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PLATE TO PLANET – INDIA'S TAKE ON FOOD WASTE AND CLIMATE CHANGE

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Abstract:

In India, the issue of food waste is staggering, with approximately 40% of food production going to waste. This exacerbates issues of hunger and malnutrition, affecting millions nationwide. Additionally, the environmental impact is profound, contributing to resource depletion, ecosystem degradation, and greenhouse gas emissions. Despite this, public engagement in waste segregation, particularly in urban areas like the Kalyan Dombivli Municipal Corporation (KDMC) region, is lacking. The research highlights the need for education and awareness campaigns to address this issue. As per the learnings from primary data collected via survey and interviews and secondary data, the research proposes actionable strategies to minimize food wastage and promote waste management practices which are sustainable such as - 0-Resource Wastage Model and the Sustainable and Participative Approach to Conserve Environment (SPACE) Model. The findings underscore the link between education levels and willingness to embrace government waste reduction measures. By prioritizing education, implementing policy incentives, and fostering innovative waste management solutions, India can mitigate food waste while also combating hunger and malnutrition, ultimately moving towards a more environmentally sustainable future that preserves our planet for future generations.

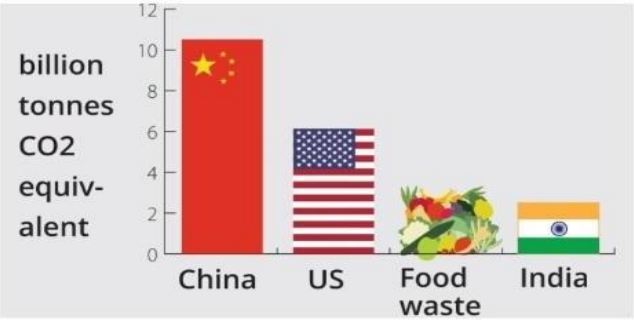
Keywords: *Food waste, climate change, environmental sustainability, India, waste management, greenhouse gas emissions, resource depletion, public awareness.*

Introduction:

Food is the primary need for human survival since it provides the essential nutrients, energy, and sustenance required for physiological functions also general wellness. Food is more than just nourishment; it is crucial for communities all over the world on a cultural, social, and economic level and the amount of food consumption is increasing globally.

Wastage of food contributes to climate change by releasing greenhouse gases like methane, among other detrimental effects on the ecosystem. Food waste increases environmental deterioration because it wastes the energy, water, and other resources needed at every stage of production. Additionally, food waste can result in the loss of essential nutrients and food ingredients, which can exacerbate food insecurity and malnutrition.

Global Food Waste and its Climate Impact:



Source: Secondary data (Food and Agriculture Organization)

Chart No: 1 - CO2 Emissions from food waste compared to countries.

Food waste begins with food production and continues through consumption. As per the FAO, nearly 33% of

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all food produced worldwide goes to waste or is lost. This equates to 130 crore tons of food waste annually. As explained by food waste index report 2021, unused food accounts for 8-10% of world greenhouse gas (GHG) emissions. Decreasing food waste at retail and consumer levels may lead to substantial influence on the environment and the planet. Food waste, when compared to countries, ranks as the third-largest greenhouse gas emitter after China and the United States. Similar conditions can be found in Asia, where the bulk of the 134 crore tonnes of food waste are attributed to China and India. This food waste worsens climate change and causes food poverty and hunger for crores of people in the region.

Food waste has become a pressing concern addressed in the UN Sustainable Development Goals (SDGs). SDG 12 emphasizes responsible consumption and production, while SDG 2

strives to alleviate global hunger. Through sustainable production and consumption practices, we can mitigate both food waste's environmental impact and global hunger crises.

This wastage not only impacts the environment but also has economic implications, with the value of wasted food estimated at around $2.6 trillion annually. Decreasing wastage of food not only addresses environmental concerns but also contributes to food security and economic sustainability (Food waste foodprint Impacts on natural resources, 2013)

Food Waste in India:

In India, wastage of food is a widespread issue. Since food is a commodity that is available to everyone and is not restricted to residents of nations, this has a significant influence on the globe as well. India wastes nearly 40% of its food production, which is 1% of its GDP (Food Wastage in India 2024: From Farm to Bin, Hidden Truth, jan,2024). Wastage of food has a direct effect on hunger and malnutrition, which is one of its main effects on a nation. Research published by Feeding India estimates that 14.3% of the world's population—approx. 19.44 crore people—are undernourished. India's position on the 2023 Global Hunger Index was 111th out of 125 countries. (Understanding the malnutrition crisis in India, 2022) Food waste is a crucial global problem that has negative impact on the environment, society, and economy. (UNEP Food Waste Index Report, 2021)

The food waste index study from the United Nations Environment Programme (UNEP) states that 68.7 million tons of food gets wasted annually in Indian households—roughly 50 kg per person. In terms of food waste in households, it stands second in the world, only after China.

Food Safety and Standards Authority of India (FSSAI) states that nearly 33% of all food produced in India gets wasted or spoils before getting consumed. In a report titled "Food Waste in India," Chintan, an environmental NGO that promotes social justice and environmental sustainability, estimated that food waste in the nation costs approximately Rs. 92,000 crores annually. This underscores the gravity of the problem, as 190 million Indians still go hungry despite the nation's adequate food production.

Wastage of food is a careless behaviour that gets added to the trash load and puts more burden on the waste management system. Even when garbage is disposed of in landfills, it usually ends up in bodies of water. However, food waste is more than just a social or humanitarian issue; it is also an environmental one.

Climate Change:

The term ‘climate change’ describes long-term changes in weather and temperature brought on by both environmental and human influences. The climate on Earth is changing, and it is anticipated that this century and beyond will see further changes in the global climate. The burning of fossil fuels by humans, deforestation, and certain industrial and agricultural practices that increase greenhouse gas (GHG)

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emissions, majorly carbon dioxide (CO2) and methane (CH4), are the main causes of the current rise in the average world temperature. People are at risk from climate change due to increasing flooding, intense heat waves, a shortage of food and water, a rise in disease, and financial loss.

While some limits to accommodation have already been achieved, accommodating to climate change through initiatives like flood control measures or drought-resistant crops partially lessens climate change. Although they account for a minor portion of global emissions, poorer populations.

India emits less greenhouse emissions annually than the remaining world combined, at around

2.5 tons per person or 3 gigatonnes (Gt) CO2eq. Although the country is home to 17% of the world's population, it only contributes 7% of global emission. By 2030, India will have the third-highest population in the world and be the largest producer of greenhouse emissions worldwide. (Times, 2022)

Food waste and Climate Change:

According to estimates from the FAO of the United Nations, 8–10% of greenhouse gas (GHG) emissions worldwide are attributable to wastage of food. Approximately one-third of the greenhouse gas (GHG) emissions responsible for the current climate problem are attributed to the food industry (2022).

According to Project Drawdown, reducing food loss and waste is the most effective approach to combat the climate crisis and lower emissions. Wastage and loss of food contribute up to 10% of global emissions, so addressing this issue is essential to meeting the 1.5–2°C(2.7–3.6-

°Fahrenheit) warming target set by the Paris Agreement.

The energy and resources required to produce food that is wasted, also methane released during food riots in fields or landfills, are the sources of emissions related to food loss and waste. Methane has more than 80 times the warming capacity of carbon dioxide but having a shorter half-life than CO2. We can prevent the emissions that contribute to global warming by reducing food loss and waste.

To tackle the issue of food waste and its impact on climate change in India, it's imperative for individuals, families, and policymakers to champion sustainable food practices, curbing food

Statement of the Problem:

1. Escalating greenhouse gas released from food waste in India necessitate urgent measures for waste reduction and sustainable management to mitigate environmental impact.
2. Resource depletion and environmental degradation stemming from unsustainable practices demand immediate action to promote sustainable resource management and conservation efforts.
3. The absence of public awareness and involvement concerning environmental issues highlights the necessity for intensified education and outreach campaigns to cultivate a culture of sustainability and collective action.

Objectives of the Study:

- To investigate the escalating greenhouse gas (GHG) emissions from food waste in India.
- To examine the environmental consequences of wastage of food, focusing on resource depletion and ecosystem degradation in India.
- To assess the Current level of public awareness regarding the environmental impact of food waste in India.

Hypothesis:

Hypothesis 1

Null Hypothesis (H0): The educational level of the respondents is negatively related to the willingness to adopt the measures of the Government.

Alternate Hypothesis (H1): The educational level of the respondents is positively related to the

willingness to adopt the measures of the Government.

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Hypothesis 2

Null Hypothesis (H0): Food waste does not contribute to resource depletion and environmental degradation.

Alternate Hypothesis (H1): Food waste contributes to resource depletion and environmental degradation.

Research Methodology:

The research is grounded in both primary and secondary data sources. It is characterized as analytical, applied, and quantitative in nature. Primary data collection involved the administration of a questionnaire comprising 18 closed-ended questions and conducting interviews. The sample size consisted of 50 respondents from the KDMC region, and interviews from plant engineers, real-estate developers, and NGOs.

Secondary data was sourced from various publications, books, research papers in journals, as well as articles from newspapers and magazines. The collected data underwent analysis using techniques such as Analysis of Variance (ANOVA) and percentage analysis. Visual aids such as pictorials, graphs, charts, and statistics were utilized where necessary to aid in explanation. Proper citation of data sources is provided in the bibliography.

Limitations of the Study:

The extensive scope of the topic posed a significant limitation to the study. With India's vast population, extrapolating findings from a sample size of only 50 respondents proves challenging. Additionally, the geographical area of study was confined to the Kalyan Dombivli Municipal Corporation (KDMC), further limiting the generalizability of the results.Furthermore, constraints such as insufficient time and funding added to the limitations of thestudy.

Review of Literature:

Circular economy principles promote sustainable food waste reuse through green methods like anaerobic digestion, composting, and enzymatic treatment. Co-digestion advancements improve waste stream treatment efficiency, while pre-processing and optimized parameters enhance bioconversion and yield of valuable products. (Zeba Usmani, 2021)

Efficient food waste management requires critical evaluation of energy, environment, and economic aspects. Current technologies include composting, anaerobic digestion, pyrolysis, landfill, and biochemical methods, but sustainable approaches are needed. (Adithya Sridhar, 2021)

The potential of biogas production from food waste co-digestion with activated sludge, addressing energy demand, pollution, and wastewater treatment challenges. Biochar's properties can improve efficiency and stability, while pretreatment and co-digestion further enhance the process. (Santhana Raj Deena, 2022)

Given the global impact of food waste, consumers should assess their choices and lifestyles, taking small steps toward sustainability and zero food waste to secure a better future with ample resources for generations to come. (B. Rakesh, 2024)

Study addresses the challenge of household food waste, highlighting the need for targeted interventions. Utilizing an Impact-Likelihood methodology, it identifies impactful and likely- to-adopt behaviours through expert surveys and household data. The resulting matrix aids policymakers in strategically prioritizing effective proceeds towards for reducing food waste in diverse contexts. (Mark Boulet, 2023)

Study inspect the "Clean Your Plate" campaign's impact on Chinese university students' food waste. Results show a 2.80% lower probability of waste among familiar students but no significant correlation with weight. Using food-saving videos did not improve reduction results. The campaign's effectiveness in waste reduction seems limited. (Long Qian, 2024)

Data Analysis:

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The primary data collected for this study through a survey and few interviews studies the various aspects related to food waste and its effect on the environment. The analysis focuses on identifying gaps between awareness about food waste and the various practices related with the same.

Interview:

In light of the enormity of the problem and understanding that the scope does not limit to an individual level rather expands beyond it, interviews with industry experts were conducted to draw deeper inferences and discuss feasible solutions to this mounting challenge before mankind.

Interviewees included –

Mr. Suraj Valambi (Waste Management Department - KDMC)

Ms. Poornima Manahor (Head - Nisarg Premi)

Mr. Asish Darade (Director - Borgaonkar Group)

Mr. Satish Rane (Engineer)

Public Participation:

“Municipal authorities have put lots of money, crores of rupees, into managing waste properly. But a big problem we face is that people don't separate their waste. Even though we gave out free bins to homes and got a good response at first, people went back to old habits for not

separating their waste. This causes problems for the environment and costs the government more money,” said Mr. Suraj Valambi.

"At our organisation, Nisarg Premi, we run different programs to teach people eco-friendly ways of dealing with food waste. Unfortunately, the response from people hasn't been what we hoped for. They attend our programs, learn about better practices, but then often go back to their old, unsustainable ways of managing waste. It seems that many people aren't fully aware of the climate impact of improper waste disposal and how it can affect them personally. This lack of awareness is a big reason why they don't adopt more sustainable practices," said Ms. Poornima Manahor.

This observation aligns with the primary data collected from the general public. It's clear that there's a significant lack of knowledge regarding the climate impact of food waste, which is a concerning issue that requires immediate attention and action

Inhouse Waste Composting:

"Inhouse waste composting presents an ambitious vision, but its implementation faces significant challenges, primarily due to funding constraints and the lack of public participation. Establishing an in-house degradable waste composting system requires substantial funding, which could be mitigated by government incentives. However, the success of such systems hinges on strict adherence to waste segregation practices by the public, a behaviour that is often lacking. Without disciplined participation, the realisation of sustainable goals may be hindered," said Mr. Asish Darade.

"Inhouse composting seems achievable if the government provides incentives for it. Without government rules and

incentives, it's unlikely that property developers would adopt such practices," said Mr. Satish Rane.

Inhouse composting is highly practical and feasible. However, there are few challenges that must be addressed to bring it to life. Once implemented, it would offer significant benefits from both a climate perspective and for the well-being of our nation's people.

Hypothesis Testing:

Testing the significance between the level of education of the respondents and their willingness to follow waste segregation practices set by the Government.

Null Hypothesis (H0): The educational level of the respondents is negatively related to the willingness to adopt the measures of the Government.

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Alternate Hypothesis (H1): The educational level of the respondents is positively related to the willingness to adopt the measures of the Government.

Anova: Single Factor					
Groups	*Average*	*Variance*	*F*	*P-value*	*F crit*
Education	2.64	0.847347	40.1876	7.08726E-09	3.938111
Waste Segregation Practice	1.72	0.205714		significant	

Source: Primary data

Table No: 1 - Significance between the education levels of the respondents and their willingness to follow waste segregation practices set by the Government.

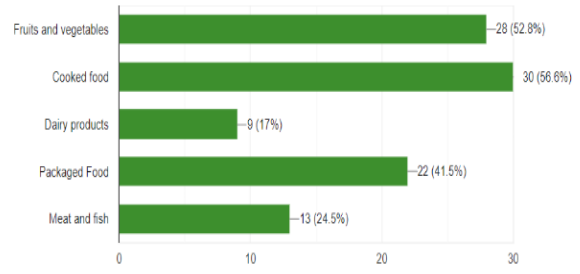
To ascertain the relationship between the educational levels of the respondents and their willingness to adopt the measures for food waste reduction by the Government, an ANOVA was conducted. The results are shown in the table above.

The p-value is less than 0.05 (5%) significance level. Hence the null hypothesis, 'The educational level of the respondents is negatively related to the willingness to adopt the measures of the Government.' is rejected at 5% significance level. Therefore, the alternate hypothesis, 'The educational level of the respondents is positively related to the willingness to adopt the measures of the Government.' is accepted.

Percentage Analysis

Null Hypothesis (H0): Food waste does not contribute to resource depletion and environmental degradation.

Alternate Hypothesis (H1): Food waste contributes to resource depletion and environmental degradation.



Source: Primary data

Chart No: 2 - Contribution of food waste in resource depletion.

From the above data, all the scenarios negatively impact the environment and resource depletion. The disposal of cooked food contributes the most as a significant number of resources are used in the process of cooking food.

According to percentage analysis method, the null hypothesis (H0): Wastage of Cooked

food does not contribute to resource depletion and environmental degradation) and accept the alternative hypothesis (H1: Wastage of cooked food significantly contributes to resource depletion and environmental degradation).

Summary of Findings:

There exists a deficiency in public awareness regarding the environmental impact of waste. It reveals a pervasive disregard for proper practices of waste management among individuals, exacerbated by the lack of proactive measures taken by municipal authorities to address the issue.

The study underscores the significant loss of resources attributable to food wastage. Each instance of discarded food represents a squandering of resources utilized throughout the food preparation process, highlighting the inefficiencies inherent in current consumption patterns.

The research findings highlight the significant carbon emissions linked to municipal

food waste disposal practices. Urgent action is warranted to initiate a robust transformation in governmental approaches to food waste management and disposal, emphasizing the need for decisive measures to mitigate environmental impact effectively.

Suggestions:

Food waste is a challenging issue with no simple solution. While government authorities are promoting awareness campaigns on proper waste disposal, more action is needed. It's crucial for individuals to grasp how food waste impacts them personally.

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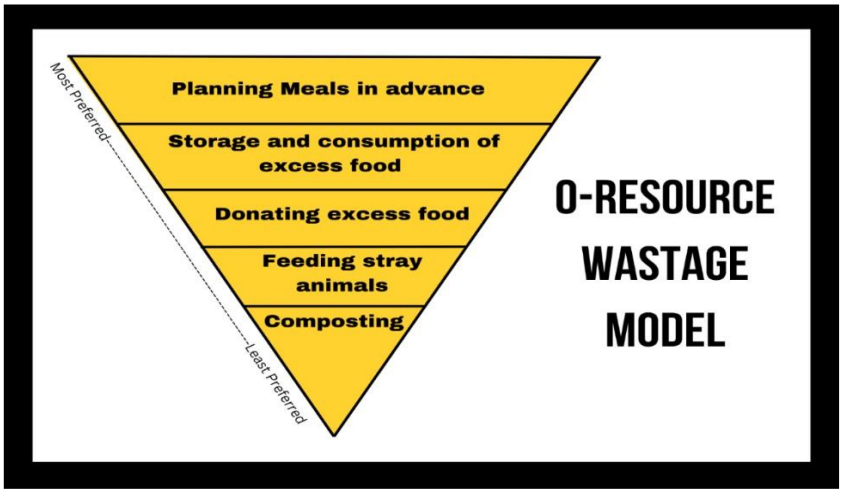
Everyone must recognize their role in reducing waste and disposing of it sustainably. Collaborative and responsible efforts from everyone are essential to address this issue effectively.

The following propositions are among the many restructurings that will facilitate taking positive steps towards sustainability by reducing waste and ultimately reaching zero waste.

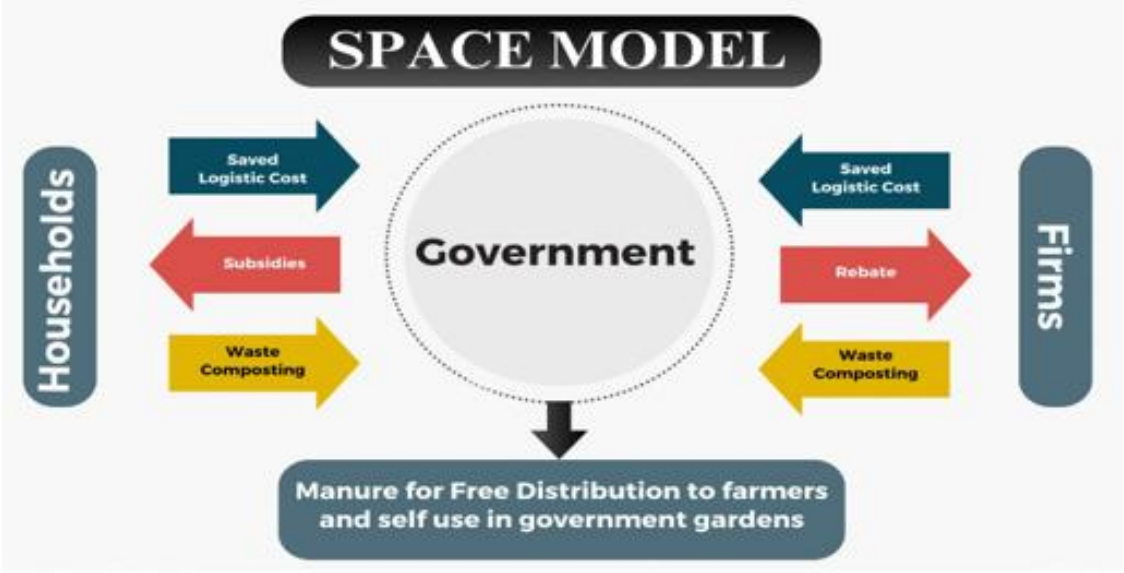
0-Resource Wastage Model



The 0-Resource Wastage Model presents a transformative framework aimed at minimizing resource wastage across various stages, striving towards achieving zero resource wastage goals. The initial step involves meticulous meal planning to ensure consumption aligns with requirements. Any surplus food can be appropriately stored for future use or donated to individuals in need, including stray animals. Remaining food scraps can be repurposed for composting, maximizing resource utilization.

Adhering to the principles of the 0-Resource Wastage Model enables us to significantly reduce waste, effectively optimizing resource utilization and moving closer to achieving net zero waste outcomes.

Sustainable and Participative Approach to Conserve Environment (SPACE) Model



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SPACE is an innovative and transformative approach which aims to significantly diminish the carbon footprint linked to the food waste disposal systems. Under the SPACE, we advocate for a transition from traditional waste disposal practices towards a more sustainable model.

To implement this approach, we suggest that governmental bodies, the Nagar-Vikas Nigam responsible for guiding real estate development in India, mandate real estate companies to establish in-house food waste compost plants within housing complexes. This measure not only diminishes the burden on municipalities for daily waste collection and disposal but also eliminates the need for costly waste disposal infrastructure. Incentivizing real estate companies with subsidies for constructing these in-house waste disposal plants could encourage compliance.

Moreover, recognizing the significant contribution of restaurants and eateries to food waste, the government could enforce regulations requiring larger establishments to install in-house wet waste disposal plants. Offering tax concessions to businesses adhering to these regulations would further incentivize compliance.

The compost produced from these initiatives could be utilized in various government-owned spaces such as gardens and roadside greenery. Surplus compost could be distributed to farmers either free of charge or at a nominal cost, bolstering agricultural productivity in India, an agrarian nation.

Adopting the SPACE model would not only mitigate carbon emissions but also contributes to achieving the country's COP targets. By reducing the number of waste collection vehicles and machinery utilized in landfills, significant reductions in carbon emissions can be achieved. This

integrated approach addresses environmental sustainability while fostering economic incentives and agricultural development.

Conclusion:

In conclusion, addressing the pressing environmental challenges posed by food waste in India demands concerted efforts in raising public awareness and fostering municipal action. Despite the alarming rise in greenhouse gas emissions attributed to food waste, effective waste management practices are often overlooked.

The paper has put forth two innovative models: SPACE and the 0-Resource Wastage Model. The SPACE Model advocates for sustainable waste management practices, emphasizing in- house composting facilities and wet waste disposal plants, while the 0-Resource Wastage Model promotes meticulous meal planning, proper storage, and composting to minimize waste.

Implementing these models not only holds the potential to optimize resource utilization and achieve net zero waste outcomes but also contributes to environmental sustainability and economic development in India.

In embracing these solutions, we envision a greener, brighter, and sustainable tomorrow. One should remember that food waste is a choice, but by recognizing our shared responsibility to this Earth and its inhabitants, one can turn waste into resources and ensure that every plate is filled, every life nourished, and every corner of our planet thrives in abundance and harmony.

It is said that change does not necessarily guarantee progress, but progress implacably demands change. Each of us need to remember that it is not just about saving a plate today, it is about saving our Earth for a better tomorrow.

Together, let's pave the way for a future where sustainability is not just a goal but a way of life.

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