challenge encountered during the process is the suboptimal quality of the compost. The compost has a coarse texture and is significantly contaminated with plastic debris, such as tablet covers and packaging materials. This poor condition not only delays nutrient availability to plants, potentially impacting yields but also increases the labor intensity and time required for application. At present, the unsorted compost is directly applied to the soil for horticulture.

The economic burden associated with this process is substantial. Jyothish previously paid approximately ₹25,000 for 240 sacks of municipal compost (15 kg per sack), in addition to incurring high transportation and labor costs for shredding and application. For example, his recent use of compost for mulching practices involved significant manual effort due to its coarse texture. While composting can enhance yields compared to non-application, the slow nutrient release from such low-quality compost may delay crop development. To address these challenges, Jyothish plans to hire workers to remove plastic contaminants when transitioning to cultivating edible crops.

Fig. 33 Visible Plastic Fragments in Municipal compost

Despite the challenges posed by compost quality, Jyothish anticipates significant yields in about 1.5 months. He believes that the effectiveness of compost applications will improve over time, but acknowledges the current limitations. He emphasises the need for compost to be enriched with essential nutrients and free from plastic for effective agricultural use. If improperly processed, the compost may negatively impact soil health and crop quality, especially for edible crops.

This pilot use highlights both the potential benefits and challenges of using municipal compost for agriculture. While compost contributes to soil conditioning and moisture retention, plastic contamination and coarse texture remain significant issues. By addressing these issues, municipal compost can play a vital role in enhancing sustainable farming practices.

Concluding remarks - Recommendations

The recommendations outlined in this chapter provide a clear roadmap for establishing a viable hub and spoke model for organic compost circularity between Alappuzha Municipality and Kanjikuzhy Panchayat. By addressing critical infrastructure needs, adopting advanced composting technologies, and implementing stringent quality assurance measures, the path is paved for effective and sustainable organic waste management.

Recommendations for Hub areas (Alappuzha Municipality)

Optimising compost quality

To improve compost quality, the hub area should focus on nutrient enrichment by integrating phosphorus, potassium, and essential micronutrients, enhancing its agricultural utility. Incorporating powdered dry leaves can improve the compost's texture and nutrient composition, while prolonging the composting period will allow full breakdown of organic materials, stabilising the C/N ratio and electrical conductivity. Precision in adding urea will help optimise nitrogen levels without risking over-salination or ammonia buildup, ensuring high-quality compost output.

Infrastructure expansion

To handle the rising volume of organic waste effectively, expanding composting infrastructure with additional bins and dedicated composting spaces is essential. Establishing facilities specifically for quality monitoring will enhance compost consistency, helping the hub area meet agricultural standards and gain farmer confidence in municipal compost.

Developing sales and Distribution pathways

Packaging and selling high-quality compost can generate revenue while promoting sustainable agricultural practices in nearby areas. Collaborations with local panchayats, such as Kanjikuzhy, will support efficient compost distribution, with streamlined logistics and quality checks in place to ensure product consistency and accessibility for end-users.

Ensure Worker Safety

Protecting workers in compost production is essential for sustainable operations. Enforcing safety protocols, including mandatory use of PPE like gloves, goggles, and masks, minimizes exposure to allergens and harmful microorganisms. Regular training on handling practices and hygiene ensures adherence to safety measures. Additionally, access to healthcare services and periodic health check-ups can address issues like skin irritation or respiratory symptoms, promoting a safe and efficient working environment.

Recommendations for Spoke areas

Promote Awareness and Training

Policy initiatives can focus on organizing regular training sessions through Krishi Bhavan to educate farmers on the benefits and techniques of municipal compost and organic fertilizers. Awareness campaigns could emphasize the long-term advantages of shifting from chemical to organic inputs, such as enhanced soil health, reduced costs, and environmental sustainability. Hands-on training for farmers on compost application, such as layering and mulching, will help them maximise the benefits of municipal compost in soil conditioning and nutrient distribution. Practical workshops will demonstrate layering techniques and highlight the use of additional organic supplements, such as poultry waste, enabling farmers to address quality issues and integrate compost more effectively. These initiatives aim to empower farmers with the knowledge necessary for adopting sustainable practices.

Facilitate Access to Quality Compost

Policies could prioritize ensuring the availability of municipal compost that meets stringent quality standards, is free from contaminants like plastics, and offers balanced nutrient profiles. Pilot distribution programs with subsidized rates for compost, combined with transparent quality testing reports, may address farmers' concerns about its efficacy. These measures could make high-quality compost more accessible and encourage its widespread use in agriculture.

Provide Financial Support and Incentives

Financial incentives might be introduced to ease the initial transition costs associated with adopting municipal compost. Subsidies can be designed to cover transportation, purchase, and supplemental nutrient inputs, while performance-based rewards may encourage sustainable practices. Such financial measures aim to reduce economic barriers for farmers and promote long-term adoption of compost as a viable alternative to chemical fertilizers.

Recommendations for establishing institutional mechanisms for hub and spoke model

Integration into Kerala Agricultural University's Package of Practices

To effectively strengthen the adoption of the hub and spoke nutrient circularity model, establishing a partnership with Kerala Agricultural University is a critical step. This collaboration would integrate the model into the university's Package of Practices (PoP), a trusted and widely followed agricultural guide by Krishi Bhavans across Kerala. By embedding high-quality municipal compost as a recommended input in these practices, the university can ensure its systematic use in sustainable farming.

Moreover, crop-specific guidelines for compost application should be developed to align with the nutrient requirements of various crops grown in Kerala. These guidelines, supported by rigorous university-led research, can detail optimal compost types, application methods, and timing to maximize soil fertility and improve crop yields.

To further facilitate adoption, these crop-specific recommendations should be incorporated into training modules and advisory services offered by Krishi Bhavans.

Farmers, agricultural officers, and extension workers can benefit from targeted training sessions that equip them with the knowledge and tools to apply municipal compost effectively. This combined approach would enhance farmer confidence in compost use, improve soil health, and contribute to a circular economy by closing the nutrient loop.

Strategic partnerships and Quality assurance

To build a resilient composting program, establishing partnerships with research institutions, agricultural experts, and farmers is essential. Policies might emphasize strengthening the role of Krishi Bhavan in promoting compost use through enhanced resource distribution, technical assistance, and regular monitoring. In addition to the incorporation of MSW composting in KAU Package of Practices, partnerships between municipalities, agricultural experts, and farmer collectives could be supported to ensure smooth integration of compost into agricultural systems. A dedicated quality assurance committee comprising farmers, agricultural experts, and municipal representatives will facilitate continuous monitoring, ensure adherence to agricultural standards, and encourage farmer input on compost quality. This committee can conduct field visits, gather data on compost effectiveness, and make informed recommendations to improve compost processes. Such measures would create a robust institutional framework to sustain the adoption of organic fertilizers and promote innovative, sustainable farming practices.

Collaborative training and Capacity building

Institutions should support regular training programs for sanitation workers, residents, and farmers on waste segregation and compost application techniques, fostering a community that is invested in high-quality compost production. These sessions will cover methods for contaminant removal, compost layering, and nutrient management, which will contribute to a well-informed network of users and producers, enhancing overall program effectiveness. These collaborative platforms will also enable farmers to share feedback on municipal compost quality and application practices. Regular dialogues between farmers, municipalities, and agricultural experts can ensure continuous improvement in compost production, enhancing trust and cooperation among stakeholders. These mechanisms would help gather valuable insights for co-developing solutions that align with farmers' needs.

Structured marketing and government-led supply chains

To address the underutilization of compost and ensure its widespread adoption, a structured marketing framework supported by government-led initiatives is essential. One key measure is to set a minimum price for compost sales, ensuring financial sustainability for municipal composting plants. This policy would prevent compost from being sold at unsustainable prices or stockpiled within plants, taking up valuable space.

Building on successful models like Odisha's, Kerala can implement a similar decentralized compost marketing policy. In Odisha, compost produced at various decentralized facilities, known as Mo-Khata, is marketed through local outlets, serving both individual consumers and bulk buyers. The agriculture and horticulture departments facilitate these sales, creating a robust supply chain for compost. To further support compost production and ensure plant sustainability, Odisha has set a price range of Rs 10-20 per kilogram for marketing, supporting livelihoods for self-help groups (SHGs) involved in the process.

Kerala can adopt a comparable approach by establishing a government-led supply chain for city-compost, targeting both farmers and the fertilizer industry. This system could enable direct marketing from composting facilities to consumers and bulk buyers, while also providing financial support to Municipalities, SHGs and other local stakeholders involved in compost production. By ensuring a minimum price and facilitating distribution through government channels, Kerala could effectively promote city-compost and increase its utilization across agricultural and industrial sectors.

Such measures would create a stable market for compost and enhance its integration into farming practices. Further, these recommendations can aid in establishing a robust framework for enhancing organic waste management through a strategic hub and spoke model between Alappuzha Municipality and Kanjikuzhy Panchayat. By strengthening compost quality, expanding infrastructure, and fostering institutional collaboration, this model aligns with circular economy principles and promotes sustainable agricultural practices. Alappuzha's role as a central processing hub, combined with Kanjikuzhy's utilisation of high-quality compost, exemplifies a practical approach to nutrient circularity, creating a pathway for improved soil health, reduced waste burden, and long-term environmental resilience in the region.

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Appendix - A

Criteria Classification

Panchayat	Classified range	Ranked Weight
Total land area (in hectare)	< 1000	1
	1001 -2000	2
	2001-3000	3
	3001-4000	4
Agricultural land area (in hectare)	< 1000	1
	1001-1500	2
	1501-2500	3
	2501-3500	4
Vegetable cultivation area (in hectare)	<50	1
	51-150	2
	151-200	3
	201-250	4
Farmers population (in number)	<4000	1
	4001-6000	2
	6001-8000	3
	8001-10000	4
Agricultural percentage	<20	1
	21-40	2
	41-60	3
	61-80	4
Sand texture	Sandy clay loam	1
	Sandy clay	2
	Sandy	3

Appendix - B

Test Results

1. Biophysical and Chemical parameters test result

KERALA AGRICULTURAL UNIVERSITY
DEPARTMENT OF SOIL SCIENCE & AGRL CHEMISTRY
COLLEGE OF AGRICULTURE, VELLANIKKARA
K. A.U, (P.O), 680 656, THRISSUR

Email :ssagchem@cohvka.kau.in

SPDL Analysis 32/24-25 22/10/2024

From
Asst. Professor & Head
Dept. of Soil Science & Agrl. Chemistry
College of Agriculture
Kerala Agricultural University
Vellanikkara

To
Noora S.B
House No.439,1st Floor
Poomthopp ward
Alappuzha – 688 006

Sub: KAU-COA-SPDL (SS&AC) – Analytical report of sample (City compost)- result- reg.

Please find furnished herewith the analytical report of the sample supplied by you.

Sl.No	Parameters tested	Value
1	pH (1: 5 dilution)	5.66
2	Electrical conductivity (dSm^{-1}) (1: 10 dilution)	6.27
3	Moisture (%)	29
4	Particle size (material passed through 4 mm sieve, %)	76.40
5	Organic Carbon (%)	37.70
6	Nitrogen (%)	0.84
7	Phosphorus (%)	1.39
8	Potassium (%)	1.23
9	C:N ratio	44.88:1
10	Sulphur (mg/kg)	1857.14
11	Calcium (mg/kg)	119400.0
12	Magnesium (mg/kg)	2895.0

13	Iron (mg/kg)	910.0
14	Manganese (mg/kg)	137.8
15	Zinc (mg/kg)	121.2
16	Copper (mg/kg)	44.2
17	Cadmium (mg/kg)	BDL*
18	Chromium (mg/kg)	54.82
19	Lead (mg/kg)	5.89
20	Nickel (mg/kg)	24.58

Below Detectable Level

Asst.Professor & Head

Dr. SANTHOSH C.
Assistant Professor

2. Microbial test result

E-mail : cohmicrobio@kau.in

Department of Agricultural Microbiology
College of Agriculture
Kerala Agricultural University
Thrissur, Kerala-680 656

Professor and Head

Date : 17/10/2024

1) Name and address of applicant : Technology and Governance Support (TAGS) Forum, Puthumpally, Poonthopp ward, Avulookunnu P.O, Allepey, 688006
2) Phone number : 7559046459
3) Name of the item : Compost
4) Number of samples : 1
5) Name and address of manufacturer : Same as above
6) Date of manufacture : NA
7) Date of expiry : NA
8) Batch number : NA
9) Date of receipt of sample : 03/10/2024
10) Parameters to be analyzed : Total bacterial count, total fungal count, total actinomycete count, *E.coli*, coliforms, *Staphylococcus* sp., *Salmonella* sp., *Shigella* sp.
11) Amount paid & Invoice No. : Rs.2800/-. Invoice No. B2C 49/2024-25 dt. 15/10/2024

RESULTS

Sl. No.	Parameters	Total Count (cfu/ml)	Remarks
1	Total Bacterial Count	5×10^8	----
2	Total Fungal Count	5×10^4	----
3	Total Actinomycete Count	7×10^2	----
4	*E.coli*	Nil	----
5	Coliforms	Nil	----
6	*Staphylococcus* sp.	9×10^6	----
7	*Salmonella* sp.	Nil	----
8	*Shigella* sp.	Nil	----

The above result reported pertains only to the sample submitted in this lab. The undersigned does not guarantee the same results for the bulk or other samples.

BGopal 18/10/2024
Professor and Head

Professor & Head
Department of Agricultural Microbiology
College of Agriculture
Kerala Agricultural University
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Advancing Nutrient Circularity through a Hub and Spoke Model in Kerala