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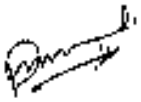
Editorial Note

CSIBER International Journal of Environment (CIJE) offers a venue where relevant interdisciplinary research, practice and case studies are recognized and evaluated. Increasingly, environmental sciences and management integrate many different scientific and professional disciplines. Thus the journal seeks to set a rigorous, credible standard for specifically interdisciplinary environmental research. CIJE is a multidisciplinary journal, publishing research on the pollution taking place in the world due to anthropogenic activities. CIJE welcomes submissions that explore environmental changes and their cause across the following disciplines like atmosphere and climate, biogeochemical dynamics, ecosystem restoration, environmental science, environmental economics & management, environmental informatics, remote sensing, environmental policy & governance, environmental systems engineering, freshwater science, interdisciplinary climate studies, land use dynamics, social-ecological urban systems, soil processes, toxicology, pollution and the environment, water and wastewater management, etc.

We invite authors to contribute original high-quality research on recent advancements and practices in Environment Management. We encourage theoretical, experimental (in the field or in the lab), and empirical contributions. The journal will continue to promote knowledge and publish outstanding quality of research so that everyone can benefit from it.

Er. D. S. Mali
Editor, CIJE



CSIBER International Journal of Environment (CIJE)

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Design and Analysis of Zero Energy Buildings

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Abstract
A net zero energy building is a residential or commercial building with greatly reduced energy needs through efficiency gains such that the balance of energy needs can be supplied with renewable technologies. The acute problem of carbon dioxide emissions reduction into the atmosphere becomes more important due to the fact of global climate change. Housing stock consumes 30 to 40% of all energy resources, according to various estimates. As a result, it is possible to get carbon dioxide atmosphere emissions reduction due to energy consumption reduction. The problem of housing stock energy efficiency improvement becomes very important and hence the zero energy buildings are the need of time. The acute problem of carbon dioxide emissions reduction into the atmosphere becomes more important due to the fact of global climate change. Housing stock consumes 30 to 40% of all energy resources, according to various estimates. As a result, it is possible to get carbon dioxide atmosphere emissions reduction due to energy consumption reduction. The problem of housing stock energy efficiency improvement becomes very important. Transition to low energy consumption buildings construction becomes a trend which shortly will transform into the task of Applied Research in the field of design and construction.

Keywords: Zero Energy, Day Lighting, U-Factor, Solar Energy, Rainwater Harvesting

Introduction
A zero-energy building also known as a net zero energy building, is a building with net zero energy consumption, meaning the total amount of energy used by the building on an annual basis is equal to the amount of renewable energy created on-site or in other definitions by renewable energy sources offsite, using technology such as heat pumps, high-efficiency windows and insulation, and solar panels. In India most of the energy used today is produced from fossil fuels like coal, oil, and natural gases, and a direct consequence of using these fuels is that greenhouse gases are released into the atmosphere, with one of the most significant being carbon dioxide (CO_2). The aim is to focus on the building to create a net zero by using renewable energy resources instead of non-renewable resources. We can use solar energy, wind energy, tidal energy, etc. to make the building net zero. We cannot use geothermal sources of energy at this level due to a lack of technology.In India some energy IS codes are developed for zero energy buildings, such as IGBC (Indian Green Building Council 2018), and ECBC (energy conservation building code 2017) It is an energy conservation building code for residential buildings to give a further fillip to India's energy conservation effort. It specified

code compliance approaches and minimum energy performance requirements for building services and verification framework eco Niwas Samhita 2021.

Literature Review

Mr. Nitin U Thakare, Mr. Utkarsh Manwar, Mr. Shivam Tiwari, Mr. Aman Shrivastava, Mr. Tejas Mothadharim, Design of Zero Energy Residential Building, IRJET Volume: 07 Issue-09, Sep,2020.

The prior motive of this research paper is to design a Net Zero Energy Residential Building. According to the study, a major effect of building on the total worldwide energy feasting level i.e. around 40% of the total energy is expended by only buildings becoming a major main energy consumptive part of the global structure. The study is carried out based on the need for zero energy building and the method of tumbling the building energy consumption and energy protection. The study has considered HVAC systems, Rainwater harvesting systems, sewage treatment, etc.

Paul Torcellini, Shanti Pless, and Michael Deru, National Renewable Energy, Laboratory Drury Crawley, U.S. Department of Energy.

A net zero-energy building (ZEB) is a residential or commercial building with greatly reduced energy needs through efficiency gains such that the balance of energy needs can be supplied with renewable technologies. The ZEB definition can emphasize demand-side or supply strategies and whether fuel switching and conversion accounting are appropriate to meet a ZEB goal. Four well-documented definitions—net-zero site energy, net-zero source energy, net-zero energy costs, and net-zero energy emissions—are studied; pluses and minuses of each are discussed. These definitions are applied to a set of low-energy buildings for which extensive energy data are available. This study shows the design impacts of the definition used for ZEB and the large difference between definitions. It also looks at sample utility rate structures and their impact on the zero energy scenarios.

Saravan Devraj, N Kaplan , T Nagaraja, Albert M, Studies on Zero Energy Building, International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 1 (2018)

In this work, a study is carried out to analyze the performance of a zero-energy building and found that it is possible to have such a building in India. The study will be carried out based on the need for zero energy building and methods of reducing the building energy consumption and energy conservation. A zero-energy building is located in BIEC, Bangalore for the study. This building is an energy-efficient building and uses renewable energy sources for heating and power generation to operate the electrical and electronic appliances.

Xenyiya Rakova, Elena Perlova, Mariia Platonova, Alexandr Gorshkov, Concept Project of Zero Energy Building, Science Direct (Elsevier)

The paper deals with the design of a building with energy consumption close to zero that is planned to be built on the Polytechnic University territory. After facility commissioning, the building will be the laboratory for energy-saving and innovative technologies in construction. During the operational phase, there will be energy monitoring of buildings, evaluation of walling's thermo-physical characteristics, and determining the actual values of energy consumption. This building will be equipped with modern measuring complexes and systems. The novelty of the project consists of an integrated approach to the house design, which will be entirely autonomous and independent from the urban networks.

Objectives:

- To provide a detailed, ambitious, clear definition and fast uptake of Zero Energy building.
- Possible technical solution of energy demand and energy production on site.
- Design a building with a zero-energy concept.
- To eliminate the necessity of active energy load on the building.

Methodology:

Passive solar design for house

Table 01: Calculation for on-grid system

Sr. No.	Description	Calculation
1.	Energy consumed by house per month is 201 units (201 kW) So, Per day	**201kW/28 = 7.17 kw**
2.	To find the requirement of the number of panels When we consider the panel of 335 watts then we require 3 panels for 1kw.	
3.	1kw panels can generate 4-5 kW/day The total number of panels required of 335 watts = 6 number.	**6 number of panels Required**
4.	Total cost required for 1 kW panels	**Rs. 73,976/-**
5.	Then the cost of the total panels For 2 kw and 6 panels	**Rs. 1,47,952/-**

Table 02: Recovery cost of installed panels.

Sr. No.	Description	Calculation
1.	Electricity cost of house per month	**Rs. 2900/-**
2.	Annual cost	**(12 x Rs. 2900)** **= Rs. 34800/-**
3.	Number of years required to recover the total cost of panels. Total cost required for installation Annual cost of electricity	**= Rs. 1,47,952** **Rs. 34,800**
4.	Numbers of to be required	**4 years and 3 months**

Table 03: Calculation for Off-grid system

Sr. No.	Description	Calculation
1.	Energy consumed by house per month is 201 units (201kw) So, Per day	**201 kW/28** **= 7.17 kW**
2.	To find the requirement of the number of panels When we consider the panel of 335 watts then we require 3 panels for 1kw.	
3.	1kw panels can generate 4-5 kw/day The the total number of panels required of 335 watts = 6 number	**6 number of panels Required**
4.	The total cost required for 1 kw panels.	**Rs. 71,442/-**
5.	Then the cost of the total panels For 2 kw and 6 panels	**Rs. 1,42,884/-**

Table 04: Recovery cost of installed panels

Sr. No.	Description	Calculation
1.	Electricity cost of house per month	**Rs. 2900/-**
2.	Annual cost	**(12xRs. 2900)** **= Rs. 34800/-**
3.	Number of years to be required for recover of total cost of panels. Total cost required for installation Annual cost of electricity	**= Rs. 1,42,884** **Rs. 34,800**

4.	Numbers of to be required	**4 years and 1 month**

Table 05: Calculation for Hybrid system

Sr. No.	**Description**	**Calculation**
1.	Energy consumed by a house per month 201 units (201kw) So, Per day.	201 kW/28 = 7.17 kW
2.	To find the requirement of the number of panels When we consider the panel of 335 watts then we require 3 panels for 1kw.	
3.	1kw panels can generate 4-5 kw/day The the total number of panels required of 335 watts = 6 number	6 number of panels are required
4.	The total cost required for 1 kw panels.	Rs. 1,14,770/-
5.	Then the cost of total panels for 2 kw and 6 panels	Rs. 2,29,540/-

Table 06: Recovery cost of installed panels.

Sr. No.	**Description**	**Calculation**
1.	Electricity cost of house per month	**Rs. 2900/-**
2.	Annual cost	**(12 x Rs. 2900)** **= Rs. 34800/-**
3.	Number of years to be required for recover of total cost of panels. Total cost required for installation Annual cost of electricity	**= Rs. 2,29,540/-** **Rs. 34,800/-**
4.	Numbers of to be required	**6. years and 7 months**

Water Requirements of House

Reuse of Water

- Use of water for Gardening purposes
- Area of garden = $45m^2$
- Daily use of plain water for the garden
- $1m^2$ area of garden use water weekly = 25 liters

- Total quantity of water use (45 m^2 area) = 45x25 = 1125 litres per week
- Daily use of water = 1125 / 7 = 160 liters per day.
- Assume the family in the house consists of 6 persons.
- Use of quantity of water per person 135 liters per day (standard)
- X 6 = 810 litres
- **Per day use of water = 810 liters**

- **Use of daily water per person**

1. Bathing = 50 liter
2. Drinking = 5 liter
3. Cooking = 5 liter
4. Washing Clothes = 20 liter
5. Washing of House = 10 liter
6. Flushing = 25 liter
7. Washing of Utensils = 20 liter

Total water used = 135 liter

Reuse of water for washing utensils and House

- Washing of Utensils / Kitchen = 20 liter
- Washing of House = 5 liter
- Total Water reused = 25 liter

Reuse of water for daily purposes

- 1 Person = 25 litre
- For 6 people in the Building
- 25 x 6 = 150 litre
- Daily Reuse of water
- For garden = 150 litre / day
- Total water required for Garden per day = 165 liter
- So we use 15 liters of regular water for garden
- The cost of the water reduced for the garden is 90 – 95 %

U-factor or U-value

Thermal transmittance also known as the u value is the rate of transfer of heat through a structure (which can be a single material or a composite), divided by the difference in temperature across that structure. The units of measurement are **W/m^2 K**. The better the insulated structure the lower the U-value will be. When we talk about the U-value of a particular component of a building such as a wall or roof we are describing how well or how

badly that component transmits the heat from the inside (usually) to the outside. On winter days or cold days, there is warmth and cozyness inside the house or building. We will be happier because of the lower U-value. It means that our wall or roof is quite good at holding up the heat getting to the outside. The component might be a homogeneous material (such as a concrete slab) or a series of materials in contact (such as a burnt brick wall) the technical name for the U-value is thermal transmittance. The U-value of building components like walls or roofs, measures the amount of energy (heat) lost through a sq. m (m^2) of a material for every degree (K) difference in temperature between inside and outside.

Units used for the calculation of the U-value are:
Energy: - flows along in watts (measured in joules)
Temperature: - temperature is measured in degrees kelvin which practically is a degree Celsius.

R-value: R-value is the capacity of an insulating material to resist heat flow. The higher the R-value, the greater the insulating power.
Units for R-value: - (m^2. K/W).
Calculation of the U-value of the components of the building
1) Wall: To find RI (the thermal resistance of the component)

RI = TiKi
Ti is the thickness of material (m)
Ki is the thermal conductivity of the material (W/m. K)

Data considered for calculation (taken from ECBC code 2017)

Ti = thickness of burnt brick + thickness of internal plastering + thickness of external plastering
Ti= 200+ 12.5+ 12.5 = 225 mm
The value of Ki is taken from ECBC code 2017 Table: 6

RI= TiKi
= 225/ 0.9
= 0.225/0.9
RI= 0.25 m^2. K/W…… Thermal resistance

Now to calculate the RT

RT =1hi + 1ho + RI (R1 +R2……)

T is the total thermal resistance m2. K/W
hi is the inside air heat transfer coefficient, W/ (m^2. K)
ho is the outside air heat transfer coefficient, W/ (m^2. K)
R1 is the thermal resistance of material 1, m^2. K/W

=19.36+ 119.86 + 0.25

RT = 0.40 m^2

To find U value: - 1RT

U =1RT

=10.40

U-value= 2.5 W/m^2. K

2) R.C.C Roof: - To find RI (the thermal resistance of a component)

Ti is the thickness of material (m)
Ki is the thermal conductivity of the material (W/m. K)
RI = TiKi

Data considered for calculation (taken from ECBC code 2017)

Ti = 165mm (100mm thickness of slab + 15mm off internal plastering + 40 mm thickness of expanded polystyrene of density 24 kg/m)
Ti= 0.165 m
Ki=for R.C.C Concrete = 1.58 W/m. K
For internal plastering = 0.72 W/m. K
For Expanded polystyrene = 0.035 W/m. K
The total value of KI = 2.338 W/m. K

To calculate RI

RI = TI / KI
RI =0.152.338
RI = 0.059 m^2

To calculate RT

RT =1hi + 1ho + RI (R1 +R2……)
hi is the inside air heat transfer coefficient, W/ (m^2. K)
ho is the outside air heat transfer coefficient, W/ (m^2. K)
RT=19.36+ 119.86 + 0.059
RT = 0.20 m^2. K / W
U value = 1RT
U value = 10.20
U value = 4.34 W/m^2. K

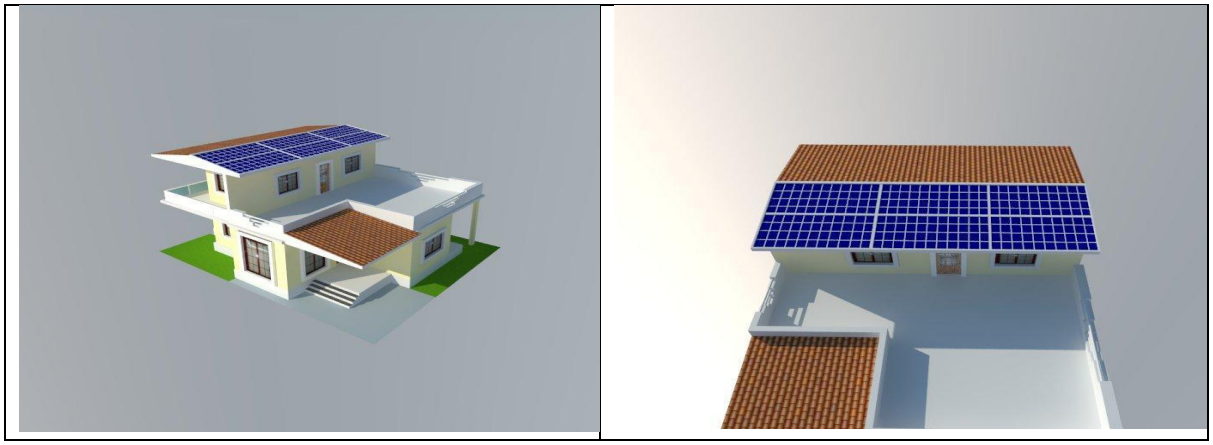

Fig 1: Proposed design of a Bungalow based on Zero Energy concept.

Conclusion

Daylighting: - When properly designed, daylighting can provide significant energy saving for building owners**.** Daylight directly affects the physiological health of building occupants and their overall well-being.
U-factor: - The results got to have a lower U-value after calculation when we compared it with the ECBC code 2017 U-values. As we know that lower U-value means a happier and healthier atmosphere inside the building.
Rainwater harvesting: - Collection of water in every possible way and every possible place it falls and store it. It can be concluded that rainwater, if conserved and utilized, can be an effective tool for replacing groundwater resources.
Passive energy: - As we observed we found that we can use renewable energy to generate energy sources by which we can save the cost of energy sources like energy bills.
Water reuse: - The pure water which is used for domestic purposes can be reused again for gardening purposes, hence we can reduce the cost of pure water by using reused water for gardening. Hence by these, we can reduce 90-95 % use of pure water.

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Bioplastic: A Sustainable Alternative for Single Use Plastic Food Packaging and Study of Hotels Attitude towards this Packing

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Abstract

Bio based plastic is made from renewable substances as an alternative to non-renewable fuels. Examples of Renewable carbon substances include corn, potatoes, rice, soy, wheat, and Oil. Biobased plastic can be partly or entirely biobased. This report presents a review of biobased or bio-degradable plastics, especially for food parcels and other packing purposes. Biobased plastic refers to either the biobased plastic or the bio-degradable characteristics of plastics. In this report, a clear distinction is made between biobased plastics and non-decomposable plastics. The basic aim of this research study is to collect more details about biobased plastic and information from different hotels in Tirunelveli, and their perspective related to this biobased plastic. This research report is about survey interpretation from the hotels where the one-time use plastics are banned and replaced with the usage of bioplastic to know their perspective about bioplastic. In addition, more details, about the positive and negative consequences of b from the perspective of hotels. A few questionnaires are asked to them to know the distinction between non-degradable plastic and biobased plastic in their hotel business. The surveys are collected on the hotels in Tirunelveli district of Tamil Nadu. After the methodology in hotels, it is clear that biobased plastics have many drawbacks rather than benefits from the perspective of the hotels. By methodology, I came to know that the hotels are using these biobased plastics at a loss, as it is more overpriced than the normal plastics. There are other consequences in the packaging (while using) these biobased plastics because these biobased plastics are not able to bear a temperature of more than 50^0C, thus food is not able to serve the food Faster than when using normal plastics. Not only that this biobased does not have much more holding capacity as compared to normal plastics because the bags they use are less than 50 Microns

Keywords: Biobased Plastics.

Introduction

Plastics are a comprehensive of artificial substances that use polythene as a main component. The flexibility during the production process makes it possible for plastic to be cast into solid objects of various shapes, making it a versatile product for many different uses. Plastics are made from non-biodegradable substances through polymerization or polymer condensation methods. After the origination of one-time plastic, it became part of the daily routine of humans because it is very easy to handle and disposable. About trillions of one-time-use plastics are used yearly across the world. The inclining population increases the usage of plastic which

leads to the production of plastic increases along with the pollution of plastic. Chemicals present in plastics are absorbed by human bodies. Not only humans, it also affects the marine and other animals. Most of the plastic items in our daily lives are used once and then chucked: grocery bags, plastic wraps, one-time-use cutlery, straws, and coffee cup lids. Plastic remains deep in landfills and toxic chemicals pollute groundwater by leaching. This has become a big issue in all developing and under-developing countries including India. To stop this plastic-related problem many Indian state governments have banned the usage of One-time plastic. Every country in the world is looking towards Innovations and another great replacement for bad plastic. Plastic pollution has become very problematic for the world. Our Indian government is also thinking of a new and better replacement for plastic. One of the very good and eco-friendly innovations is eco-plastic or bio-plastic. Biobased plastics are those plastic substances that are manufactured by using natural resources. Biobased plastic is a substance made from organic biomass sources, unlike artificial plastics which are made from the non-biodegradable substance. Bioplastics are made through several different processes. Some Use a microorganism to process base materials, such as cellulose, vegetable oils, and starches. Bioplastic is made from plant material and it should decompose relatively quickly in Landfills and, in some cases, compost bins. The most common forms are starch-based, like plastic, which is the most common foRM. BIOBASED PLASTIC CAN BREAK DOwn in 180 days, given the suitable conditions.

Literature Review

A brief review of the past studies related to bioplastic and their uses in food industries according to the N.A. MostafaaAwatef and his co-authors in their article, Production of biodegradable plastic from agricultural Wastes, explain that Agricultural residue management is considered to be a vital strategy to accomplish resource conservation and to maintain the quality of the environment. In recent years, bio-fibers have attracted increasing interest due to their wide applications in food packaging and the biomedical sciences. These eco-friendly polymers reduce rapidly and replace the usage of petroleum-based synthetic polymers due to their safety, low production costs, and biodegradability. This paper reports an efficient method for the production of cellulose acetate bio-fiber from flax fibers and cotton linters. The used process satisfied a yield of 81% and 54% for flax fibers and cotton linters respectively (based on the weight of the cellulosic residue used).

The structure of the produced bioplastic was confirmed by X-ray diffraction, FT-IR, and gel permeation chromatography. Moreover, this new biopolymer is biodegradable and is not affected by acid or salt treatment but is alkali labile. A comparison test showed that the produced cellulose acetate was affected by acids to a lesser extent than polypropylene and polystyrene. Therefore, this new cellulose acetate bioplastics can be applied in both the food industry and medicine.

Another article on Bioplastics in Food Packaging: Innovative Technologies for Biodegradable Packaging by the author Lillian Liu San Jose explains, that the challenges surrounding plastics waste treatment are multifaceted and complex – and, as numerous studies have indicated, are further being compounded as time progresses. It will be up to future generations of society to produce the necessary resources to address this growing environmental concern with viable, long-term solutions. Truly innovative global research and development has resulted in today's emerging field of bioplastics. By combining the disciplines of agricultural biology, food packaging, and microbiology, new biodegradable packaging solutions made from renewable plant resources are helping to address this environmental concern of rampant worldwide growth in plastics waste. It is important to recognize that although past and recent efforts have thus far yielded significant strides in the field of bioplastics, continued research in this field is needed if economically viable development and sustainable production processes are to be widely implemented throughout the world. As with any emerging technology, continued innovation and global support are essential for bioplastics to fully demonstrate its socioeconomic benefits and further challenge the status quo of traditional petroleum-based plastics.

Another article by the author Muthusamy Selvamurugan on the article Bioplastics – An Eco-Friendly Alternative to Petrochemical Plastics explains that plastics have varied applications and have become an essential part of our daily lives. The use of plastics has increased twenty-fold in the past half-century and is expected to double again in the next 20 years. As a global estimate, around 330 million tons of plastics are produced per annum. The production, use, and disposal of plastics emerged as a persistent and potential environmental nuisance. The improper disposal of plastics ends up in our environment, resulting in the deaths of millions of animals annually and also the reduction in the fertility status of the soil. The bioplastics products are manufactured to be biodegradable with similar functionality to that of conventional plastics, which has the potential to reduce the dependence on petrochemicals-based plastics and related environmental problems. The expansion and development of bioplastics and their products would lead to an increase in the sustainability of the environment and a reduction in the emission of greenhouse gases. The bioplastics innovation would be a key to the long-term solution for plastic pollution. However, widespread public awareness is also essential in effecting longer-term change against plastic pollution.

Another book Innovations in Food Packaging, a volume in Food Science and Technology chapter 15 - utilization of Bioplastics for the Food Packaging Industry by authors Young-Jae Byun, and Young Teck Kim, reviews the bioplastics market. Most market reports claim that the bioplastics market is growing. In 2011, bio-based pets had the highest production capacity followed by bio-based pets. Among biodegradable and compostable bioplastics, pla

had the highest production capacity. It is expected that non-biodegradable bioplastics, such as bio-based pe, pp, and pet, will lead the entire bioplastics market over the next 10 years. Braskem, coroplast, coca-cola, Nature Works, novamont, and Pepsico, are major key players in the current bioplastics market. New technologies for bioplastic production will emerge over the next 10 years.

The other article on Bioplastics from agro-wastes for food packaging applications by authors Isabel Gonçalves de Moura, Arsénio Vasconcelos de Sá, Ana Sofia Lemos Machado Abreu and Ana Vera Alves Machado says, that Bioplastics exhibit unique properties and can be produced from plants and crop wastes, among others, cellulose, proteins, and starch are some of the examples. Due to environmental concerns, it is of high priority to replace conventional plastics with bioplastics, and even better if they are directly synthesized from agro-waste. Green chemistry methodology is applied to extract natural polymers, such as cellulose, from vegetable wastes. This article focuses on the preparation of new functional biopolymers for packaging based on extracted cellulose, which exhibits broadly tunable thermomechanical properties and biodegradation. Therefore, this contribution shows the potential of agro-wastes to produce new cellulose-based bioplastics for food packaging applications

Another article Sustainable bioplastics derived from renewable natural resources for Food Packaging by authors Xianhui Zhao 10, Ying Wang 10, Xiaowen Chen, Arthur Ragauskas, Soydan Ozcan, Hongli Zhu explains, that Food packaging is one of the leading sectors for the end use of plastics. Bioplastic is produced from natural renewable resources such as crops, wood pulp, and herbaceous fibers. This article summarizes the rational design of bioplastics from natural resources for food packaging. The bioplastic properties considered include thermal properties, mechanical performance, oxygen/moisture resistance, and biodegradability. Bioplastic degradability and technologies for handling bioplastic waste are discussed. Various aspects of the sustainability of bioplastics (e.g., environmental profile, techno-economic analysis, and societal impact) are investigated. The main challenges of bioplastic application, such as low fracture strain and inferior barrier properties, are discussed. Mitigation approaches to overcome the mechanical properties of bioplastics, such as adding plasticizers, are also discussed. Bioplastic can have properties comparable with fossil-based plastics. Bioplastic can be an alternative to conventional plastic in most applications of food packaging, which can reduce the carbon footprint and environmental impact because of its biodegradability.

The article on Bio-Based Bioplastics in Active Food Packaging by authors Elena Stoleru, Anamaria Irimia, and Elena Butnaru says that Plastics are the most common packaging materials and bioplastics (in particular biologically derived plastics) proved, that they can

be used in active food packaging applications, mainly in applications that include products with short shelf-life. The bio-based bioplastics are split into two categories, namely, biodegradable and non-biodegradable materials. Relatively recent is evidenced that bioplastics can represent a solution to overcome the drawbacks associated with the conventional plastics used in food packaging (environmental issues, health problems, etc.). Packaging plays an important role in maintaining food quality and active packaging appears to be a smart solution to successfully extend shelf-life or to enhance food quality and safety. This chapter aims to review the latest developments and challenges in the field of bio-derived plastics applied in the food packaging sector (focusing on active food packaging). It highlights the bio-derived plastics most used in this field and their advantages and limitations over common plastics and gives an overview of the recent developments in active food packaging applications

Methodology

Qualitative & Exploratory Research. Visited 5 Hotels (having more than 2 branches) in Tirunelveli Tamil Nadu.Biobased plastics are plastic materials produced from degradable biomass substances, such as oils and fats of vegetables, starch of corn, food waste which are recyclable, etc. Bioplastic can be Made from agricultural waste and also from used plastics by using microorganisms. Application areas identified in India for biobased plastics are Agricultural compost, pharmaceutical packing, Industrial Packaging, Milk pouches, food centers, Personal Care, Medical Devices, etc.

The Tamil Nadu government has banned plastic packaging of items even at the manufacturing Stage. The Environment and Forest Department issued an order (https://tnpcb.gov.in/pdf/GO/G.O_84_BanPlastic3718.pdf).It Has to be enforced with immediate effect, but it is unclear how authorities will proceed with this enforcement. Ever since the ban on plastics was announced by the Tamil Nadu government, hotels and Restaurants across the State have been working on various options and some have even adopted Innovative methods. However, once the industries here start producing the bio bag, all the hotels in the city will switch over to it. These are very effective and environment friendly too. The survey was collected from the hotels in Tirunelveli Tamil Nadu and collected their perspective Related to these plastics

Results and Discussion

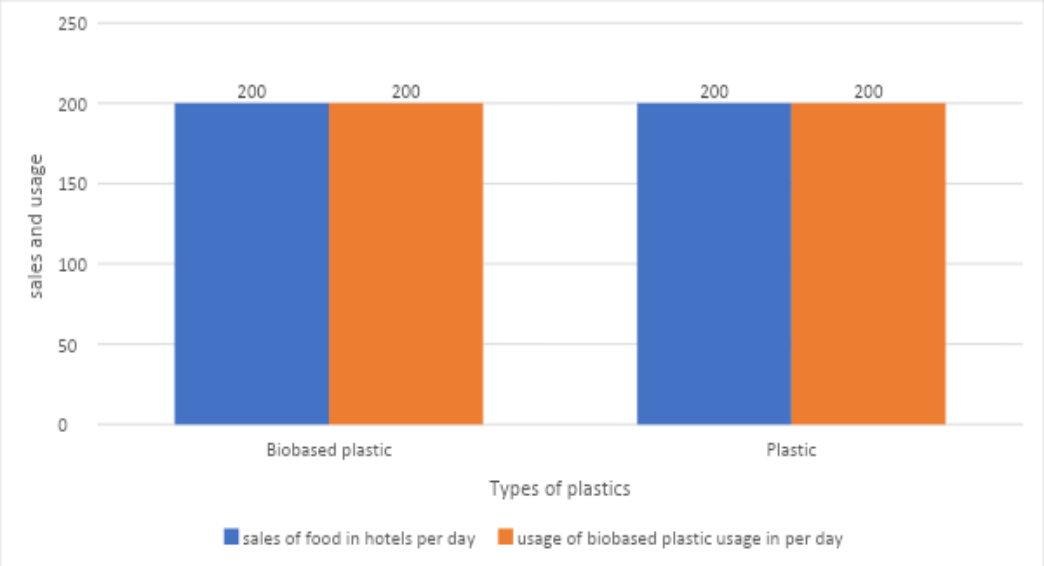
Perspective of people about bioplastic (hotels)
Questionnaire of hotels about bioplastics. (Methodology)

The methodology is done through a questionnaire and the sample size of hotels is 5 (hotels having more than 2 branches in the city)

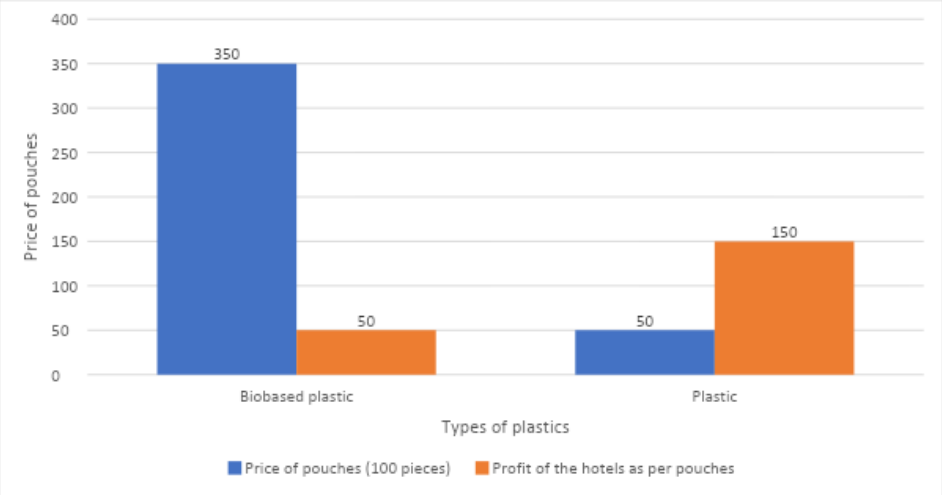
1. How much quantity of eco plastic did you use for a day?
   Response: The quantity used depends upon the sales of the food on that day. But approximately more than 200 packaging packs.
2. How did you manage the price of this eco-plastic compared to normal plastic?
   Response: The prices of the bags are higher than the normal plastics they used before. Rather than loss, they don't collect extra money from Customers.
3. Is eco-plastic easy to handle?
   Response: It is not very easy to handle but the foods should not be more than 50oc while packaging.
4. As per you what is the difference between the bioplastic and normal plastic?
   Response: There are many differences between both of them like not easy to package and low holding capacity and profit-wise loss to them from these bioplastic packages.
5. Do you have any problem buying or using this plastic?
   Response: There is no problem related to buying these plastics but there are a few problems while using them like packaging was difficult.
6. Where did you buy this bioplastic?
   Response: They are supposed to buy these bioplastics from the companies that are producing them with the proper licenses. They do not buy this from any local companies because the government is strict about these bioplastics.

Data Analyses of the Hotels Survey

Usage comparison of biobased plastics and plastics in hotels

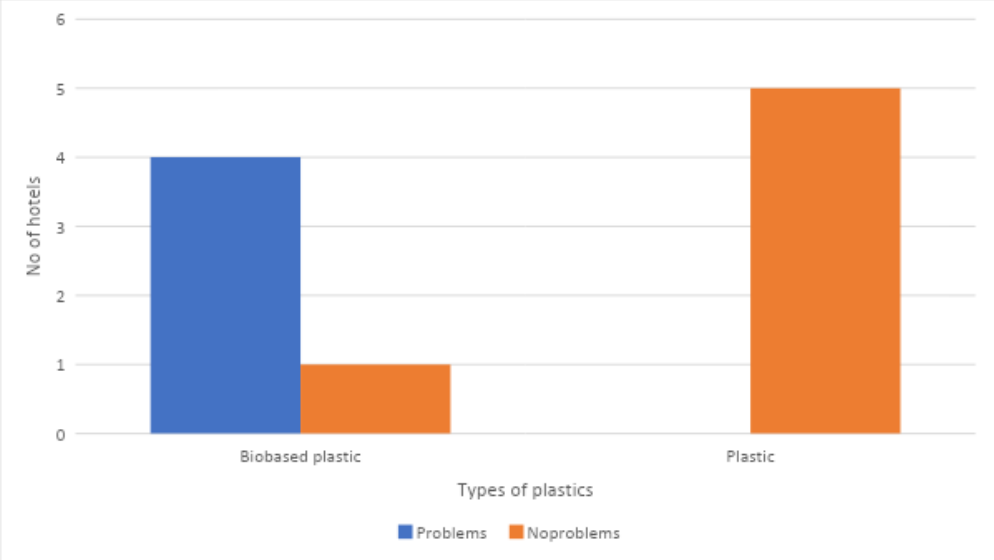


According to analysis no changes in the usage of plastic and biobased plastics. The usage of bioplastics depends on the sales of the food in the hotels Price and profit comparisons of the hotels by using biobased plastics in replacement of plastics



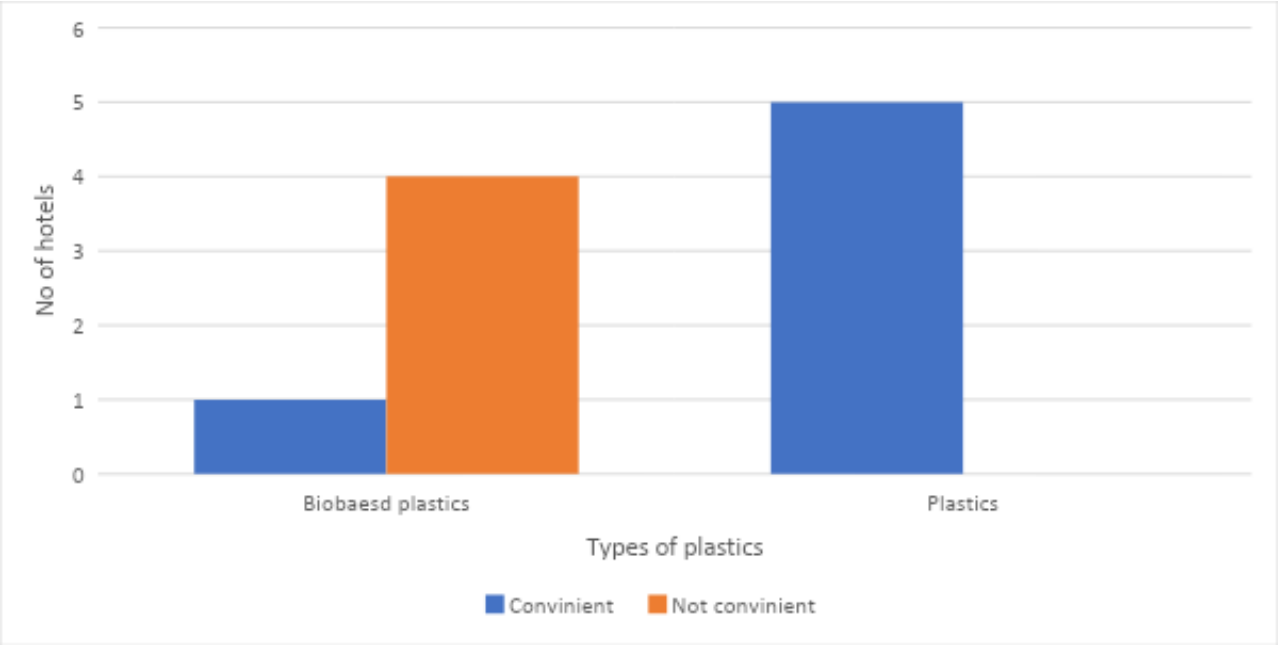
According to analysis, the profit of the hotels is less in the usage of biobased plastic compared to normal plastics

Problems related to plastic and biobased plastics



According to analysis biobased have more problems related to packaging and holding capacity while normal plastics have no problems

4. Handling was convenient or inconvenient



According to analysis, biobased plastics are less convenient as compare to plastics

Table 1: Comparison between Bioplastic and Non-Decomposable Plastics

Comparison Between Bioplastic and Non-Decomposable Plastics			
Sr.No.	Characteristics	Conventional plastics	Biobased plastic
1.	Energy consumption in production	Energy consumption is high due to the usage of fossil fuels.	Low energy consumption compared to conventional plastic. Comparatively lower than fuel-based plastic production
2.	Raw Materials	Non-renewable resources are used to make these plastics like petrol and other fossil fuels.	Renewable resources are used to make this type of plastic. Biomass obtained from starch of corn, sugarcane, potato, and other renewable crops is also used.
3.	Carbon Footprint	The carbon footprint is very high as petroleum is involved	Carbon footprint is very low as compared to conventional plastic. Less emission of

			CO2 which is significantly less than traditional plastics
4.	Presence of chemicals	It contains polyvinyl chloride (PVC). It is the most toxic and the most harmful form of plastic. It also contains bisphenol A (BPA), lead, phthalates, mercury, dioxins and cadmium	Mostly made by plant-based and renewable substances. Thus, less presence of any toxic chemical
5.	Biodegradability	It could take more than 500 years to decompose completely or need to be recycled. Can stay on land for a long time and can cause problems to the soil.	Decomposes within 180 days if decomposed in the right environment; releases methane on decomposition which can be harnessed to produce energy
6.	Arable land usage	No agricultural lands are used to manufacture this conventional plastic.	Currently, very low agricultural lands are used
7.	Effect on holding contents	Fails to retain the flavor and scent of the food stored in them; potentially releases harmful substances in the food on long exposures	Retains the original flavor and scent of the food being carried in them
8.	Handling and holding capacity	Easy to handle and easily hold heavy things	Little difficult to handle and lightweight things because of less thickness
9.	Price.	The price is very low.	The price is very high compared to conventional plastics. Comparatively higher than conventional plastics due to less technology development

Conclusion

After this methodology, it is clear that biobased plastics have many drawbacks rather than benefits from the perspective of the hotels. Biobased plastics are eco-friendly and safe for humans and animals, but not friendly for hotels that are using them. By methodology, I came to know that the hotels are using these biobased plastics at a loss, as it is more costly than plastics. There are other problems in the packaging (while using) this biobased because this plastic is not able to bear temperatures more than 50^0C, thus food is not able to serve the food faster than when using normal plastics. Not only that, these biobased plastics do not have much more holding capacity as compared to normal plastics because the bags they use are less than

50 microns. There is lots of wastage while packaging. The hotels are taking more care of packing while packing food. There is no problem related to these biobased plastics packages but they should buy these packs in large quantities and keep them in stock. These packs also have expiry dates thus holding them can be a loss for them.

The main conclusion from this study is that biodegradation of biobased plastic materials strongly depends on both, the environment where they are placed and the chemical nature of the material. Companies have understood the importance and potential mindset of people towards the Go Green campaign and have started producing biopolymers-based packaging for the food industry. When one looks at the present market for biodegradable food packaging materials it is still non-existent compared to conventional plastics used in packaging reasons being their high production costs and sometimes their underperformed properties, but there are still a heap of opportunities for the industries to develop new products with specific properties and more research is required to put these bioplastics in direct applications for different products. The growth of bioplastics In India is a positive change in consumer behavior and with continued support from the government and the citizens themselves, awareness about bioplastics can become even more widespread. As these bioplastics have some drawbacks it is very important for humans as well as the environment. As many governments are implementing laws against the usage of plastic it should be followed strictly. There are very few drawbacks in bioplastic but it can be improved though it will be very beneficial.

Suggestion

This bioplastics package should be more than 50 micrometres because the bio bags of less than 50 microns are very weak to carry, as they can decompose easily, increasing the little thickness of them can help hotels to use them.

The hotels should estimate the usage of these bioplastics packages because it helps them from the wastage of these packs. As they can melt when the food is more than 50oc they can use these packs while the food is less hot. They can request some subsidies from the government related to these bioplastics because they are expensive to buy. However, bio-based plastic products often have a very similar appearance compared to conventional fossil-based plastic products. As a consequence, they cannot be easily distinguished by consumers. The same is valid for biodegradable versus non-biodegradable products. Logos and labels can be used to make clear to the consumer (and retailer) whether a plastic is bio-based and/or compostable, and how to dispose of the plastic after use.

As they are also made of oils Waste Frying Oil Can Be Converted into Bioplastic. Second-generation bioplastic can be made from used frying oil. This kind of oil is a great source of polyhydroxy butyrate that can be used to make bioplastics. Instead of using vegetables, we can use the increase of bioplastics from agricultural waste. Or the bioplastics company can buy the

vegetables. The hotels are the area where they get this waste more which will price them cheaper than buying the vegetables.

Bioplastics are very expensive due to their chemicals but not by machinery so our Indian scientists can research to create that chemical in a simple and less costly way.
As bioplastics are very expensive government should encourage local companies through various policies and subsidies The growth of bioplastics in India is a positive change in consumer behavior and with continued support from the government and the citizens themselves, creating awareness among their parents and other people about bioplastics can become even more widespread which will lead to the plastic-free INDIA!

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Need of Pipe Composting in Rapid Urbanization for Clean, Green Environment

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Abstract
In the era of globalization, privatization & liberalization in most of the countries all over the world, are changing drastically towards the highest growth of urbanization. As a result, the population is shifting towards urban areas from villages. The density of population in urban areas is increasing consistently. The disposal of domestic urban waste is becoming very difficult for local authorities like Municipal Councils and Municipal Corporations. It is resulting in unhygienic conditions & spreading of epidemics. Such local authorities are trying to decentralize waste disposal/treatment plants as far as possible. One of the simplest ways of disposal of organic domestic waste effectively in minimum space in urban areas is "Pipe Composting.". It is easiest, compact, odourless way of composting domestic organic waste, especially from the kitchen. It can be used in very small areas even in a flat on any floor on a balcony, verandah, passage, etc. It is composting of waste by aerobic method in which waste is allowed to come in contact with oxygen in the air. It is a very low-cost way of disposing of kitchen waste or similar by the owner/occupier of the flat, bungalow, or even row house. The success of Pipe Composting has been experimented & proved by the authors. Pipe composting provides excellent quality organic fertilizer which may be used for gardening, or farms.
Keywords: Aerobic –Type of bacteria that convert the waste in the open atmosphere

Introduction:
One of the biggest issues the world is now facing is the disposal of solid waste. This issue must be on priority considering its size. About 2 billion tonnes of waste/year are produced worldwide. It must be disposed of securely and without endangering the environment. India is using poorly managed landfills, and waste is dumped in a disorganized manner in most places. Such a dumping of waste results in air, water & land pollution, infiltration, and spreading of illnesses. Domestic waste from the kitchen is mainly organic waste, which may be composted. Proper segregation of waste must be carried out for disposal. The separated organic waste may be turned into nutrient-rich fertilizers which may be used for gardens & farming. Pipe composting is one of the ways of low-cost models for home composting. Solid waste is generated by human activities and includes materials such as organic waste, plastics, metals, paper, glass, and electronic waste. Even in developed countries, solid waste management is a challenge, with concerns over landfill capacity and environmental impacts. According to the US Environmental Protection Agency, food waste is 20 to 25 % of all municipal solid waste. Composting is an eco-friendly way of disposal of organic waste.

Everyone can compost together and take care of the environment, which may be an ideal situation for sustainable development.

The amount of waste that needs to be moved and processed, as well as the costs and carbon emissions involved, etc. are reduced by composting. Due to the abundant nutrients in your biodegradable things, composting is a better choice than dumping your organic waste. Composting provides nutrients to the soil, reducing the need for fertilizers and pesticides. Compost improves the soil's capacity to hold moisture, which reduces surface runoff and controls soil erosion and the amount of floods. Plants grown with compost manure have better resistance to diseases and pests. The moist soil is easier to work for farmers and reduces fossil fuel emissions for plowing. Plants develop quickly in soil with compost added, which allows them to absorb more carbon dioxide from the atmosphere. Due to rapid urbanization, population growth, and economic development, India now produces 277.1 million tonnes of solid garbage annually. This amount is expected to increase to 387.8 million tonnes in 2030 and 543.3 million tonnes by 2050. Municipal solid waste is the waste that is exclusive from households, restaurants, institutes, road cleaning, and commercial activities. It does not include any waste from industries. Types of solid waste management are landfill, incineration, composting, recycling, and vermicomposting. Out of all these methods, we as individuals can easily perform composting of organic waste at home to reduce the load on solid waste management.

Due to India's rapid urbanization, industrialization, and population expansion, managing solid waste will be a big problem for state governments and local municipal bodies in the twenty-first century. For the health and welfare of the city, solid waste management is crucial. To solve these issues with waste management, the "Swachh Bharat Abhiyan" was created, and it taught the public how solid waste should be handled. The concept of managing waste has gained traction since the campaign's start.

Literature Review:

The conventional way of treating organic waste is by the land-fill approach. The waste is converted to safe status by the anaerobic bacteria action which is working without oxygen & away from exposed air & sunlight. They produce methane gas in their bio-degradation of the organic waste. The methane gas may be used as fuel as biogas for cooking or any other purpose if produced in a Biogas plant. The decomposed material after treatment should be taken out digging below the ground which needs labor & involves expenditure too. It may spread odor & unhygienic conditions near the plant. The second way of treating organic waste is the windrows method by Aerobic action. The organic wastes like municipal organic waste or molasses from Sugar factories are spread up in a row open to the sky called a windrow. The leachate [i.e. the liquid coming out from Vermicomposting or aerobic composting containing

a high amount of aerobic bacterial count] or spent wash is sprinkled on the windows of molasses as seeding. For better ventilation & effective action of aerobic bacteria, the waste is aerated by machines called aerators. It takes about 40 to 45 days to treat the waste to non-harmful material. It needs very large space for windrows and also produces foul gasses i.e odor. Such plants must be far away from residential areas. The third way is the Vermicomposting reactor which could generate better compost due to the high vermin process efficiency. It can effectively provide value-added advantages for residential areas throughout the co-composting process.

Pipe composting will become popular in urban areas due to the easy, economical, compact & effective way of disposal of organic household waste in a short duration. Pipe systems can also reduce leachate formation and unpleasant odors commonly found in traditional composting. Studies suggest that home composting with pipe systems can transform solid waste management and promote sustainable living.

One of the biggest issues facing urban environments today, in the majority of nations, is the collection and disposal of municipal solid waste (MSW). Solutions for MSW management must be technically practical, economically viable, socially and legally acceptable, and ecologically beneficial. The largest problem facing authorities in both small and large cities is solid waste management. Inadequate waste management affects ecosystems and contributes to air, water, and soil pollution, which poses a serious hazard to human health methodology
An easy way to comply with the conference paper formatting requirements is to use this document as a template and simply type your text into it. Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract.

Methodology

Composting using vertical pipes can be an effective method for processing organic waste into nutrient-rich compost. The method involves the use of vertical pipes that are filled with organic waste and then allowed to decompose over time. Here is a general methodology for composting using vertical pipes without a leachate recirculation system.

Equipment and Material

1. Vertical pipes - PVC pipes of diameter of 5 to 8 inches [120 to 200 mm dia.] and a length of 5 to 7 feet [1500 to 2100 mm] are recommended for this method. The number of pipes required depends on the amount of organic waste to be processed per day. It is recommended to have a balance of carbon-rich and nitrogen-rich materials. Set up the vertical Pipes, with their base embedded in soil @ 1’ [300 mm] for support.

2. Drilling hole - Drill small holes at the vertical faces of pipes @3 to 4 mm in diameter for better air circulation. Provide an end cap at the top of the pipe which helps as the lid on the pipe for feeding purposes. Place the pipes vertically in a designated area in the shaded area and have easy access for maintenance and monitoring.

3. Composting material: Organic waste such as food waste, skins of fruits, unused parts of vegetables, yard waste, and agricultural waste can be used for composting.

4. Fill the Pipes: Begin filling the vertical pipes with alternating layers of carbon and nitrogen-rich organic waste and biomass (like cow dung). Start with a layer of mud to begin the composting. Continue layering with finer materials like food scraps, leaves, and grass clippings. Keep the layers relatively thin (100-150 mm, @ 4 to 5 inches) to ensure proper aeration and avoid excess compaction. Tamp down the layers as you go to remove any air pockets and ensure good contact between the materials.

5. Observe the Composting Process: Keep watch on the temperature of the composting material. Ideally, the temperature should reach 30-45°C, which indicates that the composting process is actively breaking down the organic material. Check for moisture levels. The composting material should be moist but not saturated. If necessary, add water to maintain a consistent level of moisture. Observe the air circulation in the vertical pipes as aeration is necessary for the aerobic composting process to proceed to the optimum level.

6. Feed the organic waste in crushed form or small pieces in the pipe @ 100 to 150 mm in height, over the layer of soil by opening the lid at the top. Add soil or cow dung over the waste as if a sandwich. Continue the same till the pipe becomes full. Use the next vertical pipe till it fills in the same manner. It takes about 35 to 40 days to convert the organic waste to compost manure.

7. After 35 to 40 days, take out the first pipe of composting, take out the material for gardening or similar, clean the pipe & reuse it similarly.

Design of Aerobic Pipe composting

The diameter of the pipe may be larger even up to 12 inches [300 mm] & no. of vertical pipes required is also dependent on the volume of waste to be treated /day. In all the pipes, we must maintain the proper moisture content as well as temperature. The system should be in shadow, not to be exposed to direct sunlight as it affects the temperature and moisture content. There must be good ventilation for proper aerobic composting.

Details of Experimental Setup of Pipe composting at new polytechnic

- Location Open to sky duct in front of HOD-Civil cabin, New Polytechnic, Unchagaon, Kolhapur-416005. Maharashtra, India.
- Date of installation - Tuesday 7th Feb. 2023.
- No. of Pipe installed - 4 Nos.
- The diameter of the pipe used -120 mm [@5”]
- Length of PVC Pipe - 1670 mm [@ 5”6’] with an end cap at the top as a lid.
- Base-Pottery for the garden of burnt clay @ 400 mm in height.
- Pipe embedded in soil - 300 mm [12”]
- Diameter of Holes- 3.00 mm [@1/8 “]
- No. of Holes in pipe- @ 6 at one level x 4 levels for aeration process.
- Temperature in Pipe- between 25 to 40^0C as measured twice a week.
- Moisture content- @ 50%
- Organic waste feed- Food waste from tiffin’s of Staff of Dept. of Civil Engineering
- Days for filling pipe @10 days considering Sunday weekly holiday.
- Removal of first pipe Monday, 20th March 2023 = 42 days

Fig.1 – Pipe Composting

Result and Discussion

a. The result from 1st pipe: 100% composting of food waste, fruit skins, etc. at 42 days. The same is continued for a further period till date.
b. Odor if any: Nil. It was in front of the HOD cabin where there was a rush all day.
c. Nobody has detected odour i.e. bad smell of any foul gases at all.
d. Present status of unit: Well-functioning unit, still in use for more than 8 months.
e. Effect of Manson: Bit slowly as compared to the summer season, but no odour at all.
f. Our way to the admission center was passing near the unit.

Conclusion:

The method of pipe composting is the easiest, economical, odourless, and eco-friendly which is suitable for sustainable growth in urban areas where waste disposal is a crucial problem. In most urban areas, collection & disposal of solid waste are highly expensive & not very efficient or reliable. It may result in air, water & land pollution & a source of the spreading of epidemics. The burden on local authorities of treatments on solid waste may be reduced by 15 to 20 & if most of the population adopts the technique of disposal of their kitchen waste by pipe composting. Besides this, the rate of pollutants added by landfilling or any method and pollution of water resources will be reduced on a large scale. It will also reduce carbon emissions by use of fossil fuels in the transportation of solid waste resulting in the greenhouse effect & global warming. It will help Rapid Urbanization for a Clean, Green Environment if it is implemented effectively.

Suggestions

1. Awareness should be created in the urban population to adopt Pipe-compostiong for themself.
2. Proper training should be given by free of charge Camps to the urban population.
3. A team of Volunteers should be created in urban areas for the effective implementation & operation of pipe composting
4. Local authorities may give a concession of a few % in Property tax for those who implement it.
5. To bring the "Swachh Bharat Abhiyan" into reality.

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Impacts of Festivals on Environment, Smart Cities, and Tourism in Maharashtra, India

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Abstract

A feature of modern society is the city which tries to express itself through social and physical environments. Festivals play a crucial role in the cultural, social, and economic fabric of societies worldwide. This research paper examines the multifaceted impact of festival celebrations on the environment, with a focus on smart cities and tourism. The idea of a "Smart City" is evolving in response to the demands of the areas where the majority of us live and work, as well as the most influential economic and social forces of our day. Smart city development is accompanied by the emergence of a wide variety of IoT devices. There are several different environmental concerns included in the contemporary urban sustainability challenges. These difficulties include things like neighborhood traffic congestion, air pollution, a steady increase in the production of solid waste, high (and frequently inefficient) energy use, and materials related to climate change.

Keywords: Festivals, Environment, Smart City, Tourism and Pollution

Introduction

Today, tourism is one of the largest and most dynamically developing sectors of external economic activities. It has high growth and development rates and considerable volumes of foreign currency inflows. Infrastructure development and the introduction of new management and educational experiences actively affect various sectors of the economy, which positively contributes to the social and economic development of the country as a whole (Bibri and Krogstieb, 2017).

Tourism has emerged as the fastest-rising industry in the world. It accounts for 7% of capital investment and about 20 million people around the globe are employed in this industry. Now it is one of the sectors sustaining the national economy (Gurav, 2015).

Smart Cities are the integration of information technology, telecommunications, urban planning, smart infrastructure, and operations in an environment geared to maximize the quality of life for a city's population (Patel and Doshi, 2019).

Smart City Mission

The Indian Government announced the smart city mission (SCM) in June 2015, which is a significant government effort. To make them more habitable, sustainable, and technologically

advanced, the objective seeks to remodel and modernize metropolitan areas throughout the nation. The Mission's fundamental ideas have developed as well. The National Sustainable Habitat and SCM urged state governments to choose three existing cities in each state for development in August 2014. This showed that the Mission's focus had changed from Green Field to Brown Field expansion. As a result, the focus has moved from developing 100 new SCs to improving existing ones. This cleverly emphasizes the importance of SC being built as sustainable homes. In September 2014, the Indian government sponsored a National Conclave on Building Smart Cities, which focused on three key features of smart cities:

1. Competitive (attempts to entice inhabitants and investors);
2. Long-term (the Government of India (GoI) declared that it is "dedicated to promoting wealthier, healthier, and happier cities for a higher quality of life in cities").
3. Technology is an important part of Smart City governance and plays an important role. The Conclave also acknowledged that technology, particularly ICT, is a critical component of smart cities.

The Government of India had allocated INR 7060 crore to the SCM in its interim budget for 2014-15. A government panel has approved the allocation of INR 2.73 lakh crore over the next 10 years for the building of 100 smart cities and 500 cities as part of the National Urban Rejuvenation Project (NURP) (Jawaid, *et al*. 2016 and Joshi Sujata, *et al*. 2016).

Kumar Harish *et. al*. (2019), examined the increasing rate of urban population and deteriorating conditions of physical, institutional, social, and economic infrastructure in cities are demanding smarter ways to improve public utilities and services in India. Smart city development promotes an established, interconnected, and sustainable urban system. The Indian government has launched the “100 Smart Cities Mission" for planned urbanization in the country. The “100 cities" have been selected from a two-round city challenge competition. However, some controversial viewpoints have made questionable remarks about the selection process. For the effective planning of smart cities, an exhaustive analysis is essential to find the existing critical infrastructure, key resources, and development trends. The purpose of this study is to aid city planners and decision-makers in determining city eligibility in a multi-dimensional way and to develop evaluation criteria for the city selection process to meet the goal of the smart city mission. This article proposes a weighted criteria model to assess the city selection eligibility.

The factors are identified from the literature studies. Total interpretive structural modeling is used to analyze the complex interrelationships among the factors and to develop a selection hierarchy. The fuzzy MICMAC process is used to classify the factors based on driving power and dependence. The stabilized driving power is applied to calculate the corresponding weights for each factor. In the study findings, the most driving, linkage, and dependent factors are

identified for analyzing city selection eligibility. The policy-makers, government officials, and decision-makers would benefit from the study outcomes to select the top "N" number of cities for SCM.

Smart Cities in Maharashtra

Table 1: Smart Cities in Maharashtra State

Sr. No	Name of the City	Identity of City
1.	Mumbai	The Financial Hub
2.	Pune – Pimpri Chinchwad	Cultural and Educational Capital of Maharashtra, The Emerging IT Hub
3.	Nagpur	Orange City, Green, and Sustainable City
4.	Navi Mumbai	The Satellite Destination
5.	Nashik	Beyond Vineyards, Dynamic City
6.	Chhatrapati SambhajiNagar	The Historical Gem
7.	Thane	The Lake City
8.	Solapur	The Textile Hub
9.	Amravati	The Cultural Capital
10.	Kalyan Dombivali	The Twin City

https://smartcities.gov.in/cities-profiles

Components of the Smart City Project

With different backgrounds, attributes, and necessities, for creating each Smart City the key components stay the same. These are the major areas where a variety of services and amenities will be available (Caragliu *et. al*., 2011, Giffinger, et *al*, 2007, www.ibm.com/uk/cities).

These determinant variables are:

- **Smart Environment (SE)**

It emphasizes the significance of competent and accountable resource management as well as long-term urban planning. Pollution and emission reductions, as well as environmental preservation and safety programs, can enhance the city's natural attractiveness. Smart cities promote lower energy use as well as the adoption of new technology breakthroughs that increase efficiency.

- **Smart Mobility (SM)**

It advocates for more efficient transportation systems (e.g. non-motorized options) and ensures that citizens have access to local and public transportation, as well as reintegrating ICT to boost efficiency. The goal of smart cities is to increase the efficiency with which people, goods, and vehicles are moved around cities.

- **Smart Government (SG)** Involvement at the community level is addressed more explicitly. The governance structure is open to the general public and permits them to take part in decision-making. The general public may effortlessly acquire data and information on the management of city-credited information communication technology infrastructure. Hurdles to communication could be removed by establishing a much more competent and connected framework of governance.

- **Smart Living (SL)**

The purpose is to improve the quality of life of the residents by providing them with healthy and safe living conditions. Smart city residents have simple access to health care, computerized health records, and a wide range of social services.

- **Smart Economy (SE)**

It envisages the competitiveness of the total city, which is determined by the method of ground-breaking and inventive business, R&D expenditures, entrepreneurial prospects, labor marketplace output and suppleness, and the economic role of the city and position in the nationwide and worldwide market.

- **Smart Peoples (SP)**

This means providing the populace with a premium, constant, and invariable intensity of education, as well as emphasizing the excellence of community exchanges, edifying information, progressiveness, and degree of involvement that the general public has in their acquaintances among the public sphere.

- **Smart City and Tourism**

Indian SCM can increase tourism by developing more aesthetically pleasing, functional, and visitor-friendly urban environments. These cities may provide visitors with a more pleasurable and memorable experience while also contributing to the general economic prosperity of the region by investing in infrastructure, technology, and sustainable practices. The Indian SCM may have a big effect on tourism in the nation. Numerous ways that smart city development might improve Indian city's overall tourism appeal include:

- **Infrastructure Improvements:** Smart cities strive to improve their infrastructure, which includes roads, public transportation, and utilities. This may facilitate access to and navigation of numerous tourist destinations for visitors, resulting in a smoother and more pleasurable travel experience.

- **Enhanced Public Transportation:** The development of public transportation systems is a common goal of smart cities. Modernizing and expanding public transit systems can make it easier for visitors to explore the city, which will ease traffic and pollution.
- **Better Connectivity:** High-speed internet access and digital connectivity are prioritized in smart cities. This can be especially helpful for travellers who use social media, online travel agencies, and navigation apps to organize their journeys and share their experiences.
- **Safety and Security:** Smart cities frequently make investments in cutting-edge security and surveillance technology, making both locals and visitors feel safer there. The trust of tourists to visit these cities can be increased by improved safety measures.
- **Services for Tourist Information:** Digital kiosks, mobile apps, and websites can all be used by smart cities to give visitors quick access to information. Information about tourism destinations, cultural activities, regional fares, and other topics may be included.
- **Cultural Promotion:** Technology can be used by smart cities to promote and safeguard their cultural legacy. Tourists can have more fun with cultural encounters by using digital museums, augmented reality tours, and interactive exhibitions.
- **Waste Management and Cleanliness:** Effective waste management programs can keep popular tourist locations tidy and appealing. Tourists are more likely to have a favorable opinion of a city that is clean and well-kept.
- **Sustainability:** Eco-friendly practices and sustainability are frequently given top priority in smart cities. To meet the rising demand for eco-tourism, this can involve programs like creating green spaces, installing electric vehicle charging stations, and utilizing renewable energy sources.
- **Tourist Engagement:** Smart city projects can attract visitors by offering interactive experiences like virtual reality tours, self-guided mobile exploration apps, and real-time information on activities and attractions.
- **Citizens' and tourists' safety:** Smart cities frequently include integrated emergency response systems that can improve locals' and visitors' security. For tourists in strange places, timely response to emergencies might be vital.

Core Infrastructure Elements in a Smart City

1. Adequate Water Supply
2. Assured Electricity Supply
3. Sanitation, including Solid Waste Management
4. Efficient Urban Mobility and Public Transport
5. Affordable housing, especially for poor people

6. Robust IT Connectivity and Digitalization
7. Good Governance, especially e-governance, and Citizen Participation
8. Sustainable Environment
9. Safety and Security of Citizens, Particularly Women, Children and the elderly
10. Health and Education

Smart City and Socio-Economics Aspects The idea of a "Smart City" is evolving in response to the demands of the areas where the majority of us live and work, as well as the most influential economic and social forces of our day. Smart city development is accompanied by the emergence of a wide variety of IoT devices, which raises issues with cybersecurity and privacy. Therefore, it is crucial to research the effects of smart cities on people's social lives.

It is observed that due to the increase in urbanization, population, and economic growth, it is important to make a detailed study of the prospects and challenges of tourism in smart cities in Maharashtra. According to Patel Yash & Doshi Nishant (2019), the surrounding ecosystem involves both people and corporations. It is important to note that the existing cities are turning into smart cities to address the challenges of achieving goals for social development and quality of life. So, it can be the outcome of innovative, knowledge-based initiatives designed to improve the socioeconomic, ecological, and competitive performance of cities. This article attempts to comprehend both the potential social impact and the constraints of smart cities.

ICT and IoT:

Eisebith Fromhold, *et. al*. (2019), studied SC strategies that aim at fostering sustainable urban development through the systemic implementation of modern information and communication technologies (ICTs) and continue to appeal to national and municipal governments despite increasingly skeptical academic debates. Especially in Asian emerging economies, aspirations to create SCs are widespread, yet seem hopelessly illusionary in many cases and might harm rather than benefit most citizens. This paper acknowledges these critical views, yet also accentuates constructive perspectives on SC achievements that offer rays of hope, especially for cities in less developed countries. We propose to emphasize influential process qualities of SC strategies, which can instigate broader governance and institutional transformations locally, rather than mainly looking at the technical product features of final SC settings. Refined conceptual distinctions between the product and process view on achievable outcomes of SC schemes are suggested which also borrow from evolutionary geography perspectives.

Hoon Han and Scott Hawken (2017), with the emergence of smart cities, it is more important than ever to investigate cultural nuance, human conduct, and social identity. The challenge of the smart city is critically examined in this special issue, with identity and urban culture at its core. Technology capability and advancement are the focus of current smart city discussions. A one-dimensional business strategy and set of measures are reduced to cities in global rankings. The future quality of life and distinctive cultural identity of a city must be developed

through technology if the phrase "smart city" is to have any lasting relevance. The editorial reviews emerging research on the cultural dimensions of urban innovation and smart cities and places the six special issue papers within a theoretical context. Each paper critiques smart city theories about the practical challenge of enhancing urban identity, quality, and value at a range of scales and geographic contexts. Three main themes are used to frame the debate on smart cities and urban innovation: 1) local development histories, 2) face-to-face relationships, and 3) local community scales. Each of these themes is lacking in current smart city approaches and requires innovative approaches to integrate into the smart city of tomorrow.

Shah, Jigar *et. al*. (2019), the studied population is proliferating, but the resources are not increasing. To cater to the needs of people and improve their standard of living, the concept of a Smart City's introduced. The Smart City aims to make optimal and sustainable use of all resources while maintaining an appropriate balance between social, environmental, and economic costs. The emerging technology of the Internet of Things (IoT) is used in the development of smart cities. Sensors are deployed at many places to gather data. This, in turn, is sent to the cloud where it is processed, and the generated output is used for planning strategies for the smart city. This paper will explore the technologies and projects implemented in New York City the USA to make it smart. This paper explored the technologies and projects implemented in New York City the USA to make it a smart city.

Festivals and Pollution

During the celebration of festivals, people cause air, water, and noise pollution which causes a huge impact on the surrounding environment as well as on our health. It is our responsibility to take care of the ecosystem, animals, and birds. Diwali is the biggest Indian festival that brings with it a lot of air and noise pollution. Air pollution obstructs visibility during festivals due to the fire cracking. Holi is celebrated with chemicals, color, and water; which causes the wastage of water and causes adverse effects on humans and animals. Idols of god are immersed in water that pollutes our rivers during Ganesh Chaturthi and Durga pooja. Solid waste disposal is also a prime issue during the festivals. Festivals bring people together as well as gather for the celebration which causes a lot of garbage to be disposed of around the environment and traffic issues etc. In India, many festivals have a 'Mela' organization and fairs which leads to a lot of waste material being disposed of openly and around the residential area. The constitution of India gives us the right to freely practice the religion as but as the citizens of the country we must also make it our duty to protect nature and celebrate in moderation (https://infinitylearn.com).

For the past 20 years, one of the biggest obstacles to integrating environmentally friendly initiatives has been city management (Alberti *et al.*, 2007). There are various prerequisites and difficulties for sustainable growth in cities all over the world. There are several different

environmental concerns included in the contemporary urban sustainability challenges. These difficulties include things like neighborhood traffic congestion, air pollution, a steady increase in the production of solid waste, high (and frequently inefficient) energy use, and materials related to climate change. These difficulties also include social ones such as increased social tensions and racial segregation (Oksman, and Ylikauppila, 2014), including inappropriate urban design, and its related social deprivation and community disruption (Bibri and Krogstie, 2017), urban conflict and violence, social polarization, and rising urban poverty levels (Jabareen, 2015). These challenges can be mitigated by establishing socially inclusive, environmentally friendly, and economically sustainable cities (Yigitcanlar *et al.*, 2019). The professional and academic communities have been compelled by these environmental and socioeconomic issues to think about what cutting-edge approaches, sophisticated techniques, and cutting-edge technology might be provided for the design of sustainable cities. The idea of a "Smart City" has changed as a result. A smart city has an efficient system to control air pollution and maintain clear air, especially in the air sheds where it is located. Cities generate a wide range of new physical issues, such as diminishing resources, air pollution, problems managing waste, traffic jams, and inadequate, failing, and outdated infrastructures. (Chourabi *et al*., 2012). On the other hand, cities are mostly responsible for environmental issues like water and air pollution as well as the extensive use of non-renewable energy (Grimmond, 2007; Guerra *et al*., 2016), which have effects on climate change (Choucri, 2007). Additionally, the increased urbanization creates new problems for sustainability, including an increase in poverty, social unrest, a lack of natural resources, and unique dynamics. (Ibrahim *et al.*, 2018).

Indoor Air Quality

Indoor examination tainting may happen in any setting, including the office, school, or your comfortable home: the use of toxic substances also known as volatile organic compounds (VOCs), inadequate ventilation, uneven temperature, and moisture level. Uninformed decisions can lead to indoor air pollution, such as smoking in a room or failing to treat mold-infested dividers. A person's health can be directly affected in a matter of seconds by the usage of space heaters or wood stoves, which raise the moisture level. Contribute to the decrease of CO_2 emissions from industries, vehicular pollution, and toxic gases produced on farms.

Air is a mix of gases that fills the atmosphere and gives life to the plants and animals that inhabit the earth, giving it its unique dynamic quality. Air is what allows us to breathe. Broadly speaking, the air is mostly made up of two gases: 78% nitrogen and 21% oxygen. A small number of other gases, such as carbon dioxide and argon, are also present. Air contamination is defined as a gas (or liquid or strong) dispersed through ordinary air in sufficient quantities to endanger human health or that of other animals, kill plants or stop them from growing properly, damage or disturb other aspects of the climate (e.g., disintegrating structures), or cause any other type of irritation.

Regarding the health and comfort of residents, indoor air quality describes the state of the air inside buildings and structures. Knowing and reducing Indoor Air Pollution (IAQ) is crucial since it can have some negative effects on human health. Smoke, pollen, and dust are examples of tiny solid or liquid particles in the air. The respiratory and cardiovascular conditions are linked to particulate matter (PM) 2.5, which can enter the lungs deeply. These are organic chemicals that can evaporate into the air from products like paints, cleaning supplies, and furniture. Volatile Organic Compounds (VOCs) can lead to eye, nose, and throat irritation, as well as more severe health effects. A radioactive gas that can seep into homes from the ground. It's a known carcinogen and is the second leading cause of lung cancer. A common VOC is found in many building materials, furnishings, and household products. Long-term exposure to high levels of formaldehyde can be harmful. Inadequate airflow and ventilation can lead to the buildup of pollutants in indoor spaces.

Smart Solid Waste Management

Smart Solid Waste Management is a term that refers to the management of waste in a smart way. Smart trash monitoring technologies can aid municipalities and optimize wastes, save operational costs, and better handle environmental challenges coupled with incompetent garbage collection. Cities are attempting to integrate the most recent technology, products, solutions, systems, and so on to address water supply, wastewater, and sanitation challenges, and attempts are being made to collect data to diagnose problems and prioritize and administer safeguarding issues. The Automated Waste Collection System (AWCS) can handle traditional waste collection techniques such as door-to-door, curbside, and block collections, as well as community bin collections and transportation to transfer stations.

There are several opportunities to enhance both the general infrastructure and operations of the city as well as the quality of life for citizens when a smart city is implemented. Smart sensor networks, the Internet of Things, and linked technologies are the main tools for implementing smart cities. Trash monitoring devices with intelligence can minimize waste, reduce operating expenses, and improve the way waste service managers and governments deal with environmental issues brought on by ineffective garbage collection. Cities are trying to solve issues with wastewater, sanitation, and water supply by implementing the newest goods, methods, technologies, and so forth.

They are also trying to gather data to identify concerns, prioritize them, and handle maintenance tasks. The AWCS can handle traditional waste collection techniques such as door-to-door, curb-side, and block collections, as well as community bin collections and transportation to transfer stations. The implementation of a smart city offers enormous prospects to improve people's lives and the city's overall infrastructure and operations. The primary solutions for smart city deployment include smart sensor networks (SSN), the Internet of Things (IoT), and connected technologies

Government of India Standards for Smart Cities

Table No. 2: Standards for Smart Cities

Sr. No	Parameter	Govt. of India Benchmark
1.	Transport	Maximum travel time should be 30 minutes in medium-sized cities. Dedicated and physically segregated bicycle tracks & pedestrian routes must be provided on each street. High-quality and high-frequency mass transport within 800m (10-15 minute walking distance) of all residences must be available.
2.	Water Supply	Water must be available 24/7, with 100% of homes having direct connections to the water supply. Every person needs 135 liters of water every day, 100% of water connections must be metered, and 100% of water-related fees must be collected efficiently.
3.	Sewerage and Sanitation	100% of households should be connected to the wastewater network & there must be 100% efficiency in the collection and treatment of sewage waste.
4.	Solid Waste Management	100% of households must be covered by daily door-step collection of solid waste & there must be 100% recycling of solid waste
5.	Storm Water Drainage	A smart city must have 100% coverage of the road network with a stormwater drainage network & no incidents of water logging should be reported in a year.
6.	Electricity	In a smart city, every household should have an electricity connection with a 24 x 7 supply of electricity. 100% metering of electricity supply & 100% recovery of cost must be achieved.
7.	Wi-Fi Connectivity	The Smart City must have 100% Wi-Fi connectivity with 100 Mbps internet speed
8.	Health Care Facilities	There must be the availability of telemedicine facilities to every resident in a smart city and it must have a multi-specialty hospital of 200 beds per lakh population & a general hospital - 500 beds per lakh population.
9.	Education	Primary & Secondary Education A Smart City must have 1 pre-primary/ Nursery School for every 2,500 residents with 1 integrated school (Class I to XII) per lakh of population. Higher Education A Smart city must have 1 college per 1.25 lakh population. Also, there must be 1 university in the city
10.	Fire Fighting	A Smart City must have 1 fire station per 2 lakh population / 5- 7 km radius & 1 sub–fire station with a 3-4 km radius

Challenges in Smart City Development

To illustrate our propositions, the example of India's SCM launched in 2015 is used. While the planned refurbishment of urban spaces in India is rightfully criticized by some, our qualitative empirical research – a multiple case study analysis of five SC schemes in South India in spring 2018 – reveals several promising process qualities besides implementation deficiencies. Our study finds eight mechanisms of detrimental path dependency that obstruct SC progress, but also eight mechanisms of positive evolutionary change concerning urban governance procedures. Making agents in emerging economies aware of these potential outcomes that reach beyond a mere urban technology focus can inspire more effective forthcoming SC strategies and policies.

Verma B. L., and Salvi Dharmendra (2017), studied that the Prime Minister of India had announced his vision to set up 100 SCM across the country soon after his government was sworn into power mid-last year. Since then a race has been on among cities to land on the list that the Ministry of Urban Development is compiling the 100 smart cities mission intends to promote the adoption of smart solutions for efficient use of available assets, resources, and infrastructure making a city smart is emerging as a strategy to mitigate the problems generated by the urban population growth and rapid urbanization. Yet little academic research has sparingly discussed the phenomenon. To close the gap in the literature about smart cities and in response to the increasing use of the concept, this paper proposes a framework to understand the concept of smart cities. It is based on the exploration of an extensive array of literature from various disciplinary areas eight critical factors of smart city initiatives: management and organization, technology, governance, policy context, people and communities, economy, built infrastructure, and natural environment were identified. These factors form the basis of an integrative framework that can be used to examine how local governments envision smart city initiatives. The framework suggests directions and agendas for smart city research and outlines practical implications for government professionals.

Conclusion

There are several fundamental concerns regarding SCM, such as what they represent or the obstacles and opportunities to develop new smart cities in India. The paper concludes that the SCM concept holds immense potential to achieve multiple benefits of sustainability, systems efficiency, economic growth, participatory governance, and better quality of life, considering that there is no internationally accepted definition of an SCM and no national urbanization policy in India. The management of natural hazards in densely populated areas, crime, air, water, and soil pollution that reduces the environment, climate change, and inadequate governance arrangements all contribute to the unhappy lives of urban citizens in India. Other major issues that the city administration frequently faces include unplanned development,

informal real estate markets, inevitable population growth, a lack of infrastructure, inadequate transport facilities, traffic congestion, poor power supplies, and a lack of basic services in both the city and the suburbs. Therefore, the planning and construction of smart cities are imperative to address these issues.

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Review of Plastic Waste Generation in Sangli-Miraj-Kupwad Municipal Corporation Area, Its Recycling Process and Benefits on Different Aspects of Environment

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Abstract
Plastic is one of the most versatile innovations of our time. Plastic is usually a synthetic or semi-synthetic organic compound of very high molecular mass. It is the single use of plastics that has made it an ecological and environmental poison. Innovation is needed to drive social change and solve the biggest problem of our times which is Plastic Pollution. The paper studies the existing plastic waste management infrastructure in the Sangli-Miraj-Kupwad Municipal Corporation (SMKMC) area where we can consider 'Wastecart' as a waste management company. The study gives the quantity and types of plastic waste generated in different sectors of the SMKMC area. Furthermore, it evaluates the various plastic waste management strategies, including the entire process of plastic waste collection, segregation, and the further recycling process of each category. The study helps us in data analysis of waste generation to comprehensively understand the challenges faced by Wastecart in handling plastic waste. Plastic emits greenhouse gases right from extraction of raw materials, to manufacturing till its disposal. Hence, the paper also includes the analysis of carbon emissions curtailed due to waste segregation and recycling in the SMKMC area.

Keywords: Plastic Waste Management, Carbon Emissions of Plastic Waste, Categories of Plastic.

Introduction
Plastic is derived from cellulose. Plastic is a polymer chain. Many common groups of polymers are composed of hydrocarbons. These polymers are made up of small units bonded into long chains. Carbon makes up the backbone of the chain molecule and hydrogen atoms are bonded along the backbone. Even though the basic units of the polymer are carbon and hydrogen, other elements like oxygen, chlorine, fluorine, nitrogen, silicon, phosphorous, and sulfur are also involved.

Categories of Plastic Polymer plastics are divided into two distinct groups: thermoplastics and thermosets. The majority of the plastics are thermoplastics (around 80%) which can be heated and reformed again and again. This character allows for easy processing and facilitates recycling. On the other hand, thermostats (around 20%) cannot be remelted. Once these polymers are formed, reheating will cause the material to scorch. (Hosetti, B.B., 2006. Prospects and perspective of solid waste management. New Age International)

Plastic Waste in SMKMC Area

The plastic waste in the SMKMC area is divided into 5 categories viz. Polyethylene Terephthalate (PET), High-Density Polyethylene (HDPE), Low-Density Polyethylene (LDPE), Polypropylene Plastic (PP) and Multi-layered Packaging (MLP). PET takes around 5-10 years to decompose, HDPE takes around 100 years, LDPE takes 500-1000 years, PP takes 20-30 years while MLP takes 6 months to decompose. The PET is used for soft drinks, sports drinks, water, mouthwash catsup and salad dressing bottles, pickles, jelly, and jam jars. HDPE is used in products like milk, juice, cosmetics, cereal box liners, trash bags, etc. LDPE is used in squeezable bottles, dry cleaning, bread, and frozen food bags. PP is used in catsup bottles, yogurt containers, medicine bottles, etc. MLP is used in 3-5 gallon reusable water bottles, citrus juice bottles, etc.

Plastic Waste Management

Plastic waste management has become a pressing concern worldwide due to its harmful impact on the environment and public health. The problem of plastic waste is particularly serious in developing cities due to a lack of integrated solid waste management along with socio-economic, widespread poverty, and environmental injustice. Most of the generated waste plastics are neither collected nor properly disposed of causing littering and choking of gutters. The main problem with plastic recycling is, it is difficult to automate the sorting of the waste. Hence, recycling activities in India are demoted to the informal markets and are labor-intensive. Recycled plastic that contains impurities like labels, ink, prints, etc. can only be converted into low-value applications like pellets, benches, chairs, etc. A large number of aquatic animals, different mammals, birds, etc. are killed every year due to consumption of the plastic bags. These animals either eat these plastic bags leading to the choking of the digestive system or get entangled in them. Cows, donkeys, turtles, and fishes are particularly badly affected by plastic pollution. India produces more than 3.3 million MT of plastic every year which is increasing with every single day. Out of this, a total of 15 % of the plastic waste is recycled but the remaining 85% turns into waste which is either landfilled or dumped in oceans and water bodies. But as the population is also increasing the lands are becoming scarce and are overworked. (Sugata, D., Abhishek, C., Anuj, R., Singh, T.H., Kuldeep, D., Hasan, S.A. and Tanu, J., 2022). Plastic waste in India: overview, impact, and measures to mitigate: review. J Exp Biol Agric, 10(3), pp.456-473.

Petroleum was the main source of plastic manufacturing which does not easily degrade and remain in the land. The recovery of plastic to liquid oil through the pyrolysis process had great potential. The oil produced has a high calorific value comparable with commercial fuel. Pyrolytic oil and gas helps in reducing the dependency on fossil fuels. Plastic emits greenhouse gases right from extraction of raw materials to manufacturing to disposal. Also, it undergoes anaerobic decomposition when landfilled. Improper disposal methods further lead to emissions. 1.7 GT of greenhouse gases (GHG) emitted into the environment during the

production and incineration stages of plastics causing a higher carbon footprint leading to climate change (Pathak, P., Sharma, S. and Ramakrishna, S., 2023. Circular transformation in plastic management lessens the carbon footprint of the plastic industry. Materials Today Sustainability, 22, p.100365). More than 500 million tons of CO_2 is produced by plastic annually. Nearly 0.253 Kg of carbon dioxide is emitted behind 1 Kg of plastic waste in landfills.

Literature Review

A brief review of the past studies related to Plastic waste Management.

Ola Eriksson, et al. (2009) in their article "**Plastic waste as a fuel – CO_2 - neutral or not?**" say that Municipal solid waste (MSW) is not only a societal problem addressed with environmental impact, it is also a resource that can be used for energy supply Recycling of plastic is in general environmentally favorable in comparison to landfill disposal or incineration. However, some plastic types are not possible to recycle and some plastic is of such low quality that it is not suitable for recycling. This paper focuses on the non-renewable and non-recyclable plastic in MSW. A CO_2 assessment has been made for non-recyclable plastic where incineration with energy recovery has been compared to landfill disposal in the assessment, consideration has been taken of alternative fuel in the incinerator, emissions from waste treatment, and avoided emissions from heat and power supply. For landfill disposal of plastic, the emissions of CO_2 amount to 253 g. The results suggest that efforts should be made to increase the recycling of plastics, direct incineration of plastics in places where they can be combusted with high efficiency and high electricity-to-heat ratios where it is replacing fossil fuels, and reconsider the present policies of avoiding landfill disposal of plastics.

Prosper Achaw Owusu, et al. (2017) in their article "**Reverse engineering of plastic waste into useful fuel products**" says that Thermal and catalytic reverse polymerization is an attractive method of handling plastic waste. In the experiment, a large temperature gradient was detected to exist between the reactor wall and the inside space of the reactor. It was found that fast vaporization during the cracking of HDPE in a continuous reactor lasted for about five minutes (between 35th and 40th minutes). Based on these findings, the presence of gas bubbles in the condenser can be used as an indicator to detect the beginning of the cracking process. The results showed that for a catalyst/polymer ratio of 1:10, liquid oils from HDPE, PP, and PS were low. The degradation temperature for maximum conversion was also low; and was observed at 300oC, 270oC, and 250oC for HDPE, PP, and PS, respectively. The presence of silica-alumina catalyst favored the formation of gaseous fractions.

The production of gaseous fractions increased from 17.2-20 wt% to 40.43-60 wt%. Thermal pyrolysis resulted in the highest yield of liquid oils for sample feed but at the highest degradation temperature. The degradation temperature observed during thermal pyrolysis of HDPE, PP, and PS were 450oC, 350oC, and 300oC, respectively. The yields of oil fractions in

batch pyrolysis were significantly higher than the continuous and at a lower pyrolysis temperature. The characteristics of HDPE and PP pyrolytic sample oils are similar to conventional transportation fuel. However, further processing must be carried out (especially for PS oil) before it is used in diesel engines. Furthermore, for full implementation of this technology in developing cities, detailed sustainability assessment on economic feasibility, environmental impact, and social acceptability must be conducted

Boitumelo Makgabutlane, et al. (2022) in their article "**Plastic-fly ash waste composites reinforced with carbon nanotubes for sustainable building and construction applications: A review"** says that "the building and construction industry is the largest consumer of natural resources and contributes towards high volumes of carbon emission". To achieve sustainability in the industry, waste materials have been applied in construction composites such as bricks and cement/concrete mortar to reduce the dependency on non-renewable resources. Carbon nanotubes (CNTs), which are known to possess high mechanical strength have been identified as suitable filler materials to provide the desired strength to the final products such as bricks. The dispersion of the CNTs in the composite is at a finer scale, compared to conventional fillers. Thus, extremely low contents of CNTs can make a substantial difference in enhancing the properties of the composites. The waste-derived composites enhanced with CNTs are lightweight strong materials that can withstand harsh conditions of weather, fire, or earth tremors. Moreover, the environmental concerns on the release of CNTs from the composite are reviewed to ensure their sustainable application.

Sugata Datta, et al. (2022) in their article "**Plastic Waste in India: overview, impact, and Measures to Mitigate: Review**", say that With the expanding development, the usage of plastic for anthropogenic activities has expanded many folds and India alone generated around 3.3 million metric tonnes of plastic in the financial year 2019. 79 percent of the plastic generated worldwide enters our land, water, and environment as waste; part of it also enters our bodies through the food chain. The industry in India states that 60 percent of what is generated is recycled and we had assumed that we had solved the problem of plastic waste by recycling, or burying it in landfills. The review paper aimed to examine the major impact of plastic waste in India and how to reduce plastic consumption, considering measures such as phasing out or banning multi-layered plastics that cannot be recycled, contemplating renewable raw materials, promoting the use of bioplastics, incentivizing the recycling business, and making the rules and guidelines for Extended Producer Responsibility (EPR) simple and enforceable.

Pankaj Pathak, et al. (2023) in their article "**Circular Transformation in plastic management lessen the carbon footprint of the Plastic Industry**", says that around 400 Million tons of plastic waste has been generated so far and are projected to be doubled by 2040. Despite having plastic management rules worldwide, only 12% of plastic waste is recycled and

reused, and the remaining ends cause pollution in every possible form. He says that 1.7 GT of greenhouse gasses (GHG) are released into the environment during the production and incineration stages of plastic, demonstrating a higher carbon footprint and leading to climate change. To overcome these issues it is mandatory to curtail single-use plastics from everyday use and enhance the recycling option in the plastic industry. The paper elaborates that there is **3.0 kg CO_2** emission per Kg of plastic. This paper advocates setting up stepping milestones for circular transformation in public industries that can reduce the carbon footprint by 25%.

Methodology

The waste cart collects the plastic waste from Sangli, Miraj, Kupwad, and Vishrambaug areas. Initially, awareness programs on plastic waste, its harmful effects on humans and the entire ecosystem, and different ways of plastic waste management are organized. These awareness programs are organized within schools, colleges, housing societies, different organizations, etc. Collection centers are set up in each area and representatives are appointed at each center. Collection drives are arranged every second Sunday. The waste collected during every collection drive is stored in the godowns which are further sorted and segregated by the laborers. This waste is sorted into 5 categories viz. Polyethylene Terephthalate (PET), High-Density Polyethylene (HDPE), Low-Density Polyethylene (LDPE), Polypropylene Plastic (PP), and Multi-layered Packaging (MLP). This segregated plastic waste is further sent to the recycling station in Malegaon where it undergoes different recycling processes.

- The PET bottles are first shredded in small pieces and then washed. They are further converted into polyester. Recycled PET is then used in tote bags, clothing, food and beverage containers, luggage, bottles, etc.
- HDPE is also initially shredded, washed, and then converted into small granules or pellets which are further molded into HDPE pipes. It is also used in products like liquid detergent, shampoo, motor oil bottles, recycling bins, floor tiles, dog houses, etc.
- The PP and LDPE on shredding and washing are converted to granules which are used for making low-quality materials like benches, tables, chairs, etc. Recycled PP is used in automobile battery cases, signal lights, battery cables, bicycle racks, oil funnels, brooms, brushes, etc. while recycled LDPE is used in shipping envelopes, garbage can liners, film and sheet, landscape timber, etc.
- The MLP on shredding is used for two purposes one is making threads and stripes and the other is using MLP for the pyrolysis process. At times LDPE is also utilized for pyrolysis

Results and Discussion

Below shown Table 1 below presents a breakdown of plastic waste by category for the period from January 2022 to December 2022. The plastic waste is categorized into different types,

including PET, HDPE, LDPE, PP, and MLP. This table contains data on the quantities of plastic waste in each of these categories for the specified time frame, allowing for a comprehensive overview of plastic waste distribution.

As per below Table 1, the quantity of waste collected annually is 17,570 kg. As 1 kg of plastic waste emits 0.253 kg of CO_2 during its disposal as referenced by Eriksson, O (Energy & Environmental Science, 2(9), 907-914). Thus, 17570 kg of waste will emit around 4,445.21 kg of CO_2. As per the below calculations:

As 1 kg of plastic = 0.253 kg of CO_2 emissions

Hence, for 17,570 kg of plastic waste:

X kg of CO_2 emissions = 17,570 kg * 0.253 kg of CO_2/kg of plastic waste

X = 4,445.21 kg of CO_2 emissions

Table 1: Monthly Plastic Waste Distribution

Month	PET	HDPE	LDPE	PP	MLP	TOTAL
January	150	300	300	300	450	1500
February	108	216	264	252	360	1200
March	208	368	256	320	448	1600
April	129.2	342	304	349.6	395.2	1520
May	120.6	321.6	254.6	274.7	368.5	1340
June	143	300.3	286	343.2	357.5	1430
July	117.8	232.5	381.3	353.4	465	1550
August	174	290	275.5	304.5	406	1450
September	172.5	262.2	248.4	296.7	414	1380
October	129.6	340.2	324.1	333.7	492.4	1620
November	166.1	332.2	317.1	271.8	422.8	1510
December	147	323.4	294	338.1	367.5	1470
TOTAL(Kg)	1765.8	3628.4	3505	3737.7	4946.9	17570

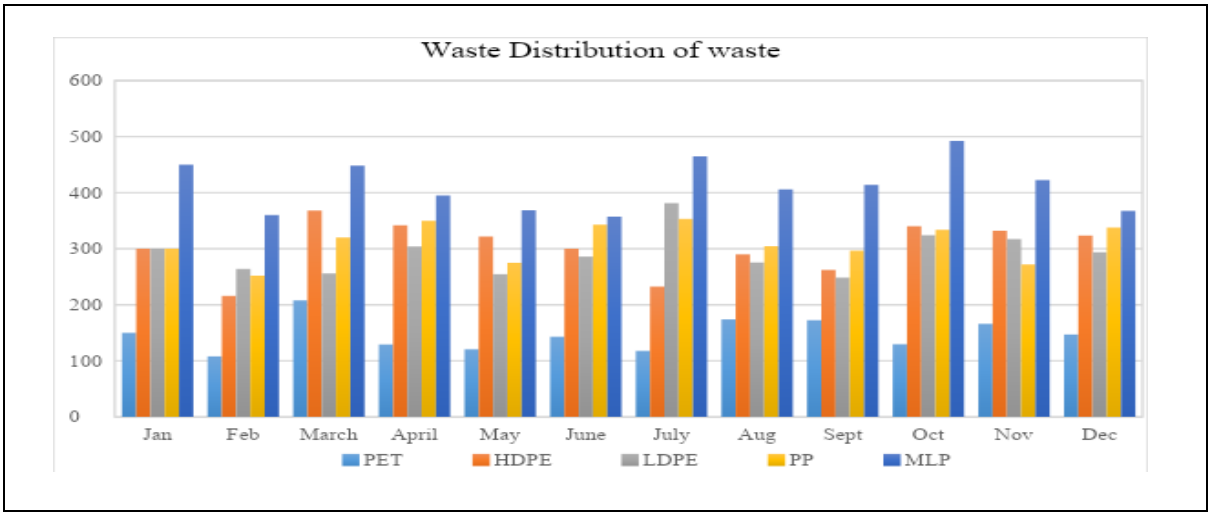


Figure 1: Bar Graph of the quantity of plastic waste

From Figure 1 we can observe that

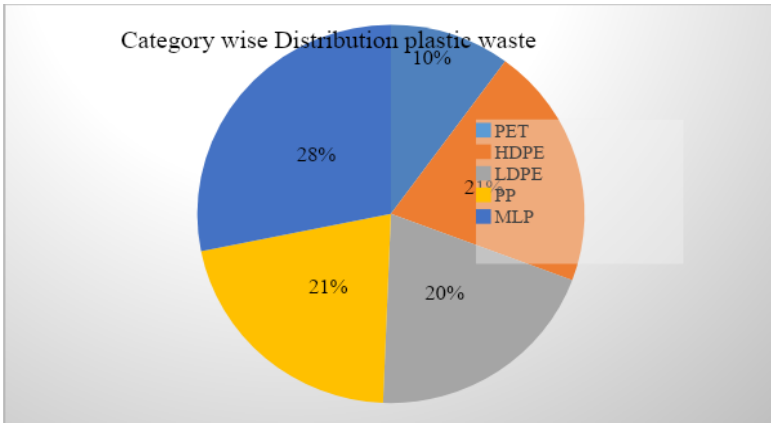
- The quantity of waste has increased in the Months of March and October in comparison to the previous month.
- PET was collected Minimum in the Month of February.
- HDPE was collected Maximum in March and Minimum in February.
- LDPE was collected Maximum in July and Minimum in September.
- PP was collected Maximum in July and Minimum in February.
- MLP was collected Maximum in October and Minimum in June.

Table 2: Distribution of 5 Types of Plastic

Sr. No.	**Type of Plastic Waste**	**Aggregate %**
1	PET	10.05
2	HDPE	20.65
3	LDPE	19.95
4	PP	21.20
5	MLP	28.15

Table 2 presents the cumulative percentage of each plastic waste category as a proportion of the total plastic waste generated in a single year. This table offers an overview of the relative distribution of plastic waste among different categories for that specific year.

Figure 2: Pie Chart of distribution of plastic waste



A total of around 1500 kg of plastic waste is generated monthly. Out of the total, PET contributes to 10.05% of the waste, HDPE forms 20.65%, LDPE forms 19.95%, PP is 21.20%, and MLP forms 28.15% of the total waste

Table 3: Differentiation of CO_2 Emissions

Month	Co_2 emission without recycling of plastic	Co_2 emission with recycling of plastic
January	4500	4120.5
February	3600	3296.4
March	4800	4395.2
April	4560	4175.4
May	4020	3680.98
June	4290	3928.21
July	4650	4257.8
August	4350	3983.1
September	4140	3790.8
October	4860	4450.1
November	4530	4147.9
December	4410	4038.1
Total	52710	48264.49

Table 3 depicts the amount of CO_2 emissions curtailed due to plastic waste management. Initially, the plastic waste would have emitted 52,710 kg of CO_2 right from its manufacturing to disposal. But, the CO_2 emissions are reduced by 4445.51 kg due to plastic waste management and recycling reducing the number of CO_2 Emissions to 48264.49 kg.

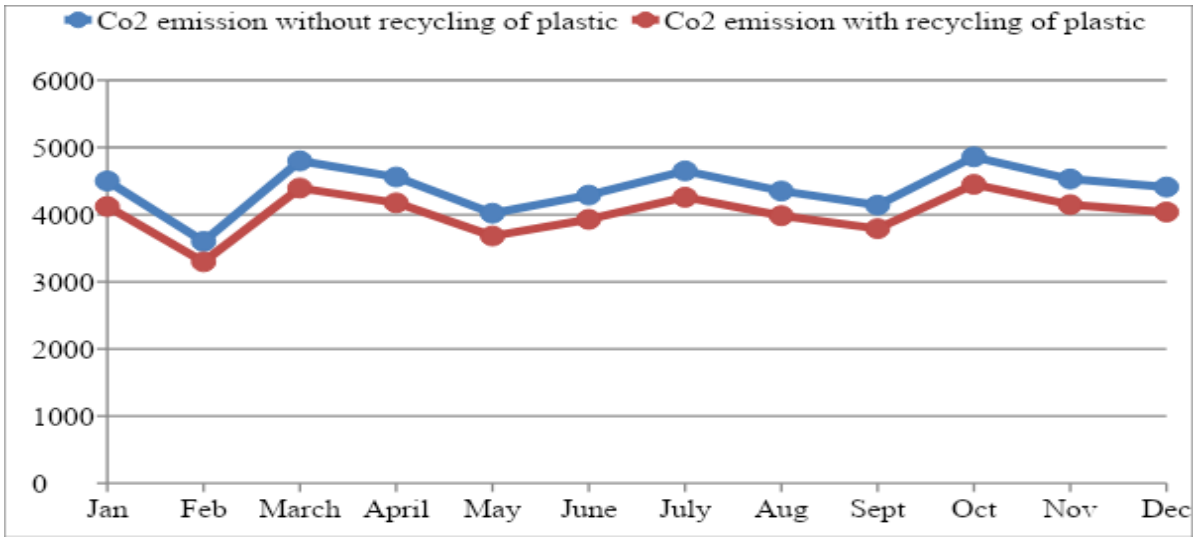


Figure 3: Comparison of Co_2 Emissions

In Figure 3 we can observe the reduction of CO_2 emissions which is shown by the red line in comparison with the estimated CO_2 emissions due to landfilling.

Suggestions:

1. Increase in Awareness

Public awareness about plastic waste management among the people should be increased. Awareness programs should be implemented for school-going children on a large scale and they should be made aware at an early stage. Social media initiatives should be implemented at a greater pace. Educational programs should be organized by the schools more often. Public awareness about the harmful effects of plastic waste on the entire mankind, animals, oceans, ecosystem should be created. Continuous awareness initiatives are essential to gradually and firmly implement eco-friendly habits and address the global waste problem effectively.

2. Considering the recycling and segregation of other categories

Other than the 5 categories, there are other types including Polyvinyl Chloride (PVC), Polystyrene (PS), and others. The other category is made up of more than one resin and is used in multilayer combinations.

3. Labour training

The main problem associated with plastic waste recycling is the unavailability of automation in waste sorting. Hence, it is primarily done by laborers. Laborers aren't trained. Sorting is done based on products, color, etc. Proper training programs must be arranged providing essential knowledge on identification, sorting, and categorisation based on its composition and recyclability. Training sessions should focus on categories of plastic waste, environmental impact awareness, and safety protocols to increase efficiency.

4. Usage of recycled plastic in new technologies

A. Clean hydrogen fuel:

Recycled plastic can be converted into hydrogen through the process of pyrolysis or gasification. As the plastic is made from hydrocarbons it can be broken down into hydrogen. This method provides us with a way of plastic recycling but also generates clean energy in the form of hydrogen which can be used in fuel cells or hydrogen-based technologies.

B. Road construction:

Plastic road technology can be used for using recycled plastic in road construction. The plastic waste consisting of bags, and bottles is shredded into small pieces and mixed with hot bitumen. The modified bitumen is then used to lay roads promoting a circular economy.

C. Carbon nanotubes:

Carbon nanotubes are produced by using recycled plastic through various methods like pyrolysis, carbon feedstock, and Chemical Vapour Deposition (CVD). Converting recycled plastic into carbon nanotubes is a sustainable way to repurpose the waste, conserving natural resources by reducing the need for raw carbon sources. Due to their properties of strength, sensitivity, and conductivity they are used in medical applications, sensors, nanotechnology, energy storage, etc.

Conclusion

The total quantity of waste collected from the Sangli-Miraj-Kupwad Municipal Corporation annually is around 17,570 kg. Out of the total, PET contributes to 10.05% of the waste, HDPE forms 20.65%, LDPE forms 19.95%, PP is 21.20%, and MLP forms 28.15% of the total waste. 17,570 kg of waste is collected annually from the Sangli-Miraj-Kupwad Municipal Corporation area. As 1 kg of plastic waste emits 0.253 kg of CO_2 during its disposal, 17570 kg of waste will emit around 4,445.21 kg of CO_2. Plastic waste management helps not only in carbon sequestration but also helps to achieve Plastic sequestration. It helps to secure used plastic out of industry and the environment into reusable building blocks made by some alterations. The raw materials used for plastic are crude oil, natural gas, and coal which are non-renewable. Hence, virgin plastic requires more energy and fuel. However recycling plastic waste helps to save these non-renewable resources along with avoiding landfilling and further land and groundwater pollution. Pyrolysis is the thermal degradation of plastic waste at different

temperatures ranging from 300–900°C in the absence of oxygen. Pyrolysis is a technique that is used to convert plastic waste to liquid oil which can be used as a substitute for traditional fossil fuels like diesel, oil, etc. Catalytic pyrolysis using zeolite as a catalyst can be beneficial. The amount of CO_2 emissions is curtailed due to plastic waste management. Initially, the plastic waste would have emitted around 52,710 kg of CO_2 right from its manufacturing to disposal. But, the CO_2 emissions are reduced by 4445.51 kg behind 17,570 kg of plastic waste on its recycling and proper management i.e. CO_2 emissions are reduced up to 48,264.49 kg from 52,710 kg.

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Analysis of Sustainability Reporting in the International Market Based on Global Reporting Initiative (GRI) Standards and its Linkage with Business Responsibility and Sustainability Reporting (BRSR).

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Abstract

The practice of sustainability reporting (SR) has emerged as a critical mechanism for transparency and accountability in business worldwide, as there is an increasing urgency to address Environmental, Social, and Governance (ESG) concerns. This research paper explores the landscape of SR in India and international businesses, focusing on the Global Reporting Initiative (GRI) and Business Responsibility and Sustainability Reporting (BRSR) at its core. Many other standards of SR are also studied giving an overview of the current trends in SR. An extensive examination of sustainability reports from six diverse companies spanning various industries is done. This analysis is centered on assessing how these companies fulfill their ESG obligations according to GRI standards. The observations of the analysis are compiled into a table that provides a clear overview of how companies in different sectors communicate their ESG-related information through their sustainability reports. This tabulated data offers valuable insights into the distinctive approaches and practices adopted by these companies when disclosing commitments and performance. The linkage of BRSR with the GRI standards is also studied in detail and Mapped in the research. So that the companies can report their sustainability scenarios in an integrated manner based on GRI and BRSR standards together.

Keywords: Sustainability Reporting, Business Responsibility and Sustainability Report, Global Reporting Initiative, Linkage of BRSR and GRI, Integrated Reporting.

Introduction

Sustainability Reporting (SR)

In General, sustainability reporting deals with information concerning environmental, social, economic, and governance issues in the broader sense. These are the criteria gathered under the acronym of ESG. The introduction of this non-financial information in published reports is seen as a forward step in corporate communication and is considered an effective way to increase transparency and corporate engagement. Sustainability reports play a crucial role in enhancing consumer trust and bolstering corporate reputations. They achieve this by showcasing a company's commitment to social responsibility initiatives and by providing transparent insights into how it manages various risks. The primary purpose of these reports is

to ensure that stakeholders have comprehensive access to essential non-financial information, which significantly impacts the overall performance of the company. Various terms, such as non-financial reporting, extra-financial reporting, social reporting, CSR reporting, and socio-environmental reporting, are used interchangeably to describe the concept of SR. In recent years, SR has gained significant attention and has evolved into a more professional practice. However, the framework governing such reporting is continually changing, placing increasing demands on companies regarding the format, content, and processes involved in SR. While the growing emphasis on SR offers numerous advantages for companies, investors, consumers, and all stakeholders, it also presents several challenges. To be meaningful and valuable, sustainability disclosures must not only be accurate and trustworthy but also subject to verification and comparison. Sustainability reporting frameworks, sometimes called ESG frameworks or ESG reporting frameworks, are essentially roadmaps for organizations. They offer a structured way to identify, evaluate, and communicate sustainability-related concerns that pertain to their business operations. These guidelines enable companies to measure their performance against industry peers and global standards, making it easier to share their sustainability achievements and progress with key stakeholders such as investors, regulatory bodies, customers, and employees. Some of the most important frameworks are as follows –

- GRI
- BRSR
- SASB
- TCFD

Global Reporting Initiative (GRI)

The Global Reporting Initiative (GRI) serves as an international, impartial standards body dedicated to assisting businesses, governmental bodies, and various organizations in comprehending and articulating their impacts regarding critical issues such as climate change, human rights, and corruption. GRI offers the most universally recognized sustainability reporting standards globally. Their framework for sustainability reporting plays a pivotal role in enabling companies to identify, collect, and present this information in a manner that is both lucid and comparable. Initially introduced in the year 2000, GRI's framework for sustainability reporting has evolved to become the most extensively employed approach by multinational corporations, governments, small and medium-sized enterprises, non-governmental organizations (NGOs), and industry associations across more than 90 nations. The most recent of GRI's reporting frameworks are the GRI Standards, GRI 2021 update to replace the previous standards beginning on January 1, 2023. In contrast to the earlier reporting frameworks, the GRI Standards have a modular structure, making them easier to update and adapt.

Business Responsibility and Sustainability Reporting (BRSR) The Securities and Exchange Board of India (SEBI) introduced the Business Responsibility Report (BRR) in 2012, marking a significant step in ESG regulatory disclosure in India. BRR was the initial framework for ESG reporting and was mandatory for the top 100 listed companies based on market capitalization. Over time, the scope of BRR expanded, and by 2019, it became mandatory for the top 1000 listed companies. However, in 2020, SEBI replaced BRR with the BRSR framework, which represented an evolution and broadening of the earlier reporting requirements. As of May 2021, SEBI made it compulsory for the top 1,000 listed entities by market capitalization to include BRSR as part of their Annual Report submitted to SEBI, starting from the financial year 2022-23. This transition reflects the growing emphasis on comprehensive sustainability reporting practices in India's regulatory landscape.

Sustainability Accounting Standards Board (SASB)

SASB, a nonprofit organization, was founded to create a standardized structure for businesses to report on sustainability matters. To achieve this, SASB has crafted industry-specific standards that offer guidance to companies when disclosing sustainability information. This information is of paramount importance to investors because it can potentially influence a company's financial performance significantly. The SASB Materiality Map is a visual representation that breaks down 26 general sustainability issues across 77 different industries. It effectively illustrates which of these concerns hold relevance within each specific industry. In contrast to traditional financial reporting, which relies on historical financial data, SASB reporting provides a more comprehensive and forward-looking perspective, shedding light on critical non-financial aspects that can impact a company's long-term sustainability and performance.

Task Force on Climate-related Financial Disclosures (TCFD)

Founded in December 2015 under the umbrella of the Financial Stability Board (FSB), TCFD has a clear mission: to improve the caliber and uniformity of financial reporting related to climate impacts. Its primary aim is to empower both businesses and investors with the information they need to make well-informed choices in an environment profoundly influenced by climate change. TCFD occupies a critical position where climate action and financial transparency converge. Its purpose is to advance business practices that prioritize sustainability and resilience. This is particularly relevant in an era where climate-related challenges carry substantial financial implications, be they risks or opportunities.

Need for Sustainability Reporting

SR helps immensely to keep an overview of what to focus on in terms of sustainability as there are a lot of things to monitor and report preparing the SR can be sometimes overwhelmingand exhausting for the companies. SR Ensures the regulation compliance to be followed by the

companies every year. It also makes the reporting organization more attractive to customers and their stakeholders. Maintaining an SR gives employees a foundation to build employee pride and loyalty and results in becoming more attractive to investors. Due to the increase in awareness based on the ESG front companies are making it a priority to add SR to the company's agenda. This eventually increases transparency, credibility, and accountability and hence can finally help in achieving sustainability

Literature Review

The increasing importance placed on sustainability reporting (SR) brings about numerous benefits for various stakeholders, including companies, investors, and consumers. However, it also introduces a set of challenges. For sustainability disclosures to truly serve their purpose and provide value, they must meet certain criteria. They should not only be accurate and reliable but also open to independent verification and meaningful comparison with other reports or benchmarks. On account of this fact. It is attempted to summarize some of the research studies undertaken in some other related study.

A brief review of the past studies related to Sustainability reporting, BRSR, GRI, and all the related terminologies related to SR.

Rajni Bhalla, et al. (2014) in their article "**Corporate Sustainability Reporting: A Study of Economic Sustainability Aspect by Selected Indian Corporations**", say that Corporate sustainability reporting is getting very popular these days but still in India it is just at the nascent stage. However research proves that its importance is growing year after year. As far as the Indian scenario is concerned there is only a limited number of companies that are showing their sustainability plans and performance to the various stakeholders. Indian corporations are following GRI guidelines to prepare sustainability reports. The present paper is an attempt to analyze the growth of sustainability reporting in India and the information which is used to be disclosed by the corporations with the help of such reports from the economic aspect of sustainability reporting. While reporting the economic aspect in the sustainability reports the organizations used to disclose the various policies and strategies which they have formulated or planning to formulate for the efficient and responsible use of the available resources of the organization which will not result in any environmental damage to the society. Companies are also presenting their sustainability performance to the various users with the help of websites and also through published reports which makes it available to the common public as well.

Anurodh Godha, et al. (2015) in their article "**Sustainability Reporting Trend in Indian Companies as per GRI Framework: A Comparative Study**", says that Sustainability reporting enables the creation of long-term value for organizations. It is forward-looking and includes quantitative and qualitative reporting measures. It is a key platform for communicating

the organization's economic, social, environmental, and governance performance, reflecting positive and negative impacts. It can be undertaken by all types, sizes, and sectors of organizations. Through the GRI Sustainability Reporting Framework, the GRI works to increase the transparency and exchange of sustainability-related information. Their study conceptually reviews sustainability reporting and its benefits for the entities. He revealed that the development of the corporate governance standard is maturing in India. Amendments in laws and changes in the regulatory mechanism are creating pressure on entities to respond to and communicate their sustainability concerns. With globalization, Indian companies are increasingly realizing that they have much to lose by not following sustainability reporting. Many respected companies already get their sustainability reports audited by a third party to ensure.

Ritika Mahajan, et al. (2022) in their article "**Sustainability Reporting in India: A Critical Assessment of Business Responsibility Reports of the Top 100 Companies**", says that This study provides insights into BR reporting in India based on an analysis of BR reports of the top 100 companies and an expert survey. Despite the mandate, it was observed that some leading companies still did not publish a BRR. The number of disclosures increased yearly 3 maximum transparency was observed in social disclosures. There is far more scope for disclosing supply chain and environmental impact data. The future reporting format must consider mechanisms for improving stakeholder engagement and materiality analysis disclosures, along with frameworks to establish accountability.

Rupam Majumder, et al. (2023) in their article "**Legal Framework for Corporate Sustainability Reporting in India**", say that a Sustainability document gives data approximately economic, environmental, governance, and social overall performance. The present study offers sustainability reporting steerage and has pioneered and evolved a comprehensive 'sustainability reporting framework' which needs to be taken into consideration for use by Indian corporates. Furthermore, there's a debate over whether or not sustainability documents ought to be a part of economic statements, annual documents, or disclosed separately based on the requisite information published by different Indian corporate bodies. Sustainability responsibilities are drastically being embedded into the missions and strategies of world and country-wide companies as attention to sustainability troubles is escalating. In addition, the study has proposed an integration of sustainability and decisional paradigms in the frameworks to complete the sustainability responsibilities. These paradigms show off the important attitude of sustainability which wishes to be considered for a right sustainability implementation project. The identification of this attitude will assist the practitioners in understanding the holistic photo of sustainability implementation.

Methodology

The study is mostly descriptive so the analysis and data gathered are in the form of Secondary research. The reports of different companies are downloaded from the official website of the respective companies which are made available to everyone. The GRI standards are also available on their official website, Also the format in which the BRSR report is expected is available on the official SEBI website.

GRI Domain

In the GRI Framework all the disclosures based on Environmental, Social, Economic, and Governance are studied taking into consideration the sustainability reports of Reliance Industries Limited, TATA Motors Limited, Toyota, ITC, IndusInd Bank, and Shell. All these reports have been thoroughly read and a table has been formulated. The table contains all the disclosures individually and whether the six companies have reported or not reported this disclosure. All the categories of the disclosures like General Disclosures, Material topics, Economical Disclosures, Environmental Disclosures, and Social Disclosures are quantified and presented in a table, which gives an idea of which company discloses more information on what front in their SR.

GRI and BRSR linkage domain

Both the standards were studied in depth, the format of BRSR available at SEBI's website was analyzed thoroughly and the actual requirement of the BRSR standard and its counterpart was studied which gave a result of the mapping of the BRSR notation with the GRI standards this is summarized in a table. This table serves as a concise reference guide, offering a clear overview of the alignment between the two sets of standards. Due to the constraint of the paper only Section A and Principle 6 of Section C are mapped in this research paper. This will give an overall idea of how both standards can be used in collaboration with each other efficiently.

Result and Discussion

GRI

SR for six different companies, each belonging to various sectors such as Manufacturing, Automobiles, FMCG (Fast-Moving Consumer Goods), Banking, and Oil and gas were obtained. These reports were downloaded from the respective company's official websites. The analysis focuses on compliance with the latest GRI standards of 2021. All the GRI standards are meticulously examined and categorized into a detailed table (Table No. I). This table encompasses a comprehensive range of disclosures, organized into five main categories: General Disclosures (30), Material Topic Disclosures (3), Economical Disclosures (17), Environmental Disclosures (31), and Social Disclosures (36). For each disclosure, we indicate

whether the respective company reported it ("R") or did not report it (“NR"). The six companies in the study are represented by unique codes:

- Reliance Industries Limited
- TATA Motors Limited
- Toyota
- ITC
- IndusInd Bank
- Shell

The analysis delves into the sustainability reporting practices of these companies within the context of GRI's 2021 standards, offering insights into their disclosure efforts across various sectors

Table 1: GRI Analysis of Six Companies

GRI Indicator No.	Disclosure Details	1	2	3	4	5	6
GRI 2	General Disclosure						
2-1	Organizational details	R	R	R	R	R	R
2-2	Entities included in the organization’s sustainability reporting	R	R	R	R	R	R
2-3	Reporting period, frequency, and contact point	R	R	R	R	R	R
2-4	Restatements of information	R	R	R	R	R	R
2-5	External assurance	R	R	R	R	R	R
2-6	Activities, value chain, and other business relationships	R	R	R	R	R	R
2-7	Employees	R	R	R	R	R	R
2-8	Workers who are not employees	R	R	R	R	R	R
2-9	Governance structure and composition	R	R	R	R	R	R
2-10	Nomination and selection of the highest governance body	R	R	R	R	R	R
2-11	Chair of the highest governance body	R	R	R	R	R	R
2-12	Role of the highest governance body in overseeing the management of impacts	R	R	R	R	R	R

2-13	Delegation of responsibility for managing impacts	R	R	R	R	R	R
2-14	Role of the highest governance body in sustainability reporting	R	R	R	R	R	R
2-15	Conflicts of interest	R	R	R	R	R	R
2-16	Communication of critical concerns	R	R	R	R	R	R
2-17	The collective knowledge of the highest governance body	R	R	R	R	R	R
2-18	Evaluation of the performance of the highest governance body	R	R	R	R	R	R
2-19	Remuneration policies	R	R	R	R	R	R
2-20	The process to determine the remuneration	R	R	R	R	R	R
2-21	Annual total compensation ratio	R	R	R	R	R	R
2-22	Statement on Sustainable Development Strategy	R	R	R	R	R	R
2-23	Policy commitments	R	R	R	R	R	R
2-24	Embedding policy commitments	R	R	R	R	R	R
2-25	Processes to remediate negative impacts	R	R	R	R	R	R
2-26	Mechanisms for seeking advice and raising concerns	R	R	R	R	R	R
2-27	Compliance with laws and regulations	R	R	R	R	R	R
2-28	Membership associations	R	R	R	R	R	R
2-29	Approach to Stakeholder Engagement	R	R	R	R	R	R
2-30	Collective bargaining agreements	R	R	R	R	R	R
GRI 3	Material Topics						
3-1	The process to determine material topics	R	R	R	R	R	R
3-2	List of material topics	R	R	R	R	R	R
3-3	Management of material topics	R	R	R	R	R	R
GRI 200	Economical						
201-1	Direct economic value generated and distributed	R	R	R	R	R	R
201-2	Financial implications and other risks and opportunities due to climate change	R	R	R	R	R	R

201-3	Defined benefit plan obligations and other retirement plans	R	R	R	R	R	NR
201-4	Financial assistance received from the government	R	R	NR	R	R	R
202-1	Ratios of standard entry-level wage by gender compared to local minimum wage	NR	NR	NR	R	NR	NR
202-2	The proportion of senior management hired from the local community	NR	NR	NR	R	R	R
203-1	Infrastructure investments and services supported	R	NR	R	R	R	R
203-2	Significant indirect economic impacts	R	NR	R	R	R	R
204-1	Proportion of spending on local suppliers	R	R	R	R	R	R
205-1	Operations assessed for risks related to corruption	R	R	R	R	R	R
205-2	Communication and training about anti-corruption policies and procedures	R	R	R	R	R	R
205-3	Confirmed incidents of corruption and actions taken	R	R	R	R	R	R
206-1	Legal actions for anti-competitive behavior, antitrust, and monopoly practices	NR	R	NR	R	R	R
207-1	Approach to tax	NR	NR	R	R	R	R
207-2	Tax governance, control, and risk management	NR	NR	R	R	R	R
207-3	Stakeholder engagement and management of concerns related to tax	NR	NR	R	R	R	R
207-4	Country-by-country reporting	NR	NR	NR	R	R	R
GRI 300	Environmental						
301-1	Materials used by weight or volume	R	R	R	R	NR	NR
301-2	Recycled input materials used	R	R	R	R	NR	NR
301-3	Reclaimed products and their packaging materials	R	R	R	R	NR	NR
302-1	Energy consumption within the organization	R	R	R	R	R	R
302-2	Energy consumption outside of the organization	R	R	NR	R	R	R

302-3	Energy intensity	R	R	R	R	R	R
302-4	Reduction of energy consumption	R	R	R	R	R	R
302-5	Reductions in energy requirements of products and services	R	R	R	R	R	R
303-1	Interactions with water as a shared resource	R	R	R	R	R	R
303-2	Management of water discharge-related impacts	R	R	R	R	R	R
303-3	Water withdrawal	R	R	R	R	R	R
303-4	Water discharge	NR	NR	R	R	R	R
303-5	Water Consumption	NR	NR	R	R	R	R
304-1	Operational sites owned, leased, managed in, or adjacent to, protected areas and areas of high biodiversity value outside protected areas	R	R	NR	R	R	R
304-2	Significant impacts of activities, products, and services on biodiversity	R	R	NR	R	R	R
304-3	Habitats protected or restored	R	R	NR	R	R	R
304-4	IUCN Red List species and National Conservation List species with habitats in areas affected by operations	R	R	NR	R	R	R
305-1	Direct (Scope 1) GHG emissions	R	R	R	R	R	R
305-2	Energy indirect (Scope 2) GHG emissions	R	R	R	R	R	R
305-3	Other indirect (Scope 3) GHG emissions	R	R	R	R	R	R
305-4	GHG emissions intensity	R	R	R	R	R	R
305-5	Reduction of GHG emissions	R	R	R	R	R	R
305-6	Emissions of ozone-depleting substances (ODS)	R	R	R	R	R	NR
305-7	Nitrogen oxides (NOX), sulfur oxides (SOX), and other significant air emissions	R	R	R	R	R	R
306-1	Waste generation and significant waste-related impacts	R	R	NR	R	R	R
306-2	Management of significant waste-related impacts	R	R	R	R	R	R
306-3	Waste generated	R	R	R	R	R	R
306-4	Waste diverted from disposal	R	R	R	R	R	R
306-5	Waste directed to disposal	R	R	NR	R	R	R

308-1	New suppliers that were screened using environmental criteria	NR	R	R	R	R	NR
308-2	Negative environmental impacts in the supply chain and actions taken	NR	R	R	R	R	NR
GRI 400	Social						
401-1	New employee hires and employee turnover	R	R	R	R	R	R
401-2	Benefits provided to full-time employees that are not provided to temporary or part-time employees	R	R	NR	R	R	R
401-3	Parental leave	R	R	R	R	R	R
402-1	Minimum notice periods regarding operational changes	NR	NR	NR	R	R	R
403-1	Occupational health and safety management system	R	R	R	R	R	R
403-2	Hazard identification, risk assessment, and incident investigation	R	R	R	R	R	R
403-3	Occupational health services	R	R	R	R	R	R
403-4	Worker participation, consultation, and communication on occupational health and safety	R	R	R	R	R	R
403-5	Worker training on occupational health and safety	NR	NR	R	R	R	R
403-6	Promotion of worker health	NR	NR	R	R	R	R
403-7	Prevention and mitigation of occupational health and safety impacts directly linked by business relationships	NR	NR	R	R	R	R
403-8	Workers covered by an occupational health and safety management system	NR	NR	R	R	R	R
403-9	Work-related injuries	NR	NR	R	R	R	R
403-10	Work-related ill health	NR	NR	R	R	R	R
404-1	Average hours of training per year per employee	R	R	R	R	R	R

404-2	Programs for upgrading employee skills and transition assistance programs	R	R	R	R	R	R
404-3	Percentage of employees receiving regular performance and career development reviews	R	R	R	R	R	NR
405-1	Diversity of governance bodies and employees	R	NR	R	R	R	R
405-2	The ratio of basic salary and remuneration of women to men	R	NR	R	R	R	R
406-1	Incidents of discrimination and corrective actions taken	R	NR	NR	NR	NR	R
407-1	Operations and suppliers in which the right to freedom of association and collective bargaining may be at risk	NR	NR	NR	R	R	R
408-1	Operations and suppliers at significant risk for incidents of child labor	R	R	NR	R	R	NR
409-1	Operations and suppliers at significant risk for incidents of forced or compulsory labor	R	R	R	R	R	R
410-1	Security personnel trained in human rights policies or procedures	NR	NR	NR	R	R	R
411-1	Incidents of violations involving the rights of indigenous peoples	NR	NR	NR	NR	NR	R
413-1	Operations with local community engagement, impact assessments, and development programs	R	NR	R	R	R	R
413-2	Operations with significant actual and potential negative impacts on local communities	R	R	R	R	R	R
414-1	New suppliers that were screened using social criteria	NR	NR	R	R	R	R
414-2	Negative social impacts in the supply chain and actions taken	NR	NR	R	R	R	R
415-1	Political contributions	NR	NR	NR	R	R	R
416-1	Assessment of the health and safety impacts of product and service categories	R	R	R	R	R	R
416-2	Incidents of non-compliance concerning the health and safety impacts of products and services	R	R	R	R	R	NR

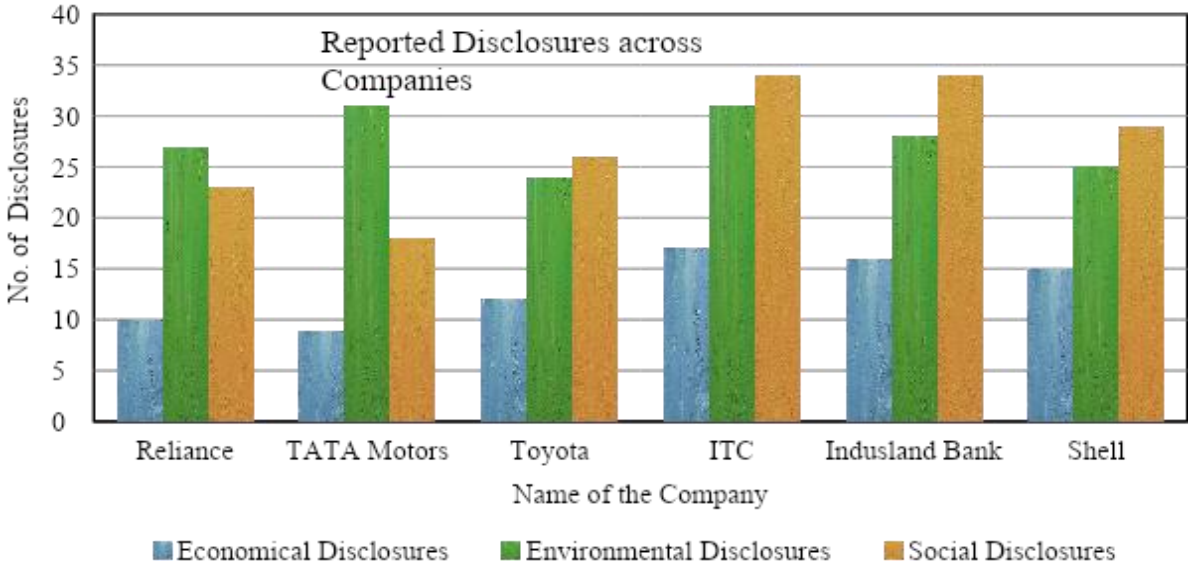
417-1	Requirements for product and service information and labeling	R	R	R	R	R	NR
417-2	Incidents of non-compliance concerning product and service information and labeling	R	R	NR	R	R	NR
417-3	Incidents of non-compliance concerning marketing communications	R	R	NR	R	R	NR
418-1	Substantiated complaints concerning breaches of customer privacy and losses of customer data	R	NR	R	R	R	NR

Table 2: Analysis of Reported Disclosures

Type of Disclosure	Disclosures	Reliance Industries Limited	TATA Motors Limited	Toyota	ITC	IndusInd Bank	Shell
Mandatory	General Disclosures	30	30	30	30	30	30
Mandatory	Material Topics	3	3	3	3	3	3
Performance Based	Economical Disclosures	10	9	12	17	16	15
Performance Based	Environmental Disclosures	27	31	24	31	28	25
Performance Based	Social Disclosures	23	18	26	34	34	29
	Total	93/117	91/117	95/117	115/117	111/117	102/117

The following table (II) summarises the quantified nature of the disclosures reported by the company individually. The disclosures are divided into two types of disclosures i.e. Mandatory and Performance-based. Mandatory disclosures are compulsory for the companies to disclose hence we can see in the table that all six companies have reported all 33 mandatory disclosures. The performance disclosures are based on the economic (17), Environmental (31), and Social performances (36) of the company. Due to this reason, we can see the difference in reporting based on the different sectors and how they vary from each other

Figure 1: Bar Graph of 3 performance indicators of all companies

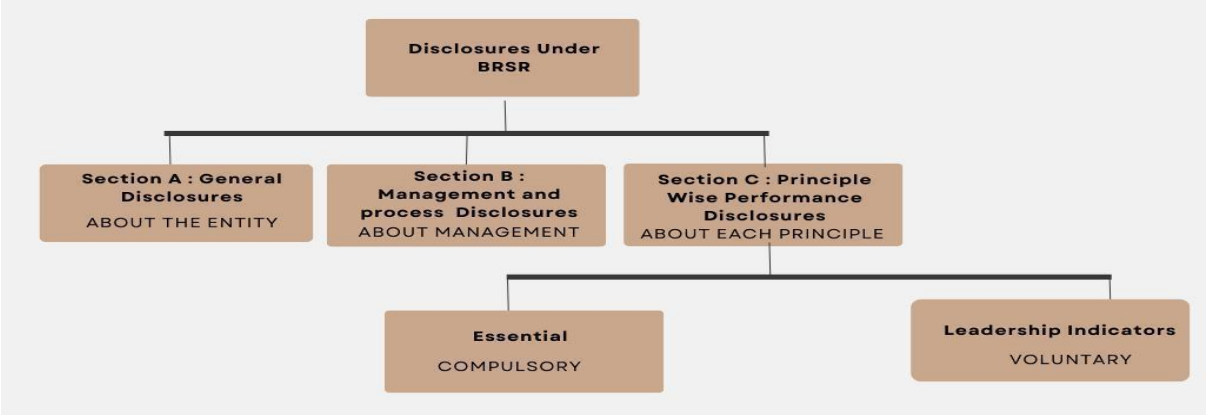


The graph in Figure 1 illustrates the disclosures reported by all six companies for all the performance-based disclosures which are Economical, Environmental, and Social Disclosures. This can give a clear idea of how a company discloses based on various sectors and on which front.

- ITC and Indus land have reportedly reported majorly on the social front.
- TATA has reported very low on the economic front.
- TATA and ITC have reported the best on the Environmental front.
- ITC has reported excellently in Economical front.

BRSR linkage with GRI

There are 3 sections in the BRSR report which are as shown in the below flow chart of BRSR. Section A consists of all the general disclosures, Section B consists of all the



management and process disclosures and Section C consists of principle-wise performance disclosures which then include essential and leadership indicators of all the nine principles.

Figure 2: BRSR Flow chart

The essential indicators are mandatory, while the leadership indicators are voluntary. The flow of sections in BRSR can be seen in the following image of Figure 2 giving an overview of all the three sections

The 9 principles according to the official format provided by SEBI's BRSR are as follows-

Table 3: BRSR 9 Principles

Principle No.	Description
1	Businesses should conduct and govern themselves with integrity, and in a manner that is ethical, transparent, and accountable
2	Businesses should provide goods and services in a manner that is sustainable and safe
3	Businesses should respect and promote the well-being of all employees, including those in their value chains
4	Businesses should respect the interests of and be responsive to all its stakeholders
5	Businesses should respect and promote human rights
6	Businesses should respect and make efforts to protect and restore the environment
7	Businesses, when engaging in influencing public and regulatory policy, should do so in a manner that is responsible and transparent
8	Businesses should promote inclusive growth and equitable development
9	Businesses should engage with and provide value to their consumers in a responsible manner

Both the standards were studied thoroughly and the mapping of BRSR requirements was done with GRI. The BRSR Notations are based on the format of the BRSR report representing the number of requirements due to the constraints of paper only Section A and Principle 6: Businesses should respect and make efforts to protect and restore the environment of Section C are shown in Table no. 4

Table 4: Mapping of BRSR with GRI

BRSR Notation	Description of BRSR requirement	Linkage to GRI Standards and Disclosures
	Section A: General Disclosures	
	I. Details of Listed Entity	
A1	Corporate Identity Number (CIN) of the Listed Entity	No direct linkage

A2	Name of the Listed Entity	GRI 2: 2-1-a
A3	Year of incorporation	No direct linkage
A4	Registered office address	No direct linkage
A5	Corporate address	GRI 2: 2-1-c
A6	E-mail	GRI 2: 2-3-d
A7	Telephone	GRI 2: 2-3-d
A8	Website	No direct linkage
A9	The financial year for which reporting is being done	GRI 2: 2-3-a, 2-3-b
A10	Name of the Stock Exchange(s) where shares are listed	No direct linkage
A11	Paid-up Capital	No direct linkage
A12	Name and contact details (telephone, email address) of the person who may be contacted in case of any queries on the BRSR report	GRI 2: 2-3-d
A13	Reporting boundary - Are the disclosures under this report made on a standalone basis (i.e. only for the entity) or on a consolidated basis (i.e. for the entity and all the entities that form a part of its consolidated financial statements, taken together).	GRI 2: 2-2-a, 2-2-c
	II. Products / Services	
A14	Details of business activities (accounting for 90% of the turnover)	GRI 2: 2-6-b-i
A15	Products/Services sold by the entity (accounting for 90% of the entity's Turnover)	GRI 2: 2-6-b-i
	III. Operations	
A16	Number of locations where plants and/or operations/offices of the entity are situated	GRI 2: 2-6-b-i
A17a	Markets served by the entity: a. Number of locations	GRI 2: 2-6-b-i
A17b	Markets served by the entity: b. What is the contribution of exports as a percentage of the total turnover of the entity?	No direct linkage
A17c	Markets served by the entity: c. A brief on types of customers	GRI 2: 2-6-b-iii
	IV. Employees	
A18a	Details as at the end of the Financial Year: a. Employees and workers (including differently abled): - Gender-wise - Permanency of the job	GRI 2: 2-7-a, 2-7-b-i-ii, 2-8-a
A18b	Details as at the end of the Financial Year: b. Differently abled Employees and workers	GRI 405: 405-1-b-iii

A19	Participation/Inclusion/Representation of Women	GRI 405: 405-1-a-I, 405-1-b-i
A20	Turnover rate for permanent employees and workers	GRI 401: 401-1-b
	V. Holding, Subsidiary, and Associate Companies (Including joint ventures)	
A21	A] Name of the holding/subsidiary / associate companies / joint ventures (A)	GRI 2: 2-2-a, 2-2-b
	B] Indicate whether holding/subsidiary/ associate/ joint venture	No direct linkage
	C] % of shares held by the listed entity	No direct linkage
	D] Does the entity indicated at A, participate in the Business Responsibility initiatives of the listed entity? (Yes/No)	No direct linkage
	VI. CSR Details	
A22	(i) Whether CSR is applicable as per section 135 of the Companies Act, 2013: (Yes/No) (ii) Turnover (in Rs.) (iii) Net worth (in Rs.)	GRI 201: 201-1-a-i-ii
	VII. Transparency and Disclosure Compliances	
A23	Complaints/Grievances on any of the principles (Principles 1 to 9) under the National Guidelines on Responsible Business Conduct	GRI 2: 2-25-e
A24	Overview of the entity's material responsible business conduct issues	GRI 3: 3-1-a-i-ii, 3-1-b
	A] Material issue identified	GRI 3: 3-2-a
	B] Indicate whether risk or opportunity	GRI 3: 3-3-a
	C] Rationale for identifying the risk/opportunity	GRI 3: 3-3-a
	D] In case of risk, approach to adapt or mitigate	GRI 3: 3-3-d-i-ii
	E] Financial implications of the risk or opportunity (indicate positive or negative implications)	No direct linkage
	Section C	
	PRINCIPLE 6: Businesses should respect and make efforts to protect and restore the environment	
	Essential Indicators	
P6-E1	Details of total energy consumption (in Joules or multiples) and energy intensity, in the following format: Total electricity consumption (A) Total fuel consumption (B) Energy consumption through other sources (C) Total energy consumption (A+B+C)	GRI 302: 302-1-a, 302-1-b, 302-1-c-I, 302-1-e

	Energy intensity per rupee of turnover Energy intensity (optional) – the relevant metric may be selected by the entity	GRI 302: 302-3-a, 302-1-b
P6-E2	Does the entity have any sites/facilities identified as designated consumers (DCs) under the Performance, Achieve, and Trade (PAT) Scheme of the Government of India? (Y/N) If yes, disclose whether targets set under the PAT scheme have been achieved. In case targets have not been achieved, provide the remedial action taken, if any.	Can be covered by - GRI 3: 3-3
P6-E3	Provide details of the following disclosures related to water, in the following format: Water withdrawal by source (in kilolitres) (i) Surface water (ii) Groundwater (iii) Third-party water (iv) Seawater / desalinated water (v) Others Total volume of water withdrawal (in kilolitres) (i + ii + iii + iv + v)	GRI 303: 303-3-a-i-v, 303-5-a
	Total volume of water consumption (in kilolitres)	GRI 303: 303-5-a
	Water intensity per rupee of turnover (Water consumed / turnover) Water intensity (optional) – the relevant metric may be selected by the entity	No direct linkage
P6-E4	Has the entity implemented a mechanism for Zero Liquid Discharge? If yes, provide details of its coverage and implementation.	Can be covered by - GRI 303: 303-1-a, 303-2-a
P6-E5	Please provide details of air emissions (other than GHG emissions) by the entity.	GRI 305: 305-7-a-i-vii
P6-E6	Provide details of greenhouse gas emissions (Scope 1 and Scope 2 emissions) & their intensity.	GRI 305: 305-1-a, 305-1-b, 305-2-a, 305-2-b, 305-2-c
	Total Scope 1 and Scope 2 emissions per rupee of turnover Total Scope 1 and Scope 2 emission intensity (optional) – the relevant metric may be selected by the entity	GRI 305: 305-4-a, 305-4-b, 305-4-c
P6-E7	Does the entity have any project related to reducing Green House Gas emissions? If Yes, then provide details	GRI 305: 305-5-a, 305-5-b, 305-5-c, 305-5-d
P6-E8	Provide details related to waste management by the entity	GRI 306: 306-3-a, 306-4-a, 306-4-b-i-iii, 306-4-c-i-iii

	For each category of waste generated, total waste recovered through recycling, re-using or other recovery operations (in metric tonnes) (I) Recycled (ii) Re-used (iii) Other recovery operations Total	GRI 306: 306-5-a, 306-5-b-i-iii, 306-5-c-i-iv
P6-E9	Briefly describe the waste management practices adopted in your establishments. Describe the strategy adopted by your company to reduce the usage of hazardous and toxic chemicals in your products and processes and the practices adopted to manage such wastes.	GRI 306: 306-2-a
P6-E10	If the entity has operations/offices in/around ecologically sensitive areas (such as national parks, wildlife sanctuaries, biosphere reserves, wetlands, biodiversity hotspots, forests, coastal regulation zones, etc.) where environmental approvals/clearances are required	GRI 304: 304-1-a-i-v
P6-E11	Details of environmental impact assessments of projects undertaken by the entity based on applicable laws, in the current financial year:	GRI 413: 413-1-a-ii
	Details of environmental impact assessments of projects undertaken by the entity based on applicable laws, in the current financial year:	GRI 303: 303-1-a No direct linkage
P6-E12	Is the entity compliant with the applicable environmental law/ regulations/ guidelines in India; such as the Water (Prevention and Control of Pollution) Act, Air (Prevention and Control of Pollution) Act, Environment Protection Act, and rules thereunder (Y/N). If not, provide details of all such noncompliance, in the following format: a. Specify the law /regulation /guidelines which was not complied with b. Provide details of the noncompliance c. Any fines /penalties/action taken by regulatory agencies such as pollution control boards or by courts d. Corrective action taken, if any	GRI 2: 2-27a-i-ii, 2-27-b-i-ii
	Leadership Indicators	
P6-L1	Provide a break-up of the total energy consumed (in Joules or multiples) from renewable and non-renewable sources.	GRI 302: 302-1-a, 302-1-b, 302-1-c-I, 302-1-e

P6-L2	Water discharge by destination and level of treatment (in kilolitres)	GRI 303: 303-4-a-i-iv
P6-L3	Water withdrawal, consumption, and discharge in areas of water stress (in kilolitres):	GRI 303: 303-3-b-i-iv, 303-4-a-i-ii
P6-L4	Please provide details of total Scope 3 emissions & their intensity.	GRI 305: 305-3-a, 305-3-b
	Total Scope 3 emissions per rupee of turnover Total Scope 3 emission intensity (optional) – The relevant metric may be selected by the entity	GRI 305: 305-4-a, 305-4-b, 305-4-c
P6-L5	Concerning the ecologically sensitive areas reported in Question 10 of Essential Indicators above, provide details of the significant direct & indirect impact of the entity on biodiversity in such areas along with prevention and remediation activities.	GRI 304: 304-2-a-i-vi, 304-2-b-i-iv, 304-3-a
P6-L6	If the entity has undertaken any specific initiatives or used innovative technology or solutions to improve resource efficiency or reduce impact due to emissions/effluent discharge/waste generated, please provide details of the same as well as the outcome of such initiatives,	GRI 3: to be used together with GRI 301, GRI 302, GRI 303, GRI 304, GRI 305, GRI 306: 3-3
P6-L7	Does the entity have a business continuity and disaster management plan? Give details in 100 words/ web link.	No direct linkage
P6-L8	Disclose any significant adverse impact to the environment, arising from the value chain of the entity. What mitigation or adaptation measures have been taken by the entity in this regard.	GRI 308: 308-2-c, 308-2-d
P6-L9	Percentage of value chain partners (by value of business done with such partners) that were assessed for environmental impacts.	GRI 308: 308-1-a, 308-2-a

Conclusion

Upon a comprehensive evaluation of the sustainability disclosures made by the companies evaluated, it becomes apparent that they have successfully addressed all mandatory and material aspects. This signifies a foundational commitment to transparency and accountability in their sustainability practices. However, while they have made commendable progress, there remains an opportunity for further enhancement, notably for Reliance, Tata Motors, and Toyota. These three companies have reported a comparatively lower number of disclosures when compared to some of their peers. An intriguing observation is the impressive commitment to reporting exhibited by ITC as they have reported a whopping amount of 115 disclosures out of 117, particularly noteworthy given its position as an FMCG company. This suggests a strong dedication to sustainability principles and a proactive stance in disclosing relevant information

to stakeholders. An essential takeaway from this assessment is the significance of meticulous attention to detail. Achieving comprehensive disclosures often hinges on scrutinizing and addressing the finer points that may initially go unnoticed. Companies can optimize their reporting by leaving no stone unturned, ensuring that every aspect of their sustainability performance is effectively communicated. Furthermore, the establishment of linkages within different facets of reporting is pivotal. Integrating sustainability reporting into the broader corporate reporting framework can lead to a more cohesive and holistic portrayal of a company's performance. This integration not only streamlines the reporting process but also facilitates a deeper understanding of the interplay between sustainability efforts and overall corporate strategies.

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Evaluation of Nutrient Content of Vermicompost and its Applications

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Abstract
In this research biodegradable waste like cow dung, buffalo dung, Goat dung sugarcane trash were collected in that vermicomposting process using earthworms like eisenai fadita. After the collection of waste material kept degrading for 90 days. After degradation, the physicochemical characteristics were analysed and from the result, it is required the waste material was converted into vermicomposting. Vermicomposting is a biological technique of converting organic wastes into a rich soil amendment. In this paper, a thorough literature is done regarding the impacting factors for a vermicomposting unit followed by the design of a pit for vermicomposting and the number of earthworms required for the obtained amount of waste. This is further continued by selecting the optimum range for parameters such as Temperature, Potential Hydrogen, and TAN.

Key words: Vermicomposting, vermicompost, Eisenaifadita, Biodegradable.

Introduction
Vermicomposting is the excreta of earthworms which are capable of improving soil health and nutrient status. Vermiculture is a process by which all types of biodegradable waste are converted while passing through the worm gut to nutrient-rich vermicompost. Vermi Worms are used here to act as biological agents to consume that waste and to deposit excreta in the process called vermicompost.
In that vermicompost 84 bacteria's are present and that way they are used in soil like plant growth promoters' like auxins, gibberellins, cytokinins, and beneficial microbes not only improve the growth and yield of crops but also increase the diversity and activate antagonistic microbes and nematodes, which help to suppress pests and diseases caused by soil-borne phytopathogens.

Heavy use of agrochemicals since the "Green Revolution" of the 1960s boosted food productivity at the cost of the environment & society destroyed their natural fertility, and impaired the power of Biological Resistance in crops making them more susceptible all over the world desperately looking for an economically viable, socially safe environmentally sustainable alternative to the agrochemicals. In this research biodegradable waste like Cow dunk, Goat dunk, Buffalo dunk, and Sugarcane trash was collected in that vermicomposting process using earthworms like Eisenia fajita. After completing the vermicomposting process,

this research compares the nutrient values like OC, OM, N, P, and K in the different vermicomposting samples and applied to the sugarcane plant as a basal dose.

Literature Review

A brief review of the past studies related to vermicompost analysis and application.

Sujit Adhikary *et al* (2012) in their article Vermicompost, the Story of Organic Gold says that Earthworms have been studied by philosophers like Pascal and Thoreau, but their role in agricultural nutrition has only gained attention in recent decades. Waste management is crucial for a sustainable society, and vermicomposting is an alternative method. Earthworm excreta (vermicast) is a nutritive organic fertilizer rich in micronutrients, beneficial soil microbes, and growth hormones. Vermicompost and its body liquid (vermiwash) are proven growth promoters and protectors for crop plants.

Chaudhary D.R. Bhandari S.C. 1, Shukla L.M. *et al* (2004) in their article Role of vermicompost in sustainable Agriculture say that Organic waste returned to the soil can improve soil quality, fertility, and productivity. Vermicompost technology reduces decomposition time and produces high-quality compost. Its crucial for integrated plant nutrient supply systems, maintaining soil health, and reducing crops are also highlighted in the article, Vermicompost can be used as a potting mixture for horticulture crops.

Manuel Blouin, Nicolas Meyer, Silene Lartigue, *et al* (2019) in their article Vermicompost significantly affects plant growth they say. A meta-analysis says that The growing world population presents a double challenge in food production and waste management. Recycling organic residues into compost for food production could help address this issue. A meta-analysis of studies on vermicomposting found that it increased commercial yield, total biomass, shoot biomass, and root biomass by 26%. The positive effect was strongest when vermicompost represented 30-50% of soil volume. Cattle manure was the best material for vermicompost production. Herbs and legumes showed the largest biomass increase. The study recommends authors provide minimum statistics for meta-analyses

Usman Ali, Nida Sajid, Azeem Khalid, Luqman Riaz, *et al* (2015) in their article A review on vermicomposting of organic wastes says that the review discusses the potential of vermicomposting as an eco-friendly solution for handling global solid waste. It highlights the integration of composting and vermicomposting processes, optimizing the conversion of organic waste by microorganisms and earthworms under controlled conditions. The nutrient-rich compost produced can be used for biogas production, enabling efficient waste management and energy production.

Addison Lynch, *et al* (2002) in their article Vermiculite: A Review of the Mineralogy and Health Effects of Vermiculite Exploitation say that vermiculite, a mica mineral used in insulation, composite cement, and horticulture has no serious health risks due to its long-term chemical durability. However, if a significant amount of asbestos is present, it could pose a health risk. Regulation prevents inadvertent exposure to asbestos in vermiculites, but caution is needed to accurately identify asbestos hazards. Test methods and action levels are recommended for asbestos in vermiculites and other raw materials.

Su Lin Lim, Ta Yeong Wu *et al* (2014) in their article The use of vermicompost in organic farming: an overview of, effect on soil and economics say that vermicomposting, a process using earthworms to convert organic materials into humus, has been found to improve soil fertility physically, chemically, and biologically. It enhances aeration, porosity, bulk density, water retention, pH, electrical conductivity, and organic matter content, leading to better crop yield. However, a high concentration of soluble salts in vermicompost can impede the growth of vermicompost, It is an important benefit in agriculture, so it should be applied at a moderate concentration for maximum plant yield.

Olle Margit *et al* (2019) in their article Vermicomposts Its Importance and Benefit in Agriculture say that vermicomposting is a process of bio oxidizing and stabilizing organic material using earthworms and microorganisms under suitable conditions warms reduce waste volume by 40-60%. This process produces rich, nutritious vermicompost, which reduces west usage, pest attacks, and weed growth. It also boosts horticulture production without agrochemicals. Despite its benefits, vermicompost uses are not widespread yet, and this review aims to increase awareness of this local soil amendment.

Vasanthi D. Kumaraswamy K. *et al* (2016) in their article Efficacy of vermicompost to improve soil fertility and rice yield says that field experiments were conducted at the agriculture college and research institute Madurai to evaluate the effectiveness of vermicompost made from various organic materials to increase rice yield and soil fertility. The experiment showed that treatment with vermicompost plus nitrogen, phosphorus, and potassium at the recommended level resulted in higher grain yields, higher organic carbon content, higher fertility status, micronutrients, and lower bulk density. The result also indicated that vermicompost was sufficient for rice crop application when applied with the recommended level of NPK

Jorge Santigo-Borraz *et al* (2006) in their article Vermicompost as a soil supplement to improve growth, yield and fruit quality of Tomato says that A greenhouse experiment investigated the impact of earthworm–processed sheep- manure on tomato growth, productivity, and chemical characteristics. Five treatments were applied, with growth and yield

parameters measured 85 & 100 days after transplantation Vermicompost increased plant height but had no effect on leaf numbers or yield. Yields were greater when vermicompost soil ratio was 1:1,1:2, or 1:3,100 days after transplantation. vermicompost also decreased soil p^H and increased soluble and insoluble in tomato

S.Manivannan, M.Balamurugnl *et al* (2007) in their article Effect of vermicompost on soil fertility and crop productivity –beans say that The study conducted in Sivapuri, Chidambaram, Tamil Nadu, compared the efficacy of vermicompost compared to inorganic fertilizers (NPK) on soil characteristics and bean growth. The result shows that vermicompost significantly improved pore space, water-holding capacity, cation exchange capacity, particle reduction,bulk density, pH, electric conductivity, and Organic carbon. Inorganic fertilizers reduced porosity organic carbon and microbial activity in both soil types.

Methodology

Available Nitrogen in vermicompost

A given weight of vermicompost is treated with an excess of alkaline $KMnO_4$ and Distilled.$KMnO_4$ is a mild oxidizing agent in an alkaline medium. The organic matter present in the vermicompost is oxidized by nascent oxygen liberated by $KMnO_4$ in the presence of NaOH and thus the ammonia released is distilled and absorbed in a known volume of standard acid. The excess of which was titrated with a standard alkali using methyl red as an indicator. Nitrogen estimated by this method is considered as potentially available nitrogen

Procedure

Distillation

Assemble the distillation assembly.

1. Take 1 gm. of vermicompost in a Kjeldahl distillation flask.
2. Add 20 ml of Distilled water and 100 ml of 0.32 % $KMnO_4$ solution.
3. By using a volumetric flask take 25 ml 0.02N H_2SO_4 in the conical flask.
4. Add 2-3 drops of methyl red indicator and dip the end of the delivery tube into it.
5. Pour 100 ml of 2.5% NaOH into the Kjeldahl distillation flask and cork it immediately.
6. Distill the Ammonia gas from the distillation flask and collect it in H_2SO_4 solution.
7. Continue distillation till the evolution of ammonia stops completely (Test it by bringing moist red litmus paper near the outlet at the condenser which will turn blue as long as ammonia is being evolved).
8. Collect distilled ammonia gas into 0.02 N H_2SO_4 in a conical flask (Approx.150ml).
9. Titrate the distillate with 0.02N NaOH – End point – Pink to Yellow.

Available Phosphorus in vermicompost

Principle

In this method, vermicompost is shaken with 0.5M NaHCO3 solution in a 1:20 ratio for half an hour in the presence of activated charcoal, and the extract is obtained by filtering the suspension. Phosphorous in the extract is treated with Ammonium Molybdate and then $SnCl_2$ reagent, which results in the formation of the blue-colored complex. The intensity of the blue color formed is directly proportional to the quantity of phosphorus entering the reaction. So phosphorus in the extract can be determined spectro-photometrically.

Procedure

A. Extraction

1. Weight 1gm of vermicompost sample in 100ml conical flask.
2. Add a pinch of activated charcoal and 20 ml of 0.5m NaHCO3 solution.
3. Shake the contents of the flask for half an hour and filter the suspension through man filter paper No.01.
4. Prepare the blank with the entire reagent.

Analytical Determination

1. Prepare a series of phosphorous concentrations in the range of 0 to 1 ppm by pipetting out 0(blank), 2,4,6,8, and 10 ml of 2 ppm of Phosphorus working standard and diluting them to 25 ml.
2. Pipette out 5 ml of extract in a 25 ml volumetric flask and dilute it to 25ml.
3. To all these solutions add 2 ml of Ammonium Molybdate Reagents and 1ml of freshly prepared $SnCl_2$.
4. Exactly after 10 min measure the absorbance at 680 nm.
5. Prepare a standard graph for phosphorus (On the X axis take a concentration of P in ppm and on the Y axis take the Absorbance reading)
6. Locate the sample reading on the standard graph and calculate the results.

Available potassium in vermicomposting Principle

The method is based on the principle of equilibrium of soil, an exchange action made of the solution of Neutral normal NH4OAc in a given soil: solution ratio, during the equilibrium, ammonium ions exchange with the exchangeable **K** ions of the soil. The K contention of the equilibrium solution is estimated with a flame photometer. Since NH_{4+} holds highly charged layers together just like K, the release of the fixed K, in an exchangeable form, is retained during NH_4OAc extraction.

Procedure

1. Weight 5ml soil in 150ml conical flask.
2. Add to it 25ml of neutral NH_4OAc solution and a pinch of Activated charcoal.
3. Shake the contents of the conical flask on a shaker for 5 minutes and filter through Whatman No.1 filter paper
4. Feed the filtrate into the atomizer of the flame photometer and note down the reading
5. Prepare a set of working standards as shown in the table below and take reading
6. Plot the graph inciting concentration on the X axis and Readings on the Y axis for determination of concentration of K.

Organic Carbon and Organic Matter Content of Vermicompost

Principle:

A weight of vermicompost sample is treated with an excess volume of standard $K_2Cr_2O_7$ in the presence of concentrated H_2SO_4. The vermicompost is slowly digested at the low temperature by the heat of dilution H_2SO_4 and the organic carbon in the vermicompost is oxidized to Co_2. The highest temperature obtained by the heat of dilution reaction produced on the Addition of H_2SO_4 is approximately 120 ^{0}c, which is sufficient to oxidize the active forms of soil organic carbon, but not the mere complex organic form of carbon that may be present. The excess of $K_2Cr_2O_7$ not reduced by the organic matter is titrated back against a standard solution of ferrous Ammonium Sulfate, in the presence of Phosphoric acid and diphenylamine indicator.

Procedure:

1. Take 1gm of vermicompost in a 500ml capacity conical flask.
2. Add 10 ml of 1N $K_2Cr_2O_7$ and shake for some time.
3. Add 20 ml Conc. H_2SO_4 swirl for 2-3 times and stand for 30 min.
4. Add 200 ml of water, and filter if the solution is not clear.
5. Add 10 ml of 85 % Phosphoric acid and 1 ml Diphenylamine indicator.
6. Titrate with FAS (0.1 N) the endpoint is a color change from Violet Blue to Bright Green. Similarly, run the blank.

Result and Discussion:

Table 1: Available Nitrogen in vermicompost.

Wt. vermicompost taken	1.000gm
Vol. of 0.02N H_2SO_4 taken	50 ml
Vol. of 0.02N NaOH used (Burette reading)	4.7 ml
Vol. of 0.02H_2SO_4 used for NH_3 absorption	45.3 ml

Result

Available Nitrogen determined for given vermicompost sample i) buffalo = 1.23 kg/ha

Cow =1.26 kg/ha

Goat = 8.04 kg/ha

Table 2: Available Phosphorus in vermicompost

Sr. No.	(P) Conc	2 ppm 'P' Std (ml)	Total Vol. (ml)	Amm. Molybdate Reagent (ml)	$Sncl_2$ Reagent (2ml)	Abs. at 680nm after 10 min
1	0	0	25	2.0	1	0
2	0.16	2	25	2.0	1	0.05
3	0.32	4	25	2.0	1	0.14
4	0.48	6	25	2.0	1	0.22
5	0.64	8	25	2.0		0.33
6	0.80	10	25	2.0	1	0.39
7	0.96	12	25	2.0	1	0.43
Sample 1 buffalo	1 gm	-	25	2..0	1	0.17
Sample 2 Cow	1 gm	-	25	2.0	1	0.19
Sample 3 Goat	1 gm	-	25	2.0	1	0.18

Result:-

Available phosphorus determined for the given vermicompost sample is

Buffalo=180 ppm

Cow =220 ppm

Goat =200 ppm

Table 3: Available Potassium in vermicompost

Sr. No	Conc Mg/lit	Ml of Std. (100 ppm)	Ml of distilled water	Total volume	Flame photometer Reading
1	0	-	50	50	2
2	5	2.5	47.5	50	20
3	10	5.0	45	50	40
4	15	7.5	43.5	50	60
5	20	10	40	50	80
6	25	12.5	37.5	50	100

Sample 1 Buffalo	5	-	-	50	38
Sample 2 Cow	5	-	-	50	57
Sample 3 Goat	5	-	-	50	79

Result:-

Given vermicompost contains

Buffalo =106.4 kg/ha

Cow =159.6 kg/ha

Gaot =221.2 kg/ha

Table 4: Table 4: Available Nitrogen (N), Phosphorous (P), Potassium (K), Organic Carbon (OC), Organic Matter (OM) in vermicompost.

Sr. No	Avl.'N' in Vermicompost st in %	Avl. 'P' in vermicompost in ppm	Avl. 'K'in vermicompost In kg/ha	OC in vermicompost in %	OM in vermicompost in %
Sample 1	1.23	180	106.4	10.47	18.05
Sample 2	1.26	220	159.6	16.29	28.08
Sample 3	8.04	200	221.2	18.99	32.73

Sample1:-Vermicompost sample (buffalo dung +Sugarcane trash)

Sample 2:- Vermicompost sample (Cow dung +Sugarcane trash) Sample 3:- Vermicompost sample (Goat dung +Sugarcane trash)

Applications

In this research, vermicompost is used in sugarcane crops as a basic dose. It provides physical, Chemical, Biological, and micro-biological improvement in the soil it is used. Studies show that amending soil with vermicompost causes germination starting from 7 to 10 days.

In this research, after the use of vermicompost conclusion is the development of sugarcane crop root, and stem size, improves plant growth and height,

Conclusion

This research noticed that vermicompost is environmentally friendly because it is derived from living things, including plants, animals, and manures while inorganic are synthetically derived chemicals plus minerals from the earth. In this research vermicompost is ideal organic manure for better growth and yield of many plants. Vermicompost is best for soil fertility and plant

growth.

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Microplastics: A Global Threat to the Environment

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Abstract

The microplastic generated from various activities represents a real problem of the current environment. Improper management of plastic generated causes a direct health impact on the community, the marine organisms, and even the whole ecosystem. Microplastics (MPs) are primarily formed as a result of environmental weathering and improper discarding. Every day, relatively large amounts of microplastics, nanoparticles, and microbeads are generated in metropolitan cities and even around the world. The problems caused by microplastic tend to be used in all types of personal care products that contain microbeads. Improper disposal of plastic or environmentally weather able plastic materials with fewer microns and exposure to such waste pose a serious threat to the environment and human health. This requires proper treatment and management before its final disposal. The paper aims to create awareness among people about the seriousness of microplastic pollution and to reduce the use of products that ultimately make their way into the creation of microplastic.

Keywords: Microplastic pollution, Microbeads, Nanoparticles, Microplastic control, Health effects.

Introduction

Plastics have propagated worldwide since they were first discovered in the early 20th century. Surpassing iron production after the 1990s, currently plastic is the most used material by humans (D.F. McCall, *et al.*). After being commercially developed, plastics have become increasingly dominant in the consumer marketplace due to their convenience and various advantages (Plastics Europe Plastics – the Facts 2013 Brussels, Belgium Google Scholar). Conversely, as the quantity of plastic used increased, the problem of environmental pollution caused by plastic waste also emerged.

Plastics are synthetic polymers typically prepared by polymerization of monomers derived from oil or gas with the addition of different chemical additives (Thompson *et al.*, 2009). They are one of the most used and multipurpose materials in the worldwide economy. Due to their

extraordinary properties such as versatility, lightweight, strength, durability, corrosion resistivity, and high thermal and electrical insulation (Halden, 2010; Thompson *et al.*, 2009). Due to overuse of the plastic and improper disposal Microplastics are found in the most remote places on land and in the ocean as well as in our food.

Several studies around the globe have now confirmed that they are also present in the air we breathe. Plastic production has correspondingly increased globally from 1.7 to 360 million tons annually within the last 70 years expanding their use across several consumer and construction products, notably in packaging, building and construction, and the automotive industry.
Precisely the first focus was mainly on the biodegradability of synthetic polymer compounds such as plastic bags. At the time, plastics were mainly concerned with waste emission and disposal, as well as the fact that plastics take decades or even hundreds of years to decompose (D. Hoornweg, P. Bhada-Tata). In 2004, it was published in Science that studies have reported increasing microscopic plastics in the ocean (R.C. Thompson, *et al.* 2009). Subsequently, the interest in the consequence of plastic accumulation in nature was heightened. Microplastic was not only found in the marine environment but also various environmental areas such as air, soil, and freshwater. Once plastics are released into the environment, they are eroded and weathered, breaking into progressively smaller fragments over time and transported to different areas.

The United Nations Environment Programme (UNEP) defines microplastics as any solid plastic particle of 5 mm or less which are insoluble in water (UNEP PLASTICS IN COSMETICS: ARE WE POLLUTING THE ENVIRONMENT THROUGH OUR PERSONAL CARE United Nations Environment Programme (2015). The International Organization for Standardization (ISO) ISO/TC 61 (Plastic)/SC 14 (Environmental Aspect) defines microplastics as any solid plastic particle insoluble in water with dimensions between 1 μm and 1000 μm in the ISO/TR 21960:2020 standard terms and definitions (ISO(2020), p. 41Google Scholar).

As these polymers are not biodegradable, they accumulate in landfills or the natural environment as well as Microplastics are mostly formed through small plastic pieces less than five millimeters long which can be harmful to the environment. As an emerging field of study, not a lot is known about microplastics and their impacts yet. The polymers mostly deployed are polypropylene (19.4%), polyethylene (low (17.4%) and high (12.4%) density), polyvinyl chloride (10%), polyurethane (7.9%), and polyethylene terephthalate (7.9%) (Plastics Europe, 2020).
Two major sources for the occurrence of these microplastics. First, microplastics are generated directly, Second, those generated from a secondary source. Microplastics are generated when

large plastic debris is broken down by weathering owing to physical and chemical effects in the natural environment. The production of primary microplastics such as microbeads has been prohibited in recognition of the seriousness of their impact on environmental pollution (C.M. Rochman, A.-M. Cook, A.A. Koelmans). However, secondary microplastics have the potential to continue to arise from plastics that have already been discarded and exist in the natural environment (D.M. Mitrano, W. Wohlleben).

Microplastic pollution in aquatic environments, in particular, has attracted the scientific community, with the majority of research to date focusing on MP in surface waters, shorelines, and continental waters including remote places such as Polar Regions (González-Pleiter *et al*., 2020) or deep sea (Zhang D. *et al.*, 2020), as well as in soils and sediments at a global scale (Boucher and Friot, 2017; Claessens *et al.*, 2011; Efimova *et al.*, 2018; GESAMP, 2015). As a consequence, plastic pollution is already a huge environmental problem that is expected to increase: annual waste production is projected to rise to 3.4 billion million tonnes in the next 30 years (Kaza *et al.*, 2018).

Plastic debris can come in all shapes and sizes, but those that are less than five millimeters in length (or about the size of a sesame seed) are called “microplastics.”

.Fig.1. Sources of Microplastic.

Microplastics come from a variety of sources (fig.1), including from larger plastic debris that degrades into smaller and smaller pieces. In addition, microbeads, a type of microplastic, are

very tiny pieces of manufactured polyethylene plastic that are added as exfoliants to health and beauty products, such as some cleansers and toothpaste. These tiny particles easily pass through water filtration systems and end up in the ocean and Great Lakes, posing a potential threat to aquatic life.
In this review article, the current status and toxicity of microplastics in water, soil, and air have been intensively reviewed.

Effects of Microplastics on Water

Contamination of water sources by substances that make the water unusable for drinking, cooking, cleaning, swimming, and other activities is called Water pollution. Pollutants include chemicals, trash, bacteria, parasites, heat, petroleum (oil), and radioactive substances. Water bodies include lakes, rivers, estuaries, oceans, aquifers, reservoirs, and groundwater. All the substances that contribute to the formation of water pollution eventually make their way to water. Air pollution settles onto lakes and oceans. Land pollution seeps into an underground stream, then it travels to the river, and finally meets the ocean.

The key causes of water pollution in India are:

- Urbanization.
- Deforestation.
- Industrial effluents.
- Social and Religious Practices.
- Use of Detergents and Fertilizers.
- Agricultural run-offs- in which insecticides and pesticides are used.

Water pollutants come from either point source or dispersed source. A point sources are those which are used for discharge from an industrial facility or a city sewerage system. A dispersed that is a nonpoint source is a very broad area from which various forms of pollutants enter the water body, such as the runoff from an agricultural area in which insecticides and pesticides are used. The water pollution caused due to Point sources is easier to control than that of dispersed sources as the contaminated water has been collected to one single point where it can be treated. Pollution from dispersed sources is difficult to control, and, despite much progress in the building of modern sewage treatment plants, dispersed sources continue to cause a large fraction of water pollution problems.

It is an important factor of living things; every person or living being is dependent on the Environment. So we must protect it. Plastic is the most prevalent type of marine debris found in our oceans and the Great Lakes. In this paper, in order to understand the problems caused due to microplastics in the water environment, an extensive literature review was carried out

on the phenomenon of microplastics in aquatic environments categorized by seawater, wastewater, and freshwater. We summed up the distribution of microplastics in the water environment and studied the environmental factors affecting them. The potential hazards caused by the aging microplastics are numerous.Studies on microplastics have been primarily carried out in the marine environment. But now, it is necessary to study microplastics in various aspects that can occur in various environmental media, such as surface freshwater, groundwater, air, soil, and sediment. The harmful impacts of microparticles on human health have not been much established yet. Microplastic particles with a size close to nanometers are highly likely to be toxic. (J. Hwang, *et al.*, J.C. Prata, *et al.*).

Microplastics in wastewater directly reflect anthropogenic activity. Microplastics in freshwater have been there because of agriculture and manufacturing industries such as textiles, including worn tire material on highways and roads. The marine industries highly influence the characteristics of microplastics in seawater.The results of microplastic detection in water systems affected by the surrounding industries and environment are summarized and shown in (Fig 3.) Microplastics at the sampling point are mostly affected by adjacent anthropogenic

activities. However, microplastics are not only found in the reagan where sampling point is carried out but also detected far from in the water environment. In order to understand the behavior of microplastics, it is necessary to consider the factors that influence their properties.

Table 1. Results of microplastic detection in water systems affected by the surrounding industries and environment.

SEAWATER	**WASTEWATER**	**FRESHWATER**
Mariculture: buoy, facilities	Urban-related factors: Population	Highway, roads: tire wear, asphalt sealant, cigarette butts
Port and ship: paint chips	Air decomposition	Agriculture: mulching, irrigation water, sludge application
Fishing: fishing gear, nets	Industries: manufacturing, textile	Weather changes: rainfall, winds, typhoons
Thermohaline water structure	Domestic sewage: facial cleansing, laundry	Hydrological influence: water system scale, water level, flow velocity
Bathing at beaches	Effluents of WasteWater Treatment Plants	

Plastic particles found in the environment are not in a manufactured form. They are usually corroded and fragmented due to environmental factors. High concentrations of organic chemicals are absorbed by aged microplastics. Marine waste that sinks into the sediment is challenging to recover. It is indeed a threat to marine ecosystems as it is very toxic in nature.

In particular, benthic species can readily ingest plastic waste found on the seabed. When there is a change in ocean currents or there is an occurrence of some sort of weather event, there is vertical mixing of the seawater layer, and the plastic waste gets realized and it correspondingly moves around.

The final destination for microplastics are the water systems. It is very necessary to regulate various industries and all types of plastic products manufactured and their release in the land in order to prevent the increase in plastic waste in the water systems. There is a need for efficient waste water management and improvement of drainage systems on land. This cannot be solved by regulating one or two countries. A global coalition and regulation will be an excellent start to solving the problem. In addition, microplastic removal technology should be developed for each water environment. These are microplastics' inherent properties such as hydrophobicity, specific gravity, and size, and environmental factors such as biological interactions in the aquatic environment, meteorological phenomena, and industrial facilities near the water system (Fig. 2.).

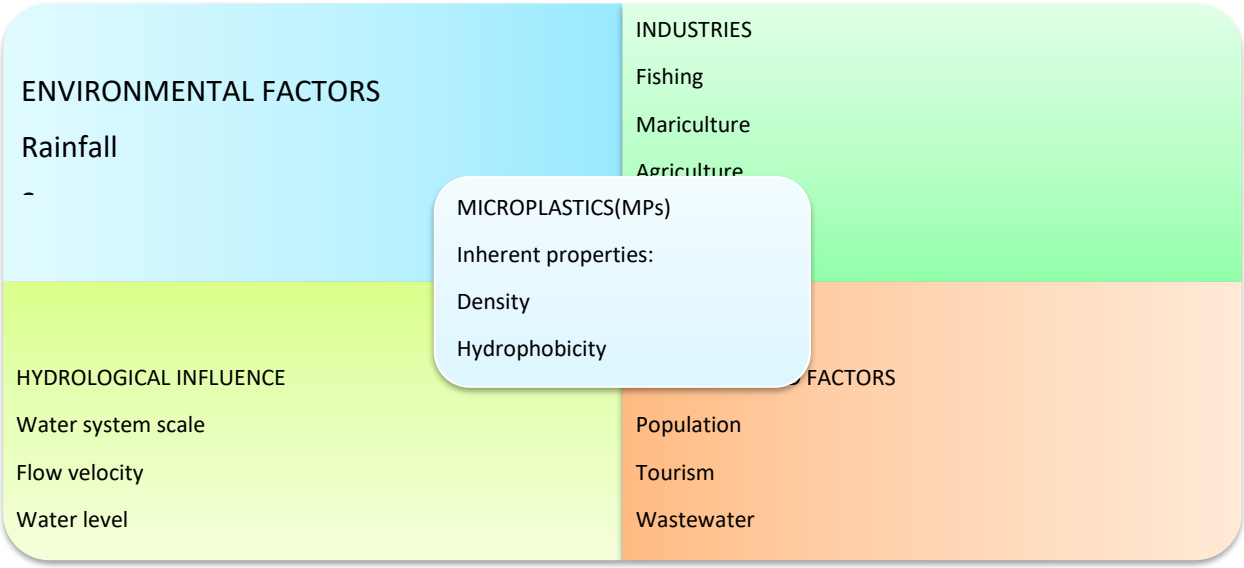

Fig. 2. Factors affecting microplastic analysis.

Effects of Microplastics on Soil

The increasing and uncontrolled plastic production in recent decades has resulted in considerable pollution in the environment. Residual remains of mulching in the form of microplastics cause soil pollution. Microplastics lead to changes in the characteristics of soil flora and fauna. Microplastics act as a trajectory for soil environmental. Owing to their potentially toxic effects, their long life span and persistence, ultimately shows us that the presence of even a small amount of Microplastics is a threat to the soil ecology and ecosystems (Hidalgo-Ruz, 2012). Large quantities of plastic fragments are left behind after the crop is

cultivated. Microplastics are responsible for many changes in the soil's physicochemical characteristics, including porosity, enzymatic activities, microbial activities, plant growth, and yield. Because of their ubiquitous nature, high specific surface area, and strong hydrophobicity, MPs play an important role in the transportation of toxic chemicals such as plasticizers, polycyclic aromatic hydrocarbons (PAHs), antibiotics, and potentially toxic elements (PTEs). MPs may travel deep into the soil and can cause pollution in the underground water.

MPs found in the soil destruction the soil structure and has adverse impacts on the soil water holding capacity. The microplastics found in the soil environment greatly change the porosity of the soil including the structure of the soil. If these residues are found in large masses, these will fill and block the soil pores. Eventually, the soil infiltration capability decreases. This will disturb the soil nutrient cycle. This can even alter microbial structure and ultimately affect crop growth (Dong *et al.*, 2021).There are many harmful effects of MPs on the soil environment. It can cause damage to soil in different means such as enzymatic activities, soil microbes, flora, fauna, and crop production.

Globally, China consumes the most plastics (30%) (NBoSo, 2017). Previous studies have shown that plastic mulch is a productive technique in agriculture (Kader *et al.*, 2017, Zhao *et al.*, 2016), but causes a high concentration of waste plastic in the soil (Mbachu *et al.*, 2021). Plastic mulching was first introduced in the 1970s and saw rapid worldwide growth, as shown in Fig.3. (National Bureau of Statistics, 2015).

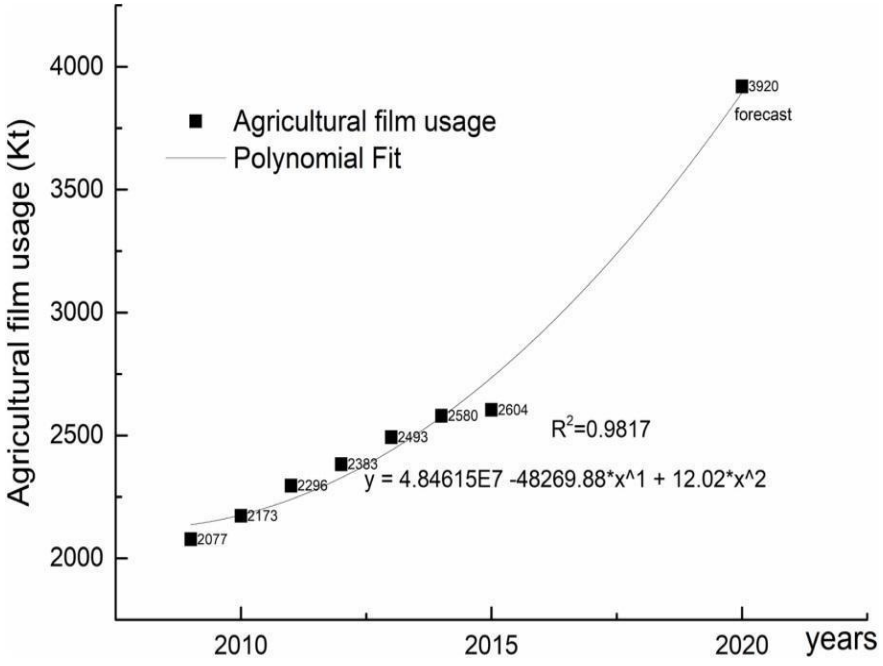

Fig. 3. Yearly production of agricultural plastic film (National Bureau of Statistics 2015).

The role of MPs as a contaminant in the soil environment is appropriately explained in Fig.4.

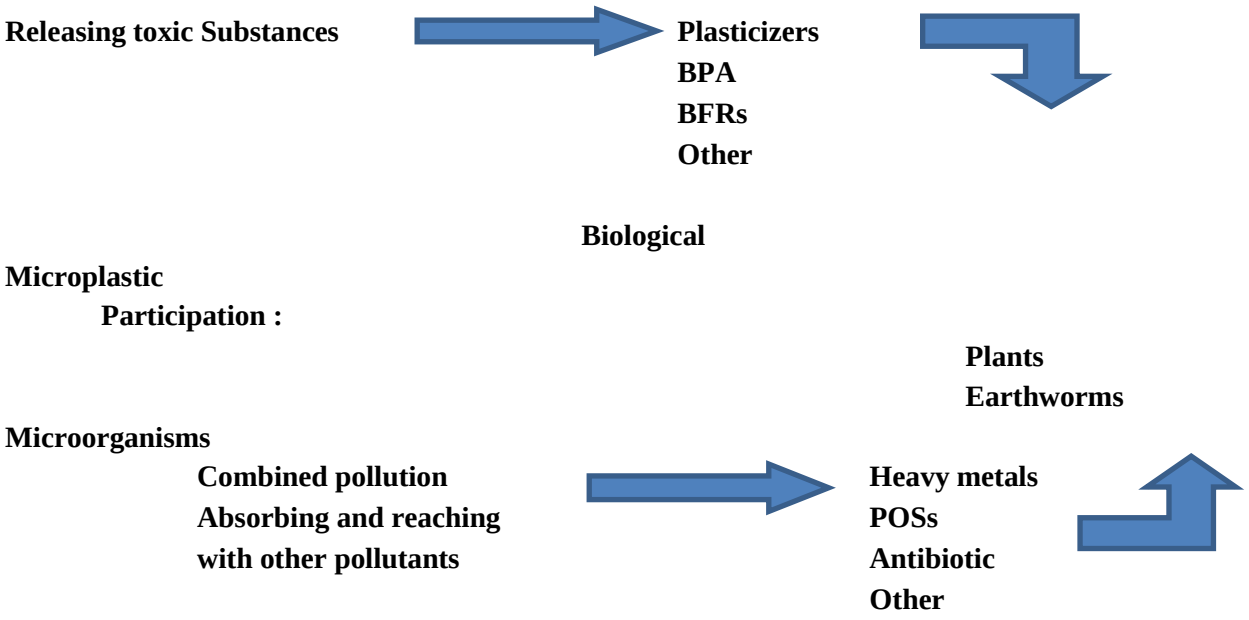

Fig.4. Microplastics found as contaminants in the soil system.

Agricultural and urban soils are thought to be the most important reservoirs for MPs (Hurley and Nizzetto, 2018). Plastic residues found in the soil due to mulching are converted into MPs by the passage of time and environmental activities. The resulting MPs mix into the soil and combine with other pollutants such as heavy metals, pesticides, and persistent organic pollutants (POPs), which causes toxic effects on flora and fauna of the soil. These MPs may be eventually make their way to rivers, oceans, and other water bodies by agricultural water runoff causing water pollution in lakes (Sighicelli *et al.*, 2018), rivers (Anderson *et al.*, 2017), and the sea (Yu *et al.*, 2016, Zhang *et al.*, 2017).

The most important sources of MPs in agricultural soil are the residual plastic fragments from mulching, sewage sludge, municipal waste, and plastic coat fertilizers (Blasing and Amelung, 2018, Rodriguez-Seijo *et al.*, 2017, Liu *et al.*, 2018).

Microplastics enter the soil through many sources, including landfill dumping, plastic mulching, and recycling operations of wastewater sludge (Rillig, 2012). These approaches usually involve high temperatures. They often produce supplementary contaminants after the plastics are broken down into tiny pieces by heat, wind, and rain. The resulting fragments do not vanish naturally. When they are mixed with the soil ecosystem they cause a decline in soil

quality. Reduction in the soil-plant nutrient transfer may cause malnutrition in plants, reducing crop growth and yields. Even, soil organisms can take up mulched particles from plastic (Lwanga *et al.*, 2018), and eventually transfer these into plants and animals, which may lead into a high rise of risk to human health (Ng *et al.*, 2018).The soil has become the ultimate sink for residual plastics.

Effects of Microplastics on Air

Environmental air pollution from microplastics (MPs) is growing day by day causing human health implications. Microplastics are tiny fragments shed during the degradation of larger pieces of plastic. They are light to get transported by the wind over large distances. Especially high microplastics concentration can be found in indoor air due to the erosion and breakage of consumer, domestic, and construction products. Airborne microplastics can be directly inhaled through air environments. This is in part because sampling and analysis of airborne MPs is a complex and multistep procedure. Although the techniques used are not yet standardized.

Recently we expected airborne microplastics would scatter sunlight. But they act like tiny disco balls and reflect sunlight to space. This provides a cooling effect on Earth's climate. Most types of aerosols in the atmosphere scatter light. Airborne microplastics are efficient at scattering sunlight. It implies a cooling effect on climate. They can also absorb radiation emitted by the Earth, which means they contribute, in a very small way, to the greenhouse effect.

Microplastics are heterogeneous in terms of chemical composition, diameter, shape, specific density, and color (Amato-Lourenço *et al.*, 2020). They include 1-D fibers (one larger dimension), 2-D fragments (flat particles), and 3-D spherules (Dris *et al.*, 2015). It can be primary or secondary in origin.

Primary Microplastics are purposefully produced and enter the environment as particles usually less than 0.5 mm used for example as abrasives in cosmetic products or 'scrubbers' used to blast clean surfaces. Whereas secondary Microplastics originate from the larger plastic fragmentation present in the environment. The most common process of generating secondary Microplastics is weathering which occurs when plastic is exposed to solar UV radiation (GESAMP, 2015) that catalyzes the oxidative degradation of polymers (Andrady *et al.*, 1996; Celina, 2013).

During degradation plastic usually loses mechanical integrity, discolors, weakens and surface cracks are formed (Cooper and Corcoran, 2010; GESAMP, 2015; Pegram and Andrady, 1989). In addition to UV radiation, there are other mechanisms e.g., mechanical stress by wind and waves, heat, hydrolysis, and the enzymatic processes of microorganisms aiding plastic degradation and fragmentation (Andrady, 2011; GESAMP, 2015).

Moreover, they are easily transferred through the food chain and thus make their way to humans (Chen *et al.*, 2020a). During the last few years, more attention has been sealed to other environmental compartments (Dris *et al.*, 2016; Evangeliou *et al.*, 2020; Zhang Q. *et al.*, Q. 2020). We are still unknown that far up into the atmosphere microplastics have reached.

The analysis of microplastics in the air is the beginning. The physicochemical properties of airborne microplastics are not well characterized. The consequent health effects of inhaled microplastics are rarely understood. Interest in the presence of microplastics in the air is increasing nowadays. Airborne particles can be directly inhaled into the human body (Prata, 2018). The distribution and behavior of microplastics suspended in the atmosphere are like those of other airborne pollutants: their concentration, transport, dispersion, and removal depend on the emission sources, meteorological conditions, and long-range transport among other factors. Higher levels of microplastics were found in urban environments than those found in rural environments. Recent studies have found the presence of microplastics in outdoor and indoor air. Although the presence of MPs in the air is a fact, human health risks due to their inhalation remain unclear (Wright *et al.*, 2020). Many questions remain unanswered in this field.

Physical mechanisms such as sedimentation, impaction, interception, or diffusion are involved in the deposition of MPs in terminal bronchioles, alveolar ducts, and alveoli (Amato-Lourenço *et al.*, 2020; Prata, 2018). Nevertheless, the human body has defense mechanical methods to prevent MPs deposition such as sneezing, mucociliary escalator, phagocytosis by macrophages, or lymphatic transport to avoid the persistence of MPs (Bank and Hansson, 2019; Gasperi *et al.*, 2018).

Microbeads

Little bits of plastic, also known as microbeads found in many cosmetic products, like face wash, have been at the center of an environmental campaign. Microbeads are manufactured solid plastic particles of less than 1 mm in their largest dimension. Due to the damage they cause when fish eat them once they're washed down our drains and enter the sea. They are most often made up of polyethylene but can also be prepared from other petrochemical plastics such as polypropylene and polystyrene. Most of the products in their label range of beauty products contain microbeads.

They are used in health science research, toothpaste, exfoliating personal care products, and biomedical. Microbeads can cause water pollution due to plastic particles and lead to an environmental hazard for aquatic animals not only in freshwater but also in the ocean. In the US, the Microbead-Free Waters Act of 2015 phased out microbeads in rinse-off cosmetics by July 2017. A number of countries have banned microbeads from rinse-off cosmetics, inclusive

of Canada, France, New Zealand, Sweden, Taiwan and the United Kingdom.They can vary in chemical composition, size, shape, density, and function. Microbeads are manufactured for specific purposes, including for use in personal care products such as scrubs, bath products, facial cleaners, and toothpaste. They may also be used in product cleaning, toners of most of the printers, etc. In industrial products such as oil and gas exploration, textile printing, and automotive molding. Other plastic products such as anti-slip, anti-blocking applications and medical applications microplastic is widely used.

Microbeads are manufactured solid plastic particles of less than 1mm in their largest dimension. They are first created and are typically created using materials such as polyethylene (PE), polyethylene terephthalate (PET), nylon (PA), polypropylene (PP), and polymethyl methacrylate (PMMA) ("Microbeads – A Science Summary July 2015").
Microplastics are organized according to their source, i.e. whether they are manufactured on the micrometer(µm) size or are the result of breakdown processes such as weathering, photodegradation, etc. (GESAMP, 2015).

For this summary:

- Microbeads are defined as synthetic polymer particles that, at the time of their manufacture, are greater than 0.1 µm and less than or equal to 5 mm in size. This includes different forms of particles including solid, hollow, amorphous, solubilized, etc.
- Secondary microplastics are synthetic polymer particles that originate from the breakdown of larger plastic items (Andrady, 2011).
- Microplastics include microbeads and secondary microplastics.
- A personal care product is defined as a substance or mixture of substances that is generally recognized by the public for use in daily cleansing or grooming.

Globally, microbeads have been found to have use in personal care products, other consumer applications, and various industrial applications. Microbeads may also be found in products including cleaning products and printer toner (Norwegian Environment Agency, 2014). Some products contain substantial quantities of microbeads. Based on the information presented in scientific literature considering personal care products, microbeads have been found in scrubs, bath products, facial cleaners, , eye shadows, blush powders, hair sprays, mascaras, creams, deodorants, makeup foundations, nail polishes, shaving creams, hair colorings, insect repellants, toothpaste, baby products, lotions, and sunscreens.Microbeads are used in medical applications that are biotechnology and biomedical research (Leslie, 2014; Norwegian Environment Agency, 2014). Microbeads are also used in industrial products such as abrasive

media, industries such as oil and gas exploration, textile printing, and automotive molding, other plastics products include anti-slip and anti-blocking applications, etc.

Microbeads can be composed of a variety of synthetic polymers depending on the required functionality. Table.2. lists the function of typical polymeric particulates found in personal care and cosmetic products (Leslie, 2014). In the sense of microbeads, the most common polymers used are polyethylene, nylon poly (methyl methacrylate), polypropylene polytetrafluoroethylene and polyethylene terephthalate (Norwegian Environment Agency, 2014).

Table.2. lists the function of typical polymeric particulates found in personal care and cosmetic products (Leslie, 2014).

Polymer name	Function in PCCP formulations
Nylon-12 (polyamide-12)	Bulking, viscosity controlling, opacifying (e.g. wrinkle creams)
Nylon-6	Bulking agent, viscosity controlling
Poly(butylene terephthalate)	Film formation, viscosity controlling
Poly(ethylene terephthalate)	Adhesive, film formation, hair fixative; viscosity controlling, aesthetic agent, (e.g. glitters in a bubble bath, makeup)
Poly (methyl methacrylate)	Sorbent for delivery of active ingredients
Polyethylene	Abrasive, film forming, viscosity controlling, binder for powders
Polytetrafluoroethylene (Teflon)	Bulking agent, slip modifier, binding agent, skin conditioner
Acrylates copolymer	Binder, hair fixative, film formation, suspending agent
Allyl stearate/vinyl acetate copolymers	Film formation, hair fixative
Ethylene/acrylate copolymer	Film formation in waterproof sunscreen, gallant (e.g. lipstick, stick products, hand creams)
Trimethylsiloxysilicate (silicone resin)	Film formation (e.g. color cosmetics, skin care, suncare)

Studies have shown that microplastics, including microbeads, are present in the environment and that they can reside in the environment for a long time. In the environment, it is extremely difficult to differentiate and discriminate between microbeads and secondary microplastics. Microbeads from 'down the drain' products will likely be released into the aquatic environment after wastewater treatment. Microbeads have been shown to elicit both short and long-term effects in laboratory organisms. As most studies report only total microplastic concentrations, it is not currently possible to quantify the contribution of microbeads versus all other plastic litter.We use a broad definition of "plastics" as organic, solid materials based on a matrix of

synthetic polymers. The scope is similar to the scope of a recent assessment of sources of microplastics. The group of materials includes traditional plastic materials, synthetic textile fibers, synthetic rubbers, as well as cured paints, fillers, and similar products based on binders of synthetic polymers.

Conclusion

With a focus on the use and release of microplastics and the presence of microplastics in the surrounding waters, this paper contains a review of existing knowledge on issues related to contamination by microplastics.

The problem of pollution in the oceans due to plastics, including microplastics, nanoplastics and microbeads is not new, but in recent years international attention towards it has increased. There is a growing concern as to whether pollution due to plastics in the long term can have greater effects on the environment than previously assumed.

- Plastics that are released into the environment in the form of microplastics, nanoplastics and microbeads remain in the environment for hundreds and thousands of years before they finally decompose.
- Thousands and tons of microplastic materials originating from homes, hospitals, food stalls, industries, cosmetic materials, howkers, textile industries, marine coatings, road markings, etc. continue to be dumped in open garbage bins and water sources in most parts of the country.
- After disposal of plastic, it degrades into smaller pieces. This means macro-scale plastics degrade to micro-scale plastics. Which further fragment into nano-scale plastics or nano-plastics.
- Global consumption of plastics is increasing, and global emissions are likewise expected to increase unless proper action is taken against these emissions.
- Plastics that reach to the sea through different sources may also be transported over long distances.
- People get exposed to microplastics through food consumption such as fish.
- In almost all levels of the marine food chain organisms microplastics are detected.
- Even the most remote places on the planet and beyond are affected by plastic pollution.
- Potentially having increasing toxic effects on the environment means that the microplastic problem has some characteristics of a "time bomb".

Good health has a positive effect on the community therefore the government should give private importance to the health care of the population and the sustainability of the environment through their policies. For better availability of resources that are slowly depleting from the environment, the government should show interest in the well-being of its citizens. They in turn will also feel more responsible and loyal towards the environment. It improves residents, retention and cuts down on government healthcare costs.The effects of microplastic emissions will only be apparent to us after many years and at that time, the effects may be very difficult

to restrict. However, we do not know whether the comparison of microplastic with “time bomb” is accurate for the situation or not.If anyone can make a difference even a small percentage it gives a lot of benefits to the world.

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Comparative study on Effects of Chemical Fertiliser, Vermicompost and FarmYard Manure on Tomato Plant Growth and Soil Fertility.

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Abstract
A healthy soil environment is required for desired crop production, which means it should have all the essential nutrients. Nutrients are used in significant amounts by growing plants and hence, they must be replaced periodically to sustain productivity and for this purpose, fertilizers are used in the fields. Chemical fertilizers are essential to enhance proper growth and crop yield and they act as catalysts in providing nutrients to the plants for their better growth and yield. On the other hand, fertilizers may endanger our ecosystems, soil, plants, and human and animal lives. Despite the past gains in crop production through chemical fertilizers, recent observations of stagnant or declining yields have raised concerns about the long-term sustainability of crop production. They also damage the natural makeup of the soil in the long term, which results in unsustainable crop production. Of course, chemical fertilizers add nutrients to the soil, but they don't add anything else. Plants need more than just nutrients to survive. They also need organic matter and living organisms. Therefore, integrated use of organic and inorganic sources of nutrients will not only supply essential nutrients to the soil but may also have some synergistic interaction to increase their efficiency and thereby, reduce environmental hazards. Nutrients from chemical fertilizers enhance the initial establishment of crops while those from mineralization of organic manure promote the yield later. In present experiments, seeds of radish (Raphanus sativus) were sown in soil affected by long-term use of chemical fertilizers and in soil, where organic compost was used as an external nutrient source. A comparative study was made revealing the fact that the germination and survival; were better in the case of soil on application of organic compost while the survival of radish was almost nil in the soil, where inorganic fertilizers were used for a long time.

Key Words: Fertilizers, Nutrients, compost, etc.

Introduction

Chemical Fertilizers

Modern chemical fertilizers include one or more of the three elements that are most important in plant nutrition: nitrogen, phosphorus, and potassium. Trace elements of secondary importance are the elements sulphur, magnesium, and calcium.

Most nitrogen fertilizers are obtained from synthetic ammonia, this chemical compound (NH_3) is used either as a gas or in a water solution, or it 1s converted into salts such as ammonium sulphate, ammonium nitrate, and ammonium phosphate, but packinghouse wastes, treated garbage, sewage, and manure are also common sources of it. Because its nitrogen content is

high and is readily converted to ammonia in the soil, urea is one of the most concentrated nitrogenous fertilizers. An inexpensive compound, it is incorporated in mixed fertilizers as well as applied alone to the soil or sprayed on foliage.

With formaldehyde it gives methylene-urea fertilizers, which release nitrogen slowly, continuously, and uniformly, a full year's supply being applied at one time. Phosphorus fertilizers include calcium phosphate derived from phosphate rock or bones. The more soluble superphosphate and triple superphosphate preparations are obtained by the treatment of calcium phosphate with sulfuric and phosphoric acid, respectively. Potassium fertilizers, namely potassium chloride and potassium sulfate, are mined from potash deposits. Of commercially produced potassium compounds, almost 95 percent of them are used in agriculture as fertilizer.Mixed fertilizers contain more than one of the three major nutrients - nitrogen, phosphorus, and potassium. Fertilizer grade is a conventional expression that indicates the percentage of plant nutrients in a fertilizer, thus, a 10-20-10 grade contains 10 percent nitrogen, 20 percent phosphoric oxide, and 10 percent potash. Mixed fertilizers can be formulated in hundreds of ways.

Farm Yard Manure

Among sources of organic matter and plant nutrients, farm manure has been of major importance. Manure is understood to mean the refuse from stables and barnyards, including both excreta and straw or other bedding material. Large amounts of manure are produced by livestock, such manure has value in maintaining and improving soil because of the plant nutrients, humus, and organic substances contained in it.

Manure is a fertilizer graded as approximately 0.5--0.25-0.5 (percentages of nitrogen, phosphoric oxide, and potash), with at least two-thirds of the nitrogen in slow-acting forms. Given that these nutrients are mostly in an unmineralized form that cannot be taken up by plants, soil microbes are needed to break down organic matter and transform nutrients into a bioavailable "mineralized" state. In comparison, synthetic fertilizers are already in mineralized form and can be taken up by plants directly. On properly tilled soils, the returns from synthetic fertilizer usually will be greater than from an equivalent amount of manure.

However, manure provides many indirect benefits. It supplies humus, which improves the soil's physical character by increasing its capacity to absorb and store water, by enhancement of aeration, and by favoring the activities of lower organisms. Manure incorporated into the topsoil will help prevent erosion from heavy rain and slow down the evaporation of water from the surface. In effect, the value of manure as a mulching material may be greater than its value as a source of essential plant nutrients.

Vermicompost

Vermicomposting is a type of composting in which certain species of earthworms are used to enhance the process of organic waste conversion and produce a better end-product. It is a

mesophilic process utilizing microorganisms and earthworms. Earthworms feed the organic waste materials, pass it through their digestive system and give it out in a granular form (cocoons) which is known as vermicompost.
Vermicompost is earthworm excrement, called castings, which can improve the biological, chemical, and physical properties of the soil. The chemical secretions in the earthworm's digestive tract help break down soil and organic matter, so the castings contain more nutrients that are immediately available to plants.

Objectives

- Comparative study of chemical fertilizers, farm yard manure, and vermicomposting on tomato plant growth.
- Comparative study of chemical fertilizers, farm yard manure, and vermicomposting on Soil fertility

Review of literature

Khan et.al (2018), studied the impact of various media combinations on the growth, the qualitative and quantitative yield of tomatoes as well as on the chemical and physical properties of soil. The study comprised seven different media treatments including T0 soil (control), T1 farm yard manure + soil (1:1), 12 coconut coir + soil (1:2), T3 leaf compost + soil (1:), T4 coconut coir +poultry manure to soil (2:1:2), T5 peat moss t spent mushroom waste + soil (1:1:) and T6 farmyard manure + poultry manure + soil (2:1:2). It was concluded that farmyard manure poultry manure +soil at proportion (2:1:2) turned out to be the better medium and perform best for plant growth due to its highest nutritional value as compared to all other treatments. Thus, by using natural fertilizers, the quality of tomatoes can be enhanced while soil fertility will also be maintained.

Kang B.S and Sidhu B.S (2005), studied protected farming as an alternative technique for seasonal and off-seasonal vegetable cultivation, particularly in high-altitude regions, and can be successfully employed for niche areas of agriculture. Experimentation on vegetable crops under protected conditions was carried out to see the feasibility of their farming at different altitudes in the central Himalayan region. For evaluating the suitable conditions required for the cultivation of vegetables, three treatments, viz., polyhouse, shade net, and plastic mulch, were selected in comparison to open conditions at both altitudes. Capacity building through organizing a training program was adopted for demonstration and dissemination of this technology to rural farmers of the region.

Adeyeye et al (2018), studied one of the limiting factors to crop production in Sub-Saharan Africa is due to poor soil fertility to increase the crop yield to meet ever increasing population

of this region, fertilizer is required as in the form of organic or inorganic. There seems to be some level of specificity in crop adaptation to the type of fertilizer to increase its growth and yield potential. So, the current field experiments were conducted to study the effect of different organic and inorganic fertilizers on the growth and yield of tomatoes during 2015 and 2016 in the rainy seasons at the Teaching and Research Farm of Federal University Wukari. The results showed a significant effect ($P<0.05$) of the treatments on the growth and yield parameters of tomatoes. The application of poultry manure significantly produced a higher number of leaves, nodes, flowers, and fruits. While organic manure treatment gave significantly higher plant height. Hence poultry manure produced the best result for the production of tomatoes.

Hashemimajd, K. *et.al* (2006), studied vermicomposting and composting are efficient methods for converting solid wastes to useful products. Incorporation of composts and vermicomposts into potting and container media is a potential use for these materials. In a greenhouse trial, the effects of a vermicompost produced from raw dairy manure (RDM) along with some other composts produced from tobacco residue (TR), yard leaf (YL), sewage sludge + rice hull (SS + RH), sewage sludge + yard leaf (SS+ YL), and RDM were studied.

Materials and Methods

The experiment was carried out by using three types of fertilizers which are the farm yard manure, chemical fertilizers, and vermicompost. Each type of fertilizer is applied to the plant with a specific dose. Chemical fertilizers were applied 50 ml on alternative days from the sapling stage. Farmyard manure and vermicomposting are applied every seven days in 100 gm from the sapling stage.

Soil analysis is carried out in 2 stages, before the addition of fertilizers and further addition of fertilizers.

Used material in the experiments

Pasture land of soil, earthen pots, vermicompost, Farm yard manure, chemical fertilizer, tomato plant.

- **Preparation of soil**
- Collecting soil from the pasture land, then drying, pulverizing, and sieving. 1 kg of soil is used for the pre-analysis. After that 4 earthen pots fill with 4 kg soil/pot.

- **Study site:**
- The Pot experimental research was carried out in CSIBER, Kolhapur.

- **Tomato variety:**
- TO-1057 was selected based on availability in the markets of the Kolhapur district.

Experimental Design-

Treatment of Different fertilizers on the same 4 tomato plants was taken for the experiment --
1st plant was grown with vermicompost at the rate of 100g per week
2nd plant was grown with an FYM rate of 100g per week
3rd plant was grown with an inorganic fertilizer rate of 100g per week
4th plant was grown without any fertilizers
Soil analysis is carried out in 2 stages, Pre-analysis of soil before the addition of fertilizers and further addition of fertilizers i.e., post-analysis of soil

Table 1: Pre-analysis of soil sample

Sr. No.	Soil Parameters	Result
1.	OCOM (mg/L)	1.95
2.	pH	7.45
3.	Water holding Capacity (%)	91.049
4.	Nitrogen Kg/ha	2144.51
5.	Potassium Kg/ha	11.76
6.	Phosphorous Kg/ha	492.441

Table 2: For soil fertility

Sr. No.	Parameters	Chemical Fertilizer	Farm Yard Manure	Vermicompost
1.	OCOM (mg/L)	3.799	2.19	15.128
2.	pH	6.90	7.52	7.29
3.	Water holding Capacity (%)	37.327	42.311	45.355
4.	Nitrogen Kg/ha	15115.52	3060.73	3010.56
5.	Potassium Kg/ha	165.312	83.328	55.104
6.	Phosphorous Kg/ha	5283.48	1056.69776	4411.456

Measurement of plant growth parameters

Vegetative growth of the studied tomato plants (viz., plant height, stem diameter, number of branches, and leaves per plant was evaluated. The plant height was measured from the soil level to the tip of the shoot and expressed in the foot.

Measurement of yield parameters

Tomato fruits were harvested twice weekly at the pink to red-ripe stage. Weekly yields were determined by pooling the two weekly harvests. Measured yield parameters included number of flowers per plant, number of fruits per plant, and yield per plant.

Expected outcome of

1. It gives 25/ more yield.
2. As compared to chemical fertilizers it has a chef cost so farmers can save their money.
3. It is eco-friendly and has no hazards for humans and animals.

Table 3: For plant growth

	Chemical Fertilizer	Farm Yard Manure	Vermicomposting
Flowers count	3	10	14
Fruits	24	4	2
Height (in cm)	67	85	70
Leaf colour	Yellowish	Green	Green

Conclusions:

In the present study, the organic fertilizers had the significant influence on the plant growth, yield and quality.

Table No. 1 & 2 shows the pre and post analysis of soil fertility and table no 3 shows the significant differences between effects of fertilizers on tomato plant height, tomato fruits count and life period of plants. The results revealed that FYM had the best effect as compared to other two fertilizers on plant height and tomato yield. Compared with conventional fertilizers, organic fertilizers, especially with FYM, could be an effective way to reduce the harmful effect of mineral fertilizer on the environment and human health.

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