ISBN: 978-93-91768-94-2

Environment and Sustainability

Volume IV

Editors

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Bhumi Publishing

First Edition: 2022

Environment and Sustainability Volume IV

(ISBN: 978-93-91768-94-2)

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Bhumi Publishing

2022

First Edition: November, 2022

ISBN: 978-93-91768-94-2

Published by:

Bhumi Publishing,

Nigave Khalasa, Kolhapur 416207, Maharashtra, India

Website: www.bhumipublishing.com

E-mail: bhumipublishing@gmail.com

Book Available online at:

https://www.bhumipublishing.com/books/

PREFACE

We are delighted to publish our book entitled ***"Environment and Sustainability Volume IV"****. This book is the compilation of esteemed articles of acknowledged experts in the fields of basic and applied environmental science.*

This book is published in the hopes of sharing the excitement found in the subject. Environmental science can help us unlock the mysteries of our universe, but beyond that, conquering it can be personally satisfying. We developed this digital book with the goal of helping people achieve that feeling of accomplishment.

The articles in the book have been contributed by eminent scientists, academicians. Our special thanks and appreciation goes to experts and research workers whose contributions have enriched this book. We thank our publisher Bhumi Publishing, India for taking pains in bringing out the book.

Finally, we will always remain a debtor to all our well-wishers for their blessings, without which this book would not have come into existence.

- Editors

CONTENT

CHALLENGES TO CROP PRODUCTION IN THE GLOBAL CLIMATE CHANGE SCENARIO: A REVIEW

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Introduction:

All changes in the atmosphere, whether brought on by natural or anthropogenic factors, are referred to as climate change. Volcanic eruption, crustal movements, solar activity, sea water temperature, ice cap distribution, westerly waves, and atmospheric waves are examples of natural factors, while carbon dioxide emissions from industry and agricultural production activities, acid rain, and deforestation are examples of man-made causes. The rise in the concentration of greenhouse gases and aerosols among artificial variables is especially worrisome. Thus, global warming-related climate change, which is the term for the average rise in global temperature, has emerged as a megatrend. Global warming was formally recognized as a global problem in the Club of Rome Report of 1972, and the World Meteorological Organization (WMO) and United Nations Environment Programme (UNEP) formally identified CO_2 as the primary cause of global warming in 1985. Since both human life and the agricultural sector are impacted by global warming, the IPCC highlights how crucial it is for the agricultural industry to adapt to climatic change. The Food and Agriculture Organization of the United Nations (FAO) estimates that more than a billion people are undernourished worldwide and there are three key issues to charge for both food insecurity and malnutrition, rising food prices, the utilization of agricultural crops as a source of biofuel, and climate change. Agriculture is facing numerous difficulties in order to meet the demand for the world's food supply due to the growing concerns posed by climate change. Most likely to cause a sharp fall in agricultural production systems are climate and global environmental changes, such as land degradation, changes in hydrological resources, and important ecosystem services. According to the World Development Report, World Bank (2010) yields are anticipated to decline in the world's semi-arid regions as a result of climate change, and food production will need to increase at a rate of 1.8% per year between 2005 and 2050 as opposed to 1% per year if there were no climate change.

There are primary and secondary effects of climate change on agricultural production. The principal effects of increased greenhouse gas emissions on the atmosphere include changes in crop growth responses, as well as changes in the energy and moisture balance of cropland. According to Na *et al.* (2007), the physical and chemical changes in agricultural soil and the shift in ideal locations for agriculture are examples of the secondary impact brought on by the change

in agricultural climate resources influenced by the initial impacts. Although climate change is predicted to have negative effects, it may also present opportunities for agriculture and crop productivity (Juhola, 2017). Understanding the impact of the climate is necessary to meet the demands of the continuously expanding human population as climate change has significant effects on global agriculture productivity.

Climate change scenarios

Based on 21 global circulation models, the Intergovernmental Panel on Climate Change Christensen *et al.* (2007) predicted that there is a 50% chance that over the course of the next century, the East Asia region (from 208N,1008E to 508N,1458E) will experience an increase in mean precipitation of 9% and regional average temperatures of 3.3 degrees. The worst-case scenario for the region's temperature and rainfall changes was a predicted rise in temperature of 4.98C and an increase in rainfall of 2%, Christensen *et al.* (2007). Although the precise size of the changes over the next 50 years is uncertain, it is generally accepted that CO2 levels will rise to close to 450 mol mol-1 (ppm), temperatures will rise by 0.8 to 1.0ºC, and precipitation will become more unpredictable as defined in the IPCC AR4 analysis (IPCC, 2007).

Global climate change and global warming

The average rise in Earth's temperature brought on by the greenhouse effect imposed by gases such as carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride is referred to as global warming (SF6). It is quite likely that the atmospheric concentration of carbon will grow above 550 parts per million (ppm), resulting in a 3–4° Celsius increase (+5.4–7.2°F) in the average global temperature, or Hell on Earth. If global fossil fuel consumption is not quickly reduced, it is likely that temperatures will rise by 6° C (10.8°F) at a carbon dioxide concentration of 600 ppm. This increase will last well beyond the year 2100. As a result of global warming, the temperatures at the North and South Poles have increased, lessening the time it takes for ice to shatter, speeding up the rate at which ice caps melt, and causing a major rise in sea level. The average land surface air temperature climbed by 1.53°C between 1850 and 1900 and from 2006 to 2015, whereas the average surface temperature worldwide increased by 0.87 °C (Arneth *et al.,* 2019). Between 1901 and 2018, India experienced an average temperature increase of 0.7 °C. (Krishnan *et al.,* 2020). Furthermore, as a result of global warming, more natural disasters occur around the world due to extreme climatic phenomena like drought, floods, and heat waves (Korea Meteorological Agency, 2008).

Parameter associated with climate change

In a study Tebaldi *et al.* (2006) and Karl *et al.* (2009) examined previous climate change in the United States and future climate projections, temperature and precipitation patterns showed a tendency toward warming of 1.5 to 2.5ºC and a modest increase in precipitation across the majority of the nation. They predicted an increase in the number of days with temperatures that are 5ºC (hot waves) greater than climatic normals, which will have an impact on agricultural systems (Change, 2014). The important parameters which are associated with climate change correspond to temperature, CO_2 concentration, Precipitation, tropo- and stratospheric ozone levels, UV-B radiation, Pest and disease.

1. CO_2 concentration: As it is directly involved in process of photosynthesis, elevated atmospheric CO_2 concentrations increase plant growth, yield and may improve plant water use efficiency.

2. Temperature: High temperatures can also have good effects, such as extending the growth season in high-latitude places with limited access to cold. High temperatures have deleterious effects, particularly in areas at low to mid-latitudes already at risk for heat stress. In regions where summer heat already limits crop production, an increase in temperatures will worsen soil moisture evaporation, crop transpiration, and the likelihood of severe droughts. If these effects are not mitigated by other factors, such as an increase in precipitation, an increase in crop WUE, a reduction in leaf area or planting density, or farmer adaptations like increasing the use of supplemental irrigation, crop losses could result.

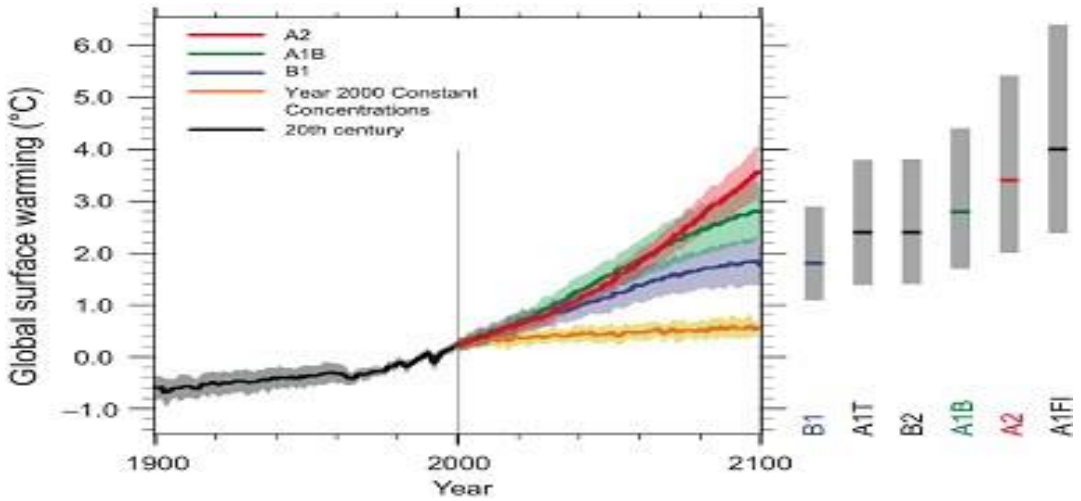

Figure 1: Estimated trend of temperature rise under each scenario *Source*: IPCC (2007)

3. Precipitation: Due to the soil's incapacity to absorb high-intensity rainfall, high-precipitation events (e.g., >5 cm in 48 h) may cause as much anxiety as drought, Hayhoe *et al.* (2007). Crops are more likely to become lodged when rainfall intensity increases due to significant storm

turbulence and wind gusts. A delayed harvest or an abundance of rain during harvest season raises the chance of many crops losing quality and the possibility of disease infection on grains. Extreme event frequency may also cause more harm in developed world locations with a long history of food production. For instance, the 2003 European heat wave, which had a 300mm precipitation deficit and a 6°C temperature increase, reduced crop yield by 30%.

4. Tropo and stratospheric ozone levels: Ozone, a consequence of some human activity, does become an issue when it is present at ground level. Ozone shields humans from UV light in the stratosphere, while reactive chemicals harm crops and forests in the troposphere.

5. Pest and disease: Considering climate change Weeds, pests, and illnesses might significantly reduce agricultural productivity. For instance, in the United States and Canada, the mountain pine beetle and other insects are more active early in the season, seriously harming the resources found in forests.

6. Rise in sea level and extreme events: The feasibility of the port and waterborne transportation system is impacted by sea level rise. Temperature-related Sea level rise due to increased temperature affects the aquaculture production system and diminishes biodiversity. Extreme occurrences, such as floods, landslides, earthquakes, or volcanic eruptions, can affect waterborne production systems, ruin crops and trees, drown living animals, and change water sources.

Climate change and food insecurity

Compared to reference scenarios that do not include climate change, it is quite likely that the number of people at risk of starvation will rise. According to estimates, up to 170 million more people could be undernourished in 2080 as a result of climate change. Climate change poses a danger to food security, and maintaining a plentiful supply of wholesome foods has grown difficult due to population growth. According to Tubiello *et al.* (2008), the main concerns regarding climate change and food security are, in general, as follows:

1. The potential for world food production is likely to rise up to a rise of 2°C; it will fall after that rise.
2. The growth in the potential for food production reflects the average of wildly disparate regional trends. In general, the net effect is due to an increase in high-latitude regions' production potential that outweighs the decline in low-latitude regions, which are typically locations with poorer food security.
3. As temperatures and precipitation rise, pest and disease pressures will also shift, ultimately leading to an increase in both. Low-latitude and poorer countries will be more severely impacted, regardless of the magnitude. The exact effect varies depending on the type of pest and disease as well as the geography.

4. Almost all GCMs forecast greater climate unpredictability and, thus, less stability in food production.
5. Access to food will continue to be the key factor affecting food security; however, the influence of socioeconomic changes is anticipated to be greater than that of climatic changes.
6. With or without the effects of climate change, Sub-Saharan Africa would surpass Asia as the region with the worst food insecurity.

Impact of climate change on the agriculture sector

For agricultural production and the use of acceptable farming techniques, crops that are suited to the local climate are chosen. The agricultural ecology is disrupted by climate change (more extreme temperature occurrences, warm nights, and more unpredictable precipitation). Strong yield losses are expected in lower latitudes at higher degrees of warming, particularly for cereals like maize and wheat, Porter (2014). Heat and cold waves in certain Indian states, including Punjab, Haryana, Uttar Pradesh, Bihar, and Rajasthan, caused the yield to drop from 0 to 100%. (Samra, 2004). Major phenological occurrences, such as the widely reported spring advancement and autumn delay, have also changed due to climate change, which has also led to phenological mismatches between trophic levels (Renner and Zohner, 2018).

1. Carbon dioxide impacts on crops

Over the past 50 years, the amount of carbon dioxide in the atmosphere has been rising continuously. Over the next 30 years, it is anticipated that this trend will continue. Maize and sorghum, crops with the so-called C4 photosynthetic pathway, have less responses than C3 crops.

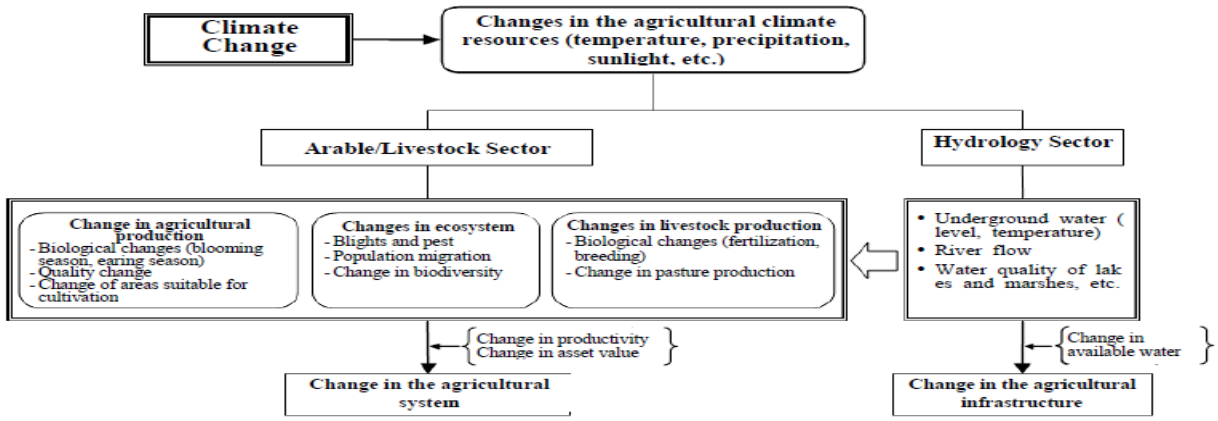

Figure 2: Flow chart of the climate change impact on the agricultural sector (Source: Kim *et al., 2009*)

In general, doubling CO_2 increased reproductive yield in C3 species by around 30% and in C4 species by about 10%. Numerous C3 weed species exhibit significant growth advantages

and pesticide resistance at high CO_2 levels. According to Kimball (2007, 2010), doubling the CO_2 concentration in C3 species boosts growth on a scale of 30% under ideal conditions. This suggests that raising the concentration to 440 mol mol-1 will increase C3 plant growth on the order of 10%.

Crop water use efficiency interactions with carbon dioxide

Crop physiological and morphological traits determine how much water is used by the crop (i.e., transpiration, T) (Kimball, 2007). Reduced conductance for water vapour loss from leaves to the atmosphere is the result of increased atmospheric CO_2, which causes partial stomatal closure. Following a meta-analysis of natural C3 and C4 grass species grown under no stressors, Wand *et al.* (1999) came to the conclusion that high CO_2 concentration decreased stomatal conductance by 39% in C3 species and 29% in C4 species. For a doubling of CO_2, soybean's conductance decreased by around 40% (Ainsworth and Rogers, 2007). When Ainsworth and Long (2005) evaluated the findings from free-air CO2 enrichment trials where daytime CO_2 concentrations were increased from present to 550 to 600 mol mol-1, they found no evidence of significant variations in stomatal conductance between two C3 and C4 species. Therefore, decreases in stomatal conductance of about 10% are likely to result from rises in atmospheric CO_2 concentration to almost 450 mol mol-1 by 2040 as predicted (IPCC, 2007).

2. Impact of temperature on crop

Each species has a certain range of maximum and minimum temperatures within which growth takes place and grows at a particular temperature. As temperature rises above the optimum, growth rates slow until they eventually stop when plants are subjected to their maximum temperature. As temperatures rise, vegetative development (the rate at which nodes and leaves form) quickens and has a higher optimal temperature than reproductive development. The impact of temperature is illustrated in table 1.

3. Ozone impacts on crops

The Midwest and eastern parts of the United States currently have some of the highest rural O_3 concentrations worldwide. Only eastern China and Western Europe have comparable (high) levels. Argentina, Brazil, and the majority of the Southern Hemisphere have far lower ozone levels than the rest of the world and are predicted to experience only a slight increase in O_3 during the next 50 years. The output of crops will be impacted by these rising O_3 levels and greenhouse gases. According to studies, cotton, wheat, soybean, and peanut (*Arachis hypogaea* L.) are the four most important agronomic crops. O_3 exposure at high concentrations (>75 nmol mol-1) reduces yield, dry matter, and photosynthesis in soybean (Morgan *et al.*, 2004).

Table 1: Effect of temperature on various crop species

Crop species	Temperature	Effect	References
Maize	Above 30˚C	damaged cell division and amyloplast replication in maize kernels which reduced the strength of the grain sink and ultimately yield	Commuri and Jones, 2001
Peanut	33˚C	Reduction in percent fruit-set with a linear decline to zero fruit-set at 43˚C bud temperature.	Prasad *et al.* (2001)
Cotton	above 30˚C	Decreased Percent boll set, boll number, boll fi lling period, rate of boll growth, boll size, and yield (Reddy *et al.,* 2005).	Reddy *et al.* (2005)
Sorghum	32/22˚C and 40/30˚C	Highest Grain yield, HI, pollen viability, and percent seed-set at 32/22˚C and progressively reduced as temperature increased, falling to zero at 40/30˚C	Prasad *et al.* (2006)
Soybean	Above 30˚C	Viability of soybean pollen is reduced by exposure to instantaneous temperatures above 30˚C (Topt), but shows a long gradual decline until failure at 47.C	Salem *et al.* (2007)
Maize	Above 30˚C	found highest photosynthetic rates occurred at temperatures of 25/20 and declined for each 1ºC increase in temperature above 30˚C	Ben-Asher *et al.* (2008)
Rice	Combined increased CO2 (360 or 680 μmol mol−1) and high night temperatures (22 or 32˚C	Increased living leaf N concentration, leaf area, carbon assimilation and caused higher photosynthetic capacity during the last stage of growth. Higher nighttime temperatures caused a significant decrease in the C and N allocation to the ears.	Cheng *et al.* (2010)

Table 2: Various challenges to crop production under climate change

Climate change	Challenge to crop production	Reference
Increased co2 concentration	Decreased protein content in cereals	Eckersten *et al.* (2008)
Extended growing season (frost on snow-free soil)	Soil temperature too low for earlier sowing	Uleberg *et al.* (2014)
Extreme precipitation, flooding	Soil erosion	Jordbruksverket (2013), Uleberg *et al*. (2014)
Increased precipitation in autumn and spring	Complicated conditions for harvesting and sowing	Jordbruksverket (2016a) Jordbruksverket, (2016b) Hakala *et al.* (2012)
Milder (especially in winter and early growing season) and wetter conditions; extended growing season; increased CO2 concentration	Increased risk of pests and weeds	Eckersten *et al.* (2007) Peltonen-Sainio *et al.* (2016)
Decreased soil freezing in winter	More difficult to till soil in spring	Fogelfors *et al.* (2009)
Increased precipitation in autumn, winter, and spring; extreme precipitation	Nitrogen leaching and phosphorus loss through erosion	Fogelfors *et al.* (2009) Jeppesen *et al.* (2011)

Adaptation and mitigation of climate change

Adaptation solutions in agriculture combine individual measures (such switching from one crop type to another) and systemic modifications to reduce the effects of climate change (e.g. diversifying livelihoods against risks or an institutional reform to create incentives for better resource management). In addition to "technological advances that minimise resource inputs and emissions per unit of output," mitigation also supports actions that "reduce or limit greenhouse gas emissions or to boost greenhouse gas sequestration".

In the agricultural sector, there are three major options to mitigate climate change:

1. **Reducing emissions**: Agriculture contributes significantly to atmospheric CO_2, CH_4, or N_2O emissions. By managing carbon and nitrogen flows in agricultural ecosystems more effectively, the fluxes of these gases can be decreased, resulting in less carbon dioxide, nitrogen, and methane released.

2. Avoiding or displacing emissions: Additionally, biofuels have the potential to occasionally take the place of the fossil fuel energy utilised in agricultural production. Increased use of wood-based products may help reduce CO_2 emissions.

3. Removing emissions: GHGs can be absorbed from the atmosphere through sinks. A sink is any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas or aerosol from the atmosphere.

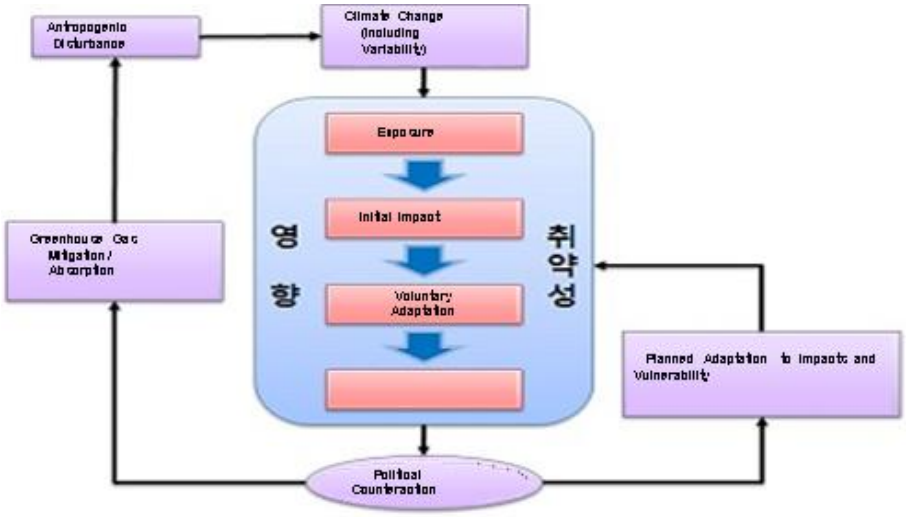

Figure 3: Approaches to the countermeasures against climate change (Source: IPCC, 2007)

Conclusion:

Globally, agriculture and climate change are inextricably intertwined, impacting and influencing one another. The other correlated changes in the environment (temperature, precipitation, O3 UV-B, humidity, pest and disease, etc.) are likely to be as important as CO2 in determining the responses of managed ecosystems, even though the increasing concentration of CO2 in the atmosphere is currently the main cause of climate change. The uneven distribution of the effects of climate change between developed and developing countries is likely to be accentuated by feedbacks among biophysical, economic, social, and technological mechanisms. Whether or not climate change occurs, agriculture must increase its capacity for resilience in order to address the problems of guaranteeing food security, increasing rural employment in emerging nations, and safeguarding the environment and natural resources. Both positive and negative responses must be thoroughly studied and put to the test in real-world settings in order to establish whether any modifications to graziers' or ranchers', farmers', or foresters' management approaches are required.

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SUSTAINABLE DEVELOPMENT: SIGNIFICANCE, CHALLENGES AND POTENTIAL SOLUTIONS IN THE CONTEXT OF CLIMATE CHANGE

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Abstract:

This chapter seeks to address the modern global challenges in achieving the sustainable livelihood and development in the present circumstances of climate change. The impacts of human interventions in the unwanted climatic adjustments leads to the depletion of natural resources and complete displacements from one habitat to another. The focus of the paper will also be laid upon the probable causes and aftermath that resulted into the very problem of climate change. Also, the best practices and potential solutions will be discovered in integrating the concept of sustainable development and climate change so as to meet the underlying global vision by 2030. This paper emphasizes on providing the suggestive measures on strengthening the national policies across the borders, spreading educational awareness about the hazardous effects of climate change and encourage systems to increase capacity for efficient planning and control of climate change, with an emphasis on women, youth, local communities, and underprivileged groups.

Keywords: Sustainable Development; Climate Change; Climate Action; SDGs; Sustainable Development & Climate Change Linkages; Sustainable Livelihood; Pillars of Sustainability.

Introduction:

The concept of sustainable development is a pure interpretation of the principle that is made to integrate the society through all its spheres in the attainment of all the important and necessary developmental objectives that are needed for every individual to survive regardless of the society and generation on definite grounds. The discussion of sustainable development in its most general sense is by far the most unique pattern of approach adopted by the supra system, United Nations Organization which gives the underlying call for the cooperative efforts towards developing an inclusive, equitable and resilient future for all in the present and upcoming. An environmental treaty called United Nations framework convention on climate change (UNFCCC) and intergovernmental panel on climate change (IPCC) gives the strong standpoint to strengthen the opinions on the collective structure adopted for advancing the knowledge of human interventions on climate change and at the same time providing the protocols to overcome the inconsistencies if present in the system.

The idea of achieving sustainable development is effectively unique in its positive sense as it not only concentrating on the issues related with environment itself but also addresses the challenges in the wholesome pattern which are present in the upfront and for the upcoming generations. Therefore, sustainable development notion calls for the holistic pattern of approach which can help in building an inductive environment and society for all to sustain in order to meet the necessary needs. The fundamental concern for sustainable development has always been to place an importance on widening the awareness about the social, environmental and economic limitations we face as a society. As a matter of fact, nonetheless, it is the mere impacts and effects of the damage that human wants have caused for the sake of different materialistic and industrial developments over years which is now resulting in the severe drawbacks in the form of tragic climate change and again, the effects of which will be comparatively immeasurable. Besides, the central objective of sustainability has always been the existence of human survival in the ways which can contribute for the effective strategies that can fill the quality of adaptability according to the needs of the society.

For the attainment of vision and the ultimate purpose of the idea of sustainable development, it is essential to synchronize the potentiality of three vital constituents that forms the set of interconnections amongst each other in order to strengthen the sustainable viewpoint of the society through comprehensive thought processes: Economic Growth & Stability, Social Inclusion and Environmental Protection. Thus, in order to perceive and recognize sustainability, it is very crucial to take into account these three main areas of impact, so called, **the three pillars of Sustainability**, which forms the backbone of the whole idea achieving the extensive intention of sustainable development. The three important aspects of sustainability considerably from the base for identification of the problems, reasons behind the emergence and evolution of the same regardless of the type of society at the grass root level. The presence and prevalence of three pillars places importance on the potentiality of providing effective solutions according to the needs and culture of the society.

Now according to the topic of discussion, the context of climate change and its pessimistic impacts on the global society has always been the central point of debate as it very much influences the vision of sustainable development. The problem of climate change has become considerably adverse during the years which is in no way is ever going to decrease. The most prevalent reason which marks the birth of every other cause to generate and become yet another to bloom out for the destruction of environment is definitely the evolution of the age of industrialization. Surely, Industrialization marks the presence of every factor because of which the unfortunate affects in the rising temperatures and changing weather patterns is clearly visible that are such as, electricity generation, manufacturing of goods, deforestation, excessive

consumption etc. Therefore, without neglecting the consequences that climate change can lead up to, SDG-13 on Climate Action put up on by United Nations Organizations on the global footprint of 17 sustainable development goals in order to meet the global objectives of peace and prosperity for all by 2030 signifies the strong call to action strategy to tackle the problems raise within globally with prior regard to the adversity existing in any country and its disadvantageous effects on the society. The main aim of the SDG-13 is to take compelling actions on immediate basis in order to tackle and combat the complications of climate change and its inauspicious effects

Thus, it becomes very clear that the problem of climate change is unfortunately affecting the global community at large where the raising carbon dioxide (CO_2) emissions and other greenhouse gases have significantly contributed to make the conditions of environment and ecosystem even worse than ever before. It is role of climate change which severely impacts the natural and anthropogenic systems of the planet through increased surface temperatures, extreme & unpredictable weather patterns, ocean acidification etc. leaving no scope of revivability to overcome the obstacles so developed. These prospects are definitely going to negatively influence and impact the livelihoods of huge masses which will uncertainly develop a situation of migration and also at the same time affecting the other SDGs to be achievable in their own dimensions. Therefore, it is extremely important to call for the collaborative planning and cooperative efforts from all the countries to strive for an immediate action that is adaptable and perceivable for all the societies in order to achieve the ultimate goal of sustainable development and build a resilient future for all.

Review of Literature:

Robinson *et al.* (2001) has argued in a review paper that there may be some significant advantages to combining climate change with sustainable development approaches, concepts, and procedures. They briefly examine current advancements in the disciplines of climate change and sustainable development to illustrate this point before moving on to the issue of how to merge them. The analysis suggests a number of possible conclusions that could be relevant to the study of climate change and sustainable development, such as the necessity of a scenario analysis methodology that integrates all areas of the study of climate change and sustainable development, the critical significance of alternative development paths, and the assumptions about the reference case or baseline that form the basis of any analysis.

Mohanty *et al.* (2009) has written a research paper that focuses on several aspects of global climate change, including its causes, anticipated effects, likely mitigation measures, and the need for increased knowledge of the subject to raise awareness of it worldwide.

Matthew *et al.* (2009) has written article, the worldwide issues that initially sparked the idea of sustainable development are briefly reviewed, and it explores how current processes of global change are affecting both the issues and this method of tackling them. While there are some reasons for hope, it is determined that a number of factors make designing and implementing sustainable development more challenging. The analysis of potential solutions and the importance of making an effort to do so is presented in the article's conclusion.

Robinson *et al.* (2006) has authored a paper that explores climate change from the standpoint of sustainable development. It reflects on the conclusions of a panel of industry, local government, and academic leaders in British Columbia, Canada, who were chosen to advise the provincial government on climate change policy, to show how this can influence the approach to climate change challenges. The panel concluded that, compared to climate policy itself, sustainable development may provide a much more fruitful means of pursuing climate policy objectives. The study covers following climate change developments in the province and offers recommendations for how British Columbia and other jurisdictions might best pursue such a sustainability approach.

Munasinghe *et al.* (2010) has written a paper which argues on Two significant global issues—sustainable development and climate change—are the focus of this essay. Poverty is one of several development issues that are already very difficult.

Research gap

The reviewers of the literature made numerous points from the aforementioned review studies. They conducted extensive research to learn about the significance, difficulties, and potential solutions of sustainable development in the context of climate change. One of the primary issues with the articles we read was that none of the research papers made any mention of rural areas. This, in our opinion, is very important, should be examined, and for which special preparations should be made. Every national policy currently in effect is only intended for metropolitan areas, ignoring rural areas. As a result, it's critical to develop flexible policies that could perhaps work for all rural areas, regardless of their ecologies.

Climate Change

Climate change is acknowledged as the notion of utmost concern in the present environment and societies which possess the potentiality of affecting the global community in this unfavorable growing age of urbanization where industrial improvisations and technological advancements are two different factors of modern wants of human beings that are undoubtedly placing the life on earth at risk and at adversity. Climate change is basically the result of the carbon emissions that are raising from all the human and industrial activities intended towards the fulfillment of new age advancements according to contemporary requisites that are ultimately

developing the situations of increased temperatures, unpredictable precipitation patterns, extreme weather conditions, rising sea level, ocean acidification, migration and complete displacements realizing these to be long term immeasurable shifts which needs an urgent call to action.

As discussed, and mentioned earlier, the main anthropogenic contributing element towards the process of climate change is the increment in the concentration of carbon content in and around the surroundings and atmosphere over different period of time. This increased concentration of carbon content in the atmosphere is caused by the toxic emissions from greenhouse gases as a result of different human activities that are highly dependent on fossil fuels for their usage. Also, the hazards and dangers caused by climate change is definitely tend to result in complete loss of livelihoods especially for the people belonging to marginalized sections of the society those are particularly dependent such as women, children and elder ones. The major obstructive effect that climate change is going to leave us with is certainly going to be the scarcity of resources because ultimately these are the resources which ensures the sustainability of life on the planet not only for the generation existing in present but for many those are upcoming. So, unavailability of accessible resources and natural wealth will create the situations of displacements and forced migration of people from one place to another as natural resources of any sort or type are always one of the essential elements to ensure the sustainable life on the globe.

One of the important contexts of climate change is the elemental shift from prime focus on physical science of climate change to the entrance and prevalence of human dimensions into the problems. The human-induced interventions have always been the biggest contributing factor in depicting the hazardous impacts of climate change across the planet regardless of the type of atmosphere and environment that becomes the ultimate cause of the negative influence of globalization on the whole ecosystem resulting in its pollution and contamination. Presence of anthropogenic factors in the degradation of climate system is the symptom of un-sustainability in the society as a result of which united nations organization imbibed the whole goal of climate action as SDG-13 that is one of the seventeen sustainable development goals as a matter of consideration to tackle the problems involved in the deterioration of the climatic facet of the ecosystem and in turn provide the best course of actions to make the accessibility possible to all natural resources in order to develop a sustainable society once again. SDG-13 regarding the climate action addressing the climatic challenges places an importance on the urgent call to action to counter the negative impacts of climate change by providing adaptive and effective measures in order to develop a society of absolute sustainability that also possess the ability to rejuvenate the accessibility of natural resources for upcoming generations without any adjustments in the quantity to be used.

Climate change leads to various adverse effects in the destruction of ecosystem because of the several dimensions of interventions it incorporates whether it may be natural or anthropogenic among which increment in the extreme hot temperature, inflation of sea levels, uncertain weather conditions are some of the deteriorating impacts of climate change that are ultimately going to result in scarcity and unavailability of resources, loss of biodiversity and vegetation and so on and so forth. Climate change is the main influential aspect in playing an important role as a prime obstacle in front of other SDGs as well for their successful achievement and therefore, SDG-13 regarding climate action acts as a primary tool to combat the emergent climate issues across the length and breadth of the globe so as to protect the sustainability of ecosystem and at the same time call for the preservation of available resources for all the living beings in order to ensure the existence of life to be continued in present and for the upcoming generations.

The human activities for the achievement of the purpose of globalization in order to maintain the continuity of industrial progression and technological advancements contributes in the long-term worsening reverberation of the whole ecosystem as a result of which increase and expansion in the carbon dioxide emissions displaces the livelihood and habitat of all living beings on absolute grounds. Climate change is not only becoming the cause for the depletion of natural resources for the present generation but it is also diminishing the ability of future generations to meet their own needs. Another factor which in some ways leading the present generation towards the disastrous impacts of climate change is the significance of overpopulation due to which over dependency on natural resources to ensure the high standards of livelihood and too much consumption of the same becomes the pivotal cause in bringing down the qualitative analysis of the whole ecosystem in terms of its smooth functioning.

Therefore, as a matter of fact, there should be a mechanism of ecological prudence which places the importance on justifiable dependency on the use of natural resources. In the present scenario of massive rate of globalization where the natural resources are on the verge of becoming endangered, the idea of ecological prudence assists on necessary use of natural resources according to the need and demand of the situation which will avoid the needless manipulation of the same. The conceptual analysis of ecological prudence proves that natural resources when used in the quantity which is legitimate in any sense, determines a massive save in the mass of natural resources which in turn receives the time to rejuvenate again after a fixed period of time for the further use. Since we have already discovered that the very problem of climate change is the ultimate symptom of un-sustainability in the society and environment for all living beings per se, it becomes extremely important to come up with such essential tools like ecological prudence that allows for the proper implementing and monitoring system for ensuring

the progressive growth of the whole ecosystem qualitatively and quantitatively. The very problem of climate change does not even allow the other SDGs to overcome the issues in their own sediments because of the various links of interconnections amongst each other and thus, it now becomes exceedingly important to overcome the issues and hazardous effects of climate change so as to ensure the element of sustainability in the ecosystem through accelerating development of natural resources and at the same time confirm the pollution free environment from all the negative aspects of climate change for establishing the eco-friendly and sustainable society that would help in achieving the vision of 17 SDGs in order to build the resilient future for all.

Climate change and sustainable development linkages

It is impossible to achieve development that is sustainable in the long term if we are constantly being threatened by natural disasters that could vanish two to three percent of your GDP. There is no way you can relieve poverty, if there are natural disasters that may wipe out the entire city and entire provinces that dislocate 20 million people and there is no way one can pursue development that is actually a development that sticks unless we address the threat of climate change and begin to mitigate that because there is no threat to sustainable development other than climate change. if we don't look into this, then this may wipe out all the current gains that have been made on all the MDG's over the past years and that certainly is something we can't afford as humanity to have and we certainly can't endanger the progress that we could potentially have on food security, health security, etc. for the longest time, or as far as we have known, or read in newspapers, books or in various awareness programs, Climate Change has been a persistent issue over the years, with so many goals coming into picture the Climate Change condition has only further deteriorated. Keeping this in mind it is very important for us that, despite the implementation of various strategies, various programs, various meeting that have been held worldwide has resulted in various attempts, which have unfortunately not been met, due to various reasons. This paper is solely going to talk about how Climate change and Sustainable development are related so we can try to find the loop holes where the entire effort of achieving the 2030 goal is fleeing and an attempt will be made, with various ideas, via which this life-threatening scenario can change. A recent news showed up on the headlines saying, "Europe hitting up more than twice global average": WMO on 2nd November 2022, wherein they talked about the increased temperature of Europe being the highest in 30 years, further causing exceptional heat, wildfires, floods, and other climate change impacts that are bound to affect the society, economies and ecosystems, according to the World Meteorological Organization. The reason why this news holds a lot of significance is because this news will help me convey the linkage being explained here.

The constant change in Climate is causing a lot of disturbance in the natural cycle of nature and is further causing our ecosystem to deplete which is highly threatening to every living specie living on earth. Sustainable Development is an approach which will help us put a halt to all the over exploiting of natural resources, which means one still gets to use everything, meanwhile also preserving sufficient for the future generations. With this we will be discussing the SDG 13 out of the 17 SDGs which specifically focuses on climate change in approach with the Sustainable Development goals. This follows the agreements in respect to the countries means to adapt with respect to their diverse situations.

How can sustainable development benefit the climate change issue?

If climate action is taken seriously, it can actually make us more prosperous. For example, the households and the different businesses cut costs through greater energy efficiency and people are able to find jobs through renewable energy and recycling initiatives.

We can also reduce the negative impacts that our unsustainable actions have on our earth though reducing the usage or withdrawing the usage of fossil fuels and cutting back on large scale usage of plastics and using out resources more sustainably wean make our planet healthier.

Through climate action we can build more peaceful just and inclusive societies managing natural and environmental resources in a sustainable fair way can support be spending and safeguard because access to basic human needs in areas where resources scarcity could otherwise contribute to tensions.

Climate action when taken into account though Sustainable development can help us address complex challenges through new partnerships binging experts on climate change and sustainable development together in areas such as financial resource mobilization, capacity building and technology cooperation will allow us to identify synergies in the way we address challenges and harness opportunities.

However, these benefits can only be reaped when used though the 5 dimensions of sustainable development.

- PARTNERSHIP
- PEACE
- PLANET
- PEOPLE

Recognizing the climate change and sustainable development are inextricably linked helps us to make the right connections and ask the right questions in order to find the right solutions.

The most important linkage that integrates the vision of sustainable development to the catastrophic problem of climate change is the interdependency and interconnections amongst

each other. All the prevailing issues in society in the contemporary scenario are the by-product of the perilous effects of climate change that are attempting to avoid the desired objectives drawn by 17 SDGs to be achieved and fulfilled. The problem of climate change encompasses broad range of concerns which are indeed the obstacle in achieving the sustainable society that builds a resilient future for all and brings inclusiveness in terms of equitable distribution of resources and therefore, SDG-13 have been placed in the list of 17 SDGs as a matter of global call to action in order to attain the desired and positive outcomes for which importance should be placed upon the uniting the national policies and programmes so as to ensure to worthwhile and worldwide peace for all the related issues in any circumstances and environment regardless of the type of the society. Thus, it is very high time to recognise the dismissive potentialities of climate change and act accordingly with highly effective mechanisms incorporated in policies that promises a contamination free and sustainable society ultimately proves out be of utmost significance in achieving the global perception of inclusivity and sustainability throughout the globe where the present and upcoming generations will be meeting their basic needs in their own dimensions of resilience.

Challenges:

The term Sustainable Development has different connotations and meanings and in view of this it is very difficult to ascertain and address the of sustainable development. The United Nations has proposed 17 sustainable development goals which are meant to be achieved by 2030. We must recognize that that alone regulatory frameworks, technological solutions or for that matter even the financial instruments cannot help us to achieve the goals of sustainable development. It requires the participation of every individual a different capacity.

1) **The very first challenge is that the 17SDGs are not a part of each and everyone's concept of values**

It is the ages of two and three years when a child for the very first time develops first roots for empathy and science proves that in early childhood development psychology. Until the age of 5 a human being has already developed the general concept of values. Making us think it is thus that we want a future world where the Sustainable Goals become a live reality, we should give the youngest of our societies the chance and the opportunity to shape the world that we are living in. we need to give them a chance so they can make the SDG's a construct of their values. Through Pedagogy.

2) **Lack of fairness dimension and environmental sustainability**

Taking the example of the United States, being is one of the most unequal societies in the high-income world, probably the most unequal. There is a huge gap between the rich and the poor and in terms of the environment then the US may have progressed in terms of air pollution

over the past few years, they and other countries are very bad at controlling the human induced climate change. There is also lack of commitment within the political parties that are responsible for acting upon them. However, in order to achieve the goals, especially the SDG13 we need to make sure that we are defining the goals more clearly and making it seem fairly more manageable and less remote, we can help people understand it and see it, and hence we can also draw more hope from it. And to move irresistibly towards it (JFK, 1963).

3) Self – evolving economy

The issue with the economy and the society is that they are very self-evolving in nature, they being highly unpredictable in nature, one may never know where the economy or the society is going as they just develop and get richer and that is especially very dangerous at this point in time as this self-kind of evolving economy doesn't by any means protect the common interest and it also doesn't keep the inequalities at manageable levels and it by no means solves the problem of the drastically changing climate. Its like these goals are about steering is not a heroic act rather it is a lifesaving act. And in order to change the situation of climate change, it will only be more manageable when one might steer, in order to deviate the vehicle from the cliff (a reference to the dangers beyond the cliff) one good point about having goals is that we know what are we steering for, the purpose is made clear. However, the implementation is mandatory and is only possible through steering. Because if not, there is no life beyond it.

4) Lack of appreciation of goals

When we impose goals onto people, such as "we need to protect the climate", "we need to stop poverty" we need to stop stating these goals and showing people how these goals (climate change) is achievable, this gives people hope and with hope there is movement. Just imposing goals may not be motivating to people, it could also be de-motivating after a point of time but when we talk about how these goals are achievable. We are not a society that sets many clear goals. President Kennedy has said one fantastic goal and that is during the spring of 1961 " I urge the American people" to adopt the goal of sending a man to the moon and bringing him safe back to earth before the end of decade and he also said that I don't want people to adopt this goal until they appreciate this as it is going to be hard, it's going to be expensive and can be dangerous and it is going to require tremendous effort because we should not take on a goal unless we actually proceed to achieve it and NASA took this into consideration and it took them 18 months just to figure out how and that is exactly the same situation with these SDG's, taking into picture Climate change, in order to achieve this goal the sheer commitment and appreciation of the goal is important among each and every individual.

5) Emission of Carbon dioxide from fossil fuels

We need to stop the emission of carbon-dioxide from fossil fuels that is overwhelmingly the head driver of Climate Change, the blanket of warm gasses which is most important is the CO2 that gets thicker and thicker gets more concentrated as we emit the CO2, Methane, Nitrous Oxide and other greenhouse gases through the respective industrial processes that tend to take place. The only way to stop this is by shifting from the fossil fuels to low carbon energy that is Hydro Power, Wind power, Solar power, nuclear power or perhaps we could switch to a technology that is called carbon capture sequestration, sadly as of now we have no more choices other than these or the geothermal and some other energy sources that are not in the potential abundance. If we talk in the technical sense then we need to change the curve og co2emissions from the usual path to the red line or even the traumatic upward sloping curve shown. And we need to get to the blue line what's called the de-carbonization and the notable point about this blue line is that it passes through zero in 2070 we have to make sure we de-carbonize the world's energy system.

Way forward

The major means of halting climate change are to put pressure on business and government to:

Leave fossil fuels in the ground. Coal, oil, and gas are examples of fossil fuels, and as more of them are mined and consumed, the worsening effects of climate change will become. As soon as feasible, all nations must transition their economies away from fossil fuels.

Invest in renewable energy sources. The greatest solution to quit using fossil fuels is to switch our primary energy sources to clean, renewable energy. These include innovations in solar, wind, wave, tidal, and geothermal power.

Change to eco-friendly transportation. Fossil fuels are used in petrol and diesel automobiles, aeroplanes, and ships. Air pollution will be decreased as a result of cutting back on flying, moving to electric vehicles, and reducing car use.

Keep our homes cosy for us. Homes shouldn't be draughty and cold because doing so is expensive and uncomfortable during the winter. The government can provide assistance to homeowners who want to heat their homes in a green manner, such as by insulating the walls and roofs and switching to heat pumps instead of oil or gas boilers.

Boost agriculture and promote vegan eating. Reduced meat and dairy consumption or turning vegan entirely are two of the best methods for people to combat climate change. To assist people in the transition, businesses and food retailers can enhance farming techniques and offer more plant-based goods.

Restore nature to increase carbon absorption. The natural environment is excellent at removing our pollutants, but we must take care of it. A good place to start is by strategically placing trees or returning land to its natural state through "rewilding" initiatives. Because photosynthesising plants absorb carbon dioxide as they develop and store it in soils, this is the case.

Save the Amazonian Forest. Protecting forests is a significant step in combating climate change because they are so important. Industrial-scale logging destroys massive trees that could be absorbing enormous amounts of carbon. Yet firms' clear forests to make room for soy, palm, or animal farms. By enacting better legislation, governments can stop them.

Safeguard the waters. Additionally, the oceans take in a significant amount of carbon dioxide from the atmosphere, which helps to maintain a stable climate. However, many are overfished, utilised for gas and oil drilling, or put in danger by deep sea mining. In the end, safeguarding the seas and the marine life within them is a means of defending humanity from climate change.

People should consume less. Different aspects of our lifestyle—such as how we travel, dress, eat, and live in general—have an impact on the climate. This is frequently intentional; for instance, businesses in the fashion and technology industries frequently release considerably more products than are actually required. However difficult it may be, cutting back on the use of these goods is definitely worthwhile. Global consumption reduction in more affluent nations can lessen the burden on the environment.

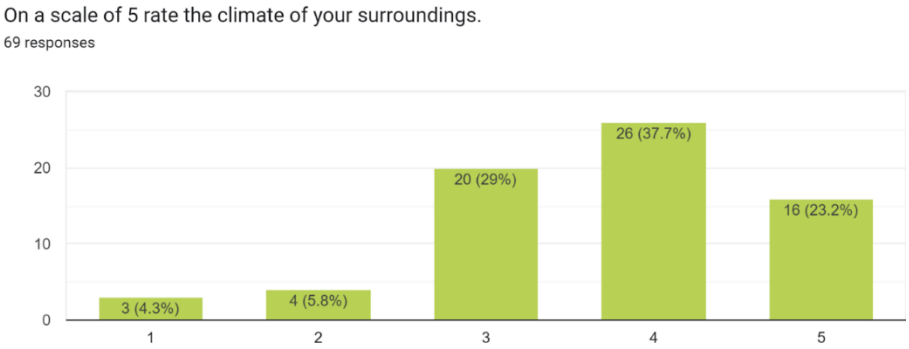
Save plastic. Oil is the raw material used to make plastic, and producing plastic (or even polyester for clothing) requires a startling amount of carbon. Since it doesn't decompose quickly in the natural environment, a lot of plastic is burned, which increases emissions. Plastic is in high demand, and by 2050, the creation and disposal of plastics will consume 17% of the world's carbon budget (this is the emissions count we need to stay within according to the Paris agreement).

Research analysis:

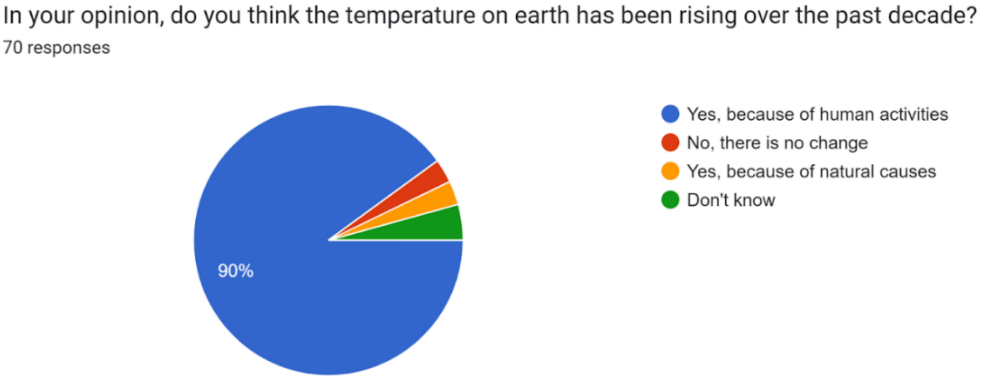
Almost 100 volunteers from all the Indian states participated in the survey, which was conducted. Male involvement was higher at 54.3% approximately, while female participation was lower at 45.7% approximately. The pupils of the relevant age group were given a set of questions that were created using the Google form. 31.4% of the participants were from rural areas, while 69.4% of the participants were from urban areas.

Increasing knowledge of the effects of climate change on health can help people adjust their behaviour and support societal initiatives to reduce greenhouse gas emissions. Additionally, it can assist in gaining the support of medical professionals for methods for mitigation and adaptation that will enhance health and lessen vulnerability. Research was conducted in order to

know how much the people are aware and concerned about climate. Following were the outcomes of the same.

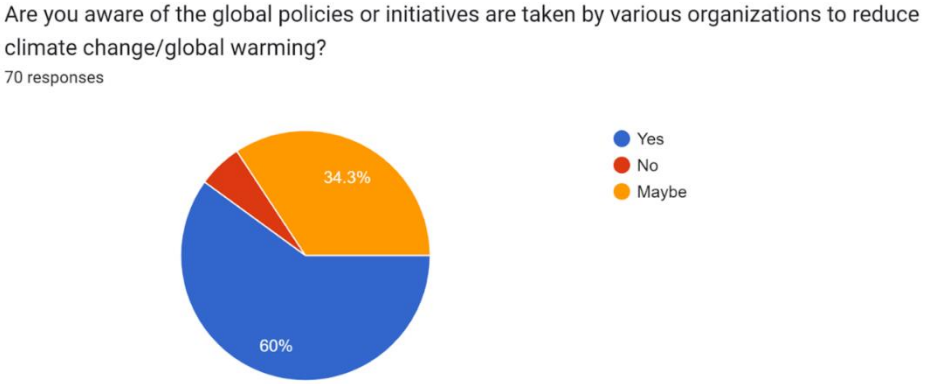


We deduced from the research report that the pupils were particularly concerned about the weather and temperature in their immediate environment. In addition to understanding local climate politics, they were also cognizant of global climate politics. All of the pupils were in complete agreement that urgent climate action is required and that they are really concerned about this.

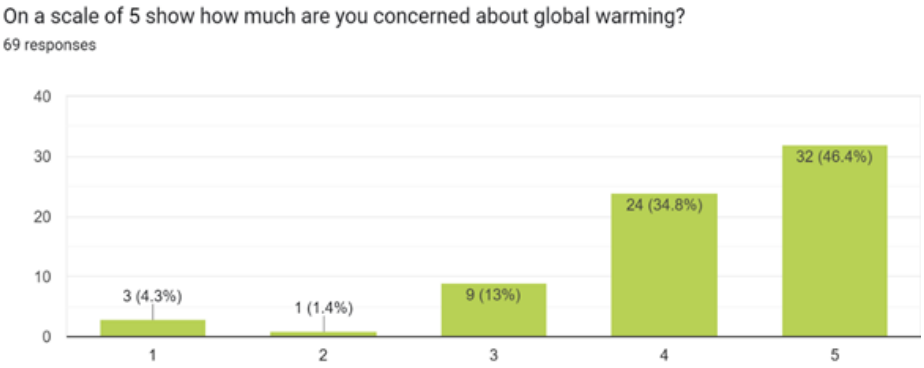


About 75 percent of them expressed fear for the future. 56 percent of people believe that humanity is doomed. Anxiety, fear, and sadness were indicated by two-thirds. Many people experienced hope as well as fear, wrath, despair, grief, and shame.

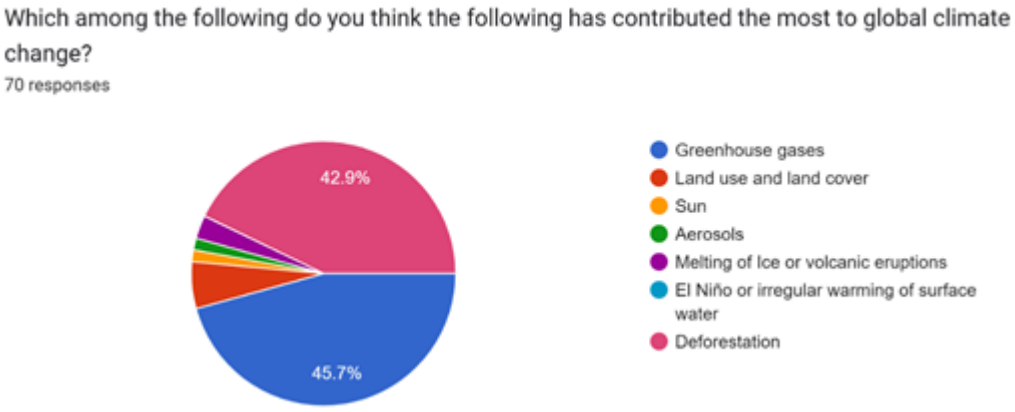
For young people, the devastation of the earth is personal, a 16-year-old said: "It's different for us."



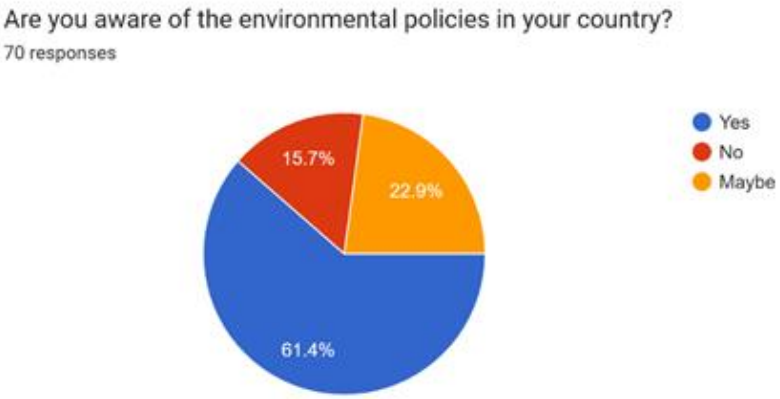
Nearly 60% of the young people interviewed said they were very or very frightened. More than 45% of individuals surveyed claimed that their everyday lives were impacted by how they felt about the climate.



"What should you do to make your surroundings aware of the enormous issue of climate change," was one of the subjective queries. People who expressed an interest in the environment advised educating those in their community through plays, plays, campaigns, social camping, and planting more trees.



In one of the statement United Nations Secretary-General, António Guterres,exclaimed that, my generation has largely failed until now to preserve both justice in the world and to preserve the planet. It is your generation that must make us be accountable to make sure that we don't betray the future of humankind. — United Nations Secretary-General, António Guterres.



Significance:

- The effects of climate change on many societal segments are interconnected. Food production and human health can be harmed by drought. Flooding has the potential to spread illness and harm infrastructure and ecosystems. Health problems can reduce worker productivity, raise mortality, and have an influence on the availability of food.
- Impacts of climate change may be observed in every area of the world we live in. However, the effects of climate change are not uniform throughout the nation and the world; even within a single city, different neighborhoods or people may experience different effects.
- Underserved communities, who frequently have the highest exposure to risks and the fewest means to respond, might become increasingly susceptible as a result of long-standing socioeconomic disparities.
- There are substantial connections between climate change and sustainable development. The least developed and underdeveloped nations, in particular, will be among those most negatively impacted and least equipped to deal with the expected shocks to their social, economic, and environmental systems.
- Climate change and sustainable development are mutually dependent. The foundation for social and economic growth is affected by climate change on the one hand, while the GHG emissions that are driving climate change and the susceptibility are influenced by society's objectives for sustainable development on the other.
- When systematically included into larger plans intended to increase the sustainability of national and regional development trajectories, climate policies can be more successful. This is due to the fact that a country's capacity to pursue sustainable development goals will be impacted by the impact of climatic variability and change, climate policy responses, and related socioeconomic development. Conversely, the potential for and effectiveness of climate policy will be impacted by the pursuit of those objectives.

Research methods:

- Methods- Descriptive, Questioner, Personal Interview, survey
- Sample- 70 students of different colleges & universities from all-over India.
- Tool- questionnaires and survey forms were made and circulated amongst the students to know about the impact and awareness of climate change in modern society of contemporary context.

Conclusion:

In a setting where nature-society imbalances may jeopardise the sustainability of the economy and the social order, sustainable development is mostly about people, their well-being, and equality in their interactions with one another. Climate change is anticipated to be a major

role in the sustainable development of many locations because it will interact with economic output and services, human settlements, and human societies. Climate change will also interact with its drivers, consequences, and policy responses.

Simply said, depending on the geographic region, the economic sector, and the level of economic and social development already obtained, climate change has the potential to have an impact on many elements of human progress.These linkages are expected to be at the core of many different types of development-oriented responses to concerns about climate change since settlements and industry are frequently focal sites for both mitigation and adaptation policy-making and activity.

The following are the most pressing concerns for sustainable development related to the effects of climate change on the topics discussed in this paper:

A. Challenges from progressive ecological changes that might result in impact thresholds and severe events that could interfere with the sustainability of communities and cultures, paying special emphasis to economies and societies in polar regions, dry land areas, and low-lying islands.
B. vulnerabilities to delicate social and ecological systems, including thresholds linked with more slow climate change that would be greater than the ability of impacted regions, communities, and industries to adapt.Effects on resource availability for urban and industrial expansion, as well as waste management, are a few examples (e.g., flooding).

In general, more developed economies are less sensitive to the effects of climate change than less developed ones, but the repercussions of going over sustainability thresholds might be very severe in developed economies since their structures are less flexible and more inflexible. When perceived climate change is slow and mild, social system inertia may prevent either industrialised or developing countries from taking appropriate action.

However, generally speaking, climate change presents a challenge to sustainable development. Its importance is essentially determined by how it interacts with other stressors and stress-related thresholds including population growth and redistribution, social and political unrest, poverty and inequality.

Long-term climate change is likely to have an impact on sustainable development by altering the global map of comparative advantage. In a globalising economy, this will support sustainable development in some regions while putting it at risk in others, particularly in regions with limited capacity for adaptation.

The severity and speed of climate change, of course, are at the heart of such inquiries. Given enough time, information, and resources, the majority of human activities and civilizations can adapt, which implies that efforts that slow down the rate of climate change are likely to lessen the negative consequences of climate change on sustainable development.

The vulnerability to the effects of climate change may also increase or diminish depending on development routes. The danger of adverse effects from climate change is increased, for example, by development that increases land usage in places susceptible to extreme weather or sea level rise.

Another example is when development pushes a culture and economy to specialise in a particular, climate-sensitive economic activity. Development that is more diverse is likely to be less dangerous. By reducing vulnerabilities to climate variation and boosting capacities to deal with other stresses and uncertainties, actions that increase industry, settlements, and society's resilience to climate change will frequently also contribute to development that takes place with or without climate change.

A wide variety of development-related decisions, from energy supplies and costs to industrial competitiveness and tourism trends, can be impacted by climate change, including the effects of climate change response strategies.

Economic consequences are most likely to hit the regions and industries most dependent on fossil fuels, necessitating adaptation methods that occasionally ask for support with capacity building, technical advancement, and transitional funding.

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MICROPLASTIC POLLUTION IN SOIL AND WATER ECOSYSTEMS: ASSESSMENT, IMPACT AND REMEDIATION

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Abstract:

The total amount of plastics manufactured worldwide in 2019 was approximately 3.6×10^8 tons. Due to their strong plasticity and durability, these are stable compound materials, widely applied in agricultural production, industrial manufacturing, clothing and medicine etc. Approximately 90 percent of plastic waste discharged directly or indirectly into soil and water (Plastics Europe, 2019). Prolonged exposure to ultraviolet radiation (UV), hydrolysis, mechanical wear and microbial action result in the progressive breakdown of plastic into countless smaller plastic particles, including microplastics (MPs). NaBr based density circulation solution for soil microplastic separation proved to be the best tool for withdrawal of microplastics both boi and non-biodegradable (Li *et al*., 2021). Pyrolysis at 500 °C proved significant decrease in content of microplasticin sludge filtrate from 550.8-960.9 particles/g to 1.4–2.3 particles/g (Ni *et al*., 2020). The addition of 0.05-0.4% polyester, 1 mg kg^{-1} PS, and 0.05 -0.4% polyacrylic particles stimulated negative impacts on the microbial activities (Machado *et al.,* 2018). Microplastic caused reduction in germination of *L. perenne* and also have an inhibitory effect of PLA on *L. perenne* shoot length (Boots *et al.,* 2019). Microplastic have suppression effect of FDAse activity caused by PVC or PE, the urease and acid phosphatase activities was both stimulated by the MPs addition in the soil (Fei *et al.,* 2019) they also affect soil pH, respiration depending on microplastic shape and polymer type (Zhao *et al*., 2021). Burrowing mammals (eg. earthworm) can also facilitate the incorporation of MPs in the soil via abrasion mechanism and lead to the incorporation of PS into the soil profile from the top surface (Rillig *et al*., 2017). Transport of micro plastics also help to mitigation the effect by collembolan (Maaß *et al*., 2017). Microplastics in soil and water ecosystems alters the soil structure and interact with other soil factors, significantly influencing soil function and organism abundance. Soil scientists suggest some positive aspects of MPs presence in soil. However, it should be more focused on hazardous substances derived from the plastics that deteriorate the quality and health of soil and ultimately human health via food chain.

Keywords: Microplastics, Pyrolysis, Mitigation, Ecosystems, Microbial action, Biodegradable

Introduction:

Plastics are synthetic polymers that are typically produced by polymerization of monomers derived from extraction of oil and gas. The world's first fully synthetic plastic was

Bakelite, invented in New York in 1907, by Leo Baekeland, who coined the term plastics. Microplastics come from a variety of sources that degrades into smaller and smaller pieces when it come in contact with UV radiations and other processes. It represent potential threat for soil ecosystem and water habitat. The size definition of microplastics was discussed at a workshop in 2008, hosted by National Oceanic and Atmospheric Administration (NOAA).

Type of plastics

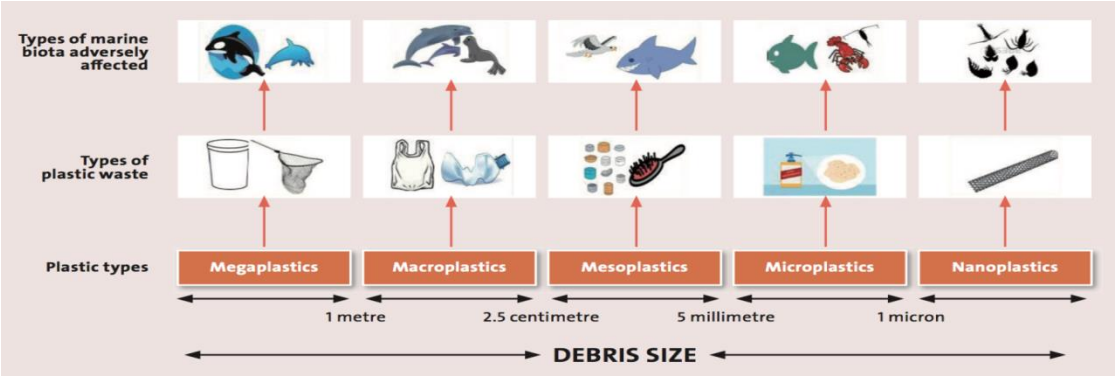

Figure 1: Type of plastics

According to plastic debris size plastic broadly classified into 5 groups

1. Megaplastics
2. Macroplastic
3. Mesoplastic
4. Microplastic
5. Nanoplastic

Microplastics are small particles of size of not more than 5 mm". But currently, nanoplastics (NPs) are referred to small microplastics in the 55 size of smaller than 0.1 μm.

Types of microplastics

The sources of microplastics are mainly classified as either primary or secondary microplastics. Primary microplastics are purposefully manufactured for specific applications, which include cosmetic abrasives, drug vectors, and industrial and engineering applications such as air blasting. These microplastics are usually difficult to remove using sewage disposal technologies and once they enter wastewater, they will ultimately accumulate in the environment and Secondary microplastics originate from larger plastics as reported by Masura *et al.* (2015).

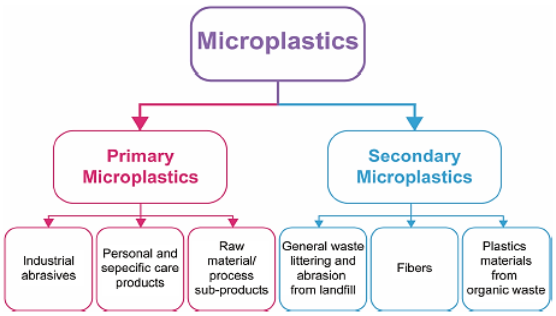

Figure 2: Types of Microplastics

There is other classification of mps according to their shape and type .It is classified to different four group according baho and coworker since 2021. Sphere, film, fragment and fiber

sphere type of structure found in PPE,LDPE and film type is PVC, polyrethrene polyethre is fragment type and poly carbonate occure fibre type shape.

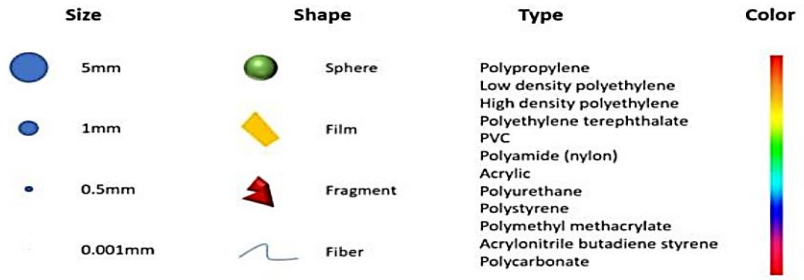

Figure 3: Different types of MPs shapes

Source of micro plastic

Entry of microplastics in environment by 1. Cosmetics industry 2. Clothing 3. Manufacturing 4. Fishing industry5. Packaging and shipping 6. Plastic water bottles. The presence of microplastics everely reduces soil quality and the migration and trophic transfer of microplastics in heavily contaminated soils, particularly those in wastewater-irrigate and plastic-film enclosed areas. Thus, soil is not only a sink for microplastics but also a source for the surrounding environments. Sources of microplastics in ocean, which mainly includes land-based sources (contributing~80%), costal tourism, recreational, commercial fishing (e.g. plastic fishing gear applications, etc., contributing~18%), marine vessels and marine-industries (e.g. aquaculture, oil-rigs, etc.)

Entry of MPs into environment

In general, the origins of microplastics in the global topsoil (0-30 cm) are in descending order: littering, sewage sludge, plastic covering, fertilizer (coating), irrigation, and dumping.

Source of micro plastic in soils

- **Sewage sludge** -A widespread practice which is an important source of primary microplastics contamination in soil as a fertiliser for agricultural land.
- **Controlled-release fertilisers (CRF)** - The N, P and K nutrient combinations are encapsulated within a nutrient pill, a coating made with a polymer. The coating allows the fertiliser to diffuse into the soil over a given time period. It represents an important source of microplastics contamination.
- **Plastic greenhouses** – Among the plastics used for agricultural purposes, plastics covering green- houses have been identified as a source of plastic litter on land.
- **Plastic mulching** – Plastic mulching is the use of plastic films on crops acting as insulation to protect seedlings and shoots. Plastic mulches are generally made of polyethylene (PE).

- **Plastics in compost** – Recent studies have shown that the use of bio- waste as a source of fertiliser represents a potential source of microplastics contamination in terrestrial environments. This is due to the fact most bio-waste from households and industry contains plastics.

Pathway of micro plastic

Microplastic in soil enter through multiple sources, including landfills soil land application of sewage sludge compost and organic fertilizer residues of agricultural mulching films tire wear and tear and atmospheric deposition. In ocean mainly land-based sources contributing ~80% of mps sources.Microplastics entered in soil will be of storage, translocation, erosion, degradation (Guo *et al.*, 2020).

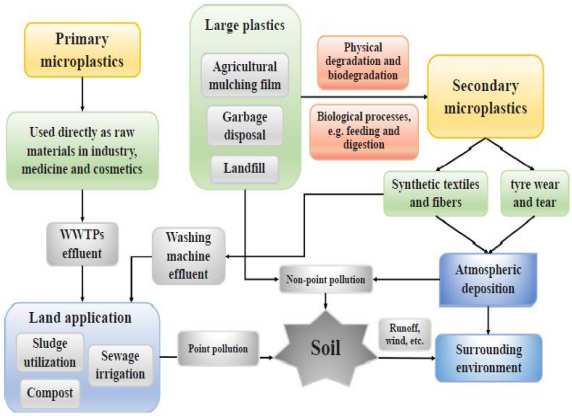

Figure 4: Microplastics sources in soil

Assessment of micro plastic

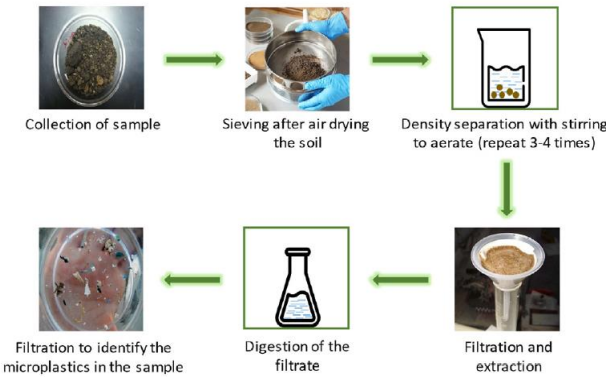

Figure 5: Assessment of micro plastic in soil sample

This is a figure 5 of mps assessment in soil samples First, collecting soil samples is the most important step for microplastics analysis. Second, soil samples should be dried, sieved (5 mm size sieve), floated, filtered, and separated by density depending on the proportion of clay and organic matter. Then density extraction is procedure in which salt solutions of known densities were utilized to float microplastic particles out from the soil matrix. Genarally Polyethylene (PE) and Polypropylene (PP) asses from soils by distilled water and polyamide

(PA), polycarbonate (PC), acrylonitrile butadiene styrene (ABS), polymethyl methacrylate (PMMA PS extracted from saturated NaCl solutions

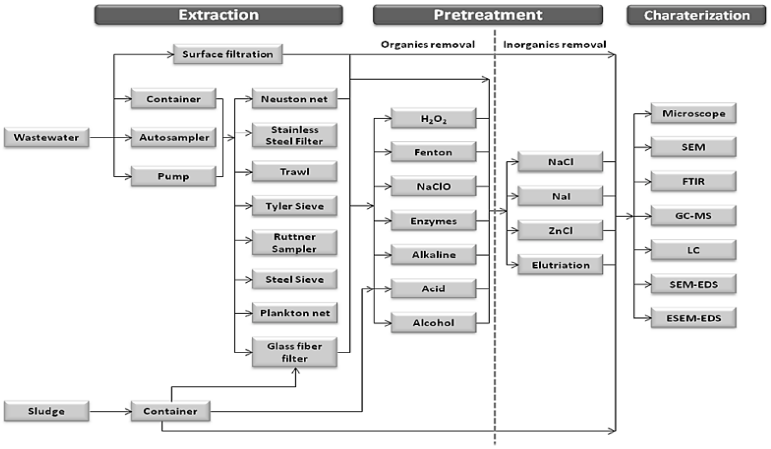

Figure 6: Flow chart summarizing steps and techniques used for microplastics detection in WWTPs

Scientist divided the analysis of microplastics into physical characterization and chemical characterization.The physical characterization mainly refers to characterization of the size distribution of microplastics as well as assessing other physical parameters such as shape and colour. and the other hand, chemical characterization was applied to explore the composition of microplastics, by destructive methods (like gas chromatography coupled to mass spectrometry (GC-MS), including pyrolysis-GC-MS and thermal extraction desorption-GC-MS, and liquid chromatography (LC)) and non-destructive techniques (like FTIR spectroscopy, Raman spectroscopy and Scanning Electron Microscopy (SEM) (Magalhaes *et al.*, 2020).

(a) Evaluation of microplastics (MPs) from soil by scanning electron microscope (SEM)-

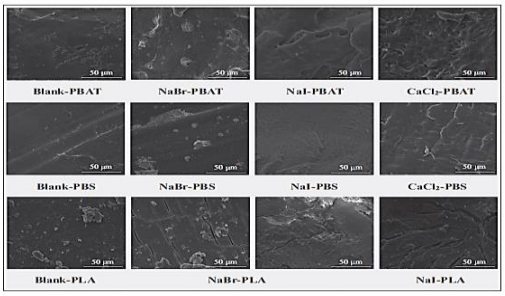

Figure 7: SEM micrographs of three biodegradable microplastics extracted with three different density solutions and blank control microplastics

Extraction of microplastics (MPs) from soil by scanning electron microscope (SEM) This images showing the effeicency of three biodegradable microplastics separated and extracted like sodium bromine sodium iodide and calcium chloride with three different density solutions and the blank control are shown in this figure. This indicates that compared with the Poly butylene terephthalate (PBAT) and Poly lactic acid (PLA) microplastics extracted with NaI

and CaCl2 density solutions, the surface morphology changes of Poly butylene terephthalate and Poly lactic acid extracted with NaBr density solutions are minimal (Li *et al*., 2021).

Table 1: Assessment of microplastics pollution by different extracting reagent

Sample	Extracting reagent	Filtering	Quantification	Result	Reference
Soil	Distilled water	Sieved at 2mm	Microscope	Recovery rates of approximately 90%	Zhang *et al*. (2018)
Soil	NaCl solutions	Sieved at 5mm	FTIR-spectroscopy	PP, PE, polyamide (PA), polycarbonate(PC), Acrylonitrile butadiene styrene(ABS), polymethyl Methacrylate (PMMA), and PS particles	He et al. (2018)
Soil	1,2,4-trichloroben zene (TCB)	-	Gas chromatography	(PE), (PP) and (PS)	Steinmetz *et al*. (2019)
Soil	Methanol, hexane, and dichloromet hane	Sieved at 5mm	Micro-FTIR-spectroscopy	Determining concentration and identity of microplastics	Fuller and Gautam (2016)
Soil	NaCl, CaCl2 solutions	0.45 mm filter	Raman spectroscopy	Recovery rates of approximately 90%	Scheurer and Bigalke (2018)

Different scientist collecting sample from a different location and analysis the different type of soil In industrial soil having a dominate with Polyvinyl chloride micro plastic and farmland soil dominated with polypropylene (50.51%) and polyethylene (43.43%), six percent Polyester.

Table 2: Microplastic abundance and composition in different soils

Soil type	Abundance	Size range	Shape	Composition	Study
1. Industrial soils	300-67,500 mg kg^{-1}	-	-	PVC(>80%), PE, PS	Fuller and Gautam (2016)
2.Floodplain soils	up to 55.5 mg kg−1 or 593 item kg^{-1}	88% in the size range of 125-500 μm	-	PE, PS, SBR, PVC	Scheurer and Bigalke (2018)
3. Farmland soils	78.00±12.91 62.50±12.97 item kg^{-1}	0.03-16 mm	Fiber, film, fragment	PE (50.51%), PP (43.43%), PES (6.06%)	Liu *et al*. (2018)
4. Tree-planted soils	7100-42,960 item kg^{-1}	10-0.05 mm	Predominant form fibers, followed by fragments and films	-	Yunnan *et al*. (2018)

Impact of microplastics pollution on soil ecosystem

Soil MPs impact on soil properties like surface adsorption, soil bulk density, soil enzyme activity and also accumulation and transport into plant and animal we further discuss in details.

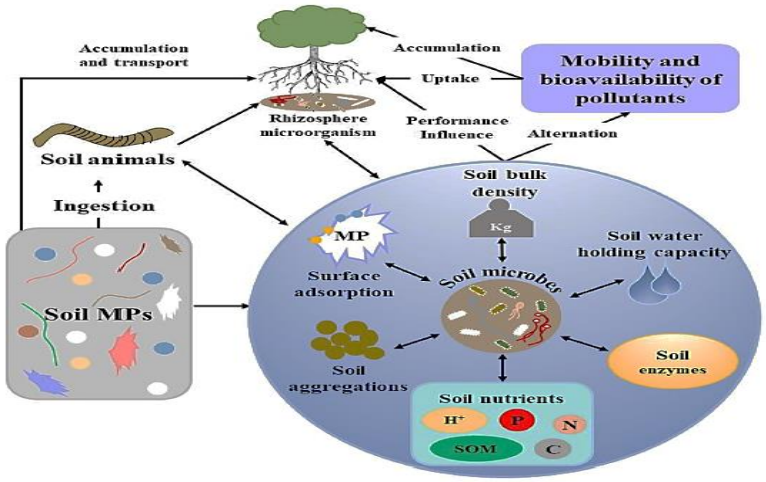

Figure 8: Impact of microplastics effects to plant growth and ion adsorption. MPs indicates microplastics

Figure 9 represent soil bulk density was decreased in both non plant and planting soil by addition of polyethylene high density (PEHD) , Polyester (PES) fibers, polyethylene terephthalate (PET), polypropylene (PP), and For polystyrene (PS) .Water stable aggregates microbial activity were found when soils treated with primary polyamide (PA) beads , Polyester (PES) fibers, polyethylene terephthalate -PET, and polypropylene (PP). Evapotranspiration was increased by ~35% by primary polyamide (PA) beads and ~50% by Polyester (PES) fibers , and

smaller increases were associated with polyethylene high density (PEHD) , polyethylene terephthalate (PET), polystyrene (PS) **De *et al*. (2019)**.

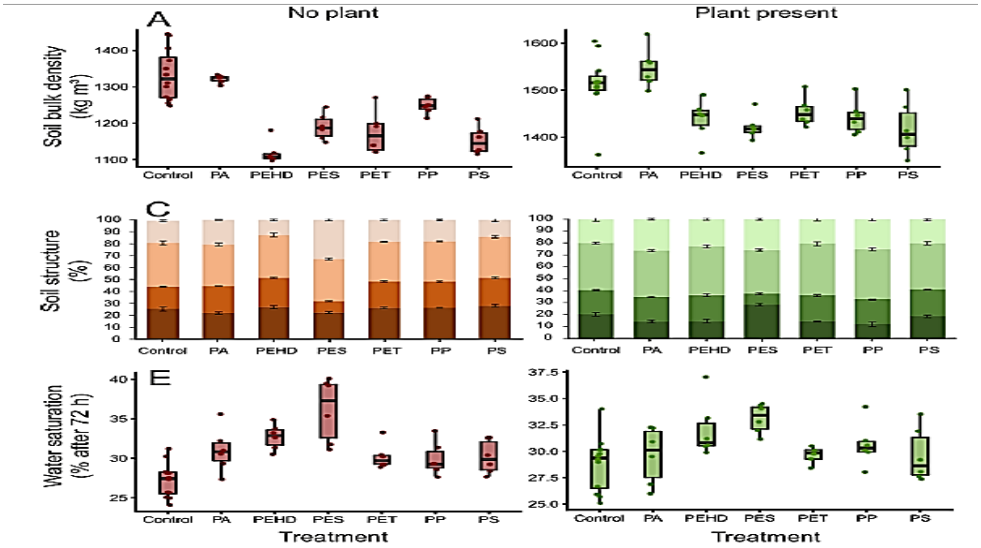

Figure 9: Microplastics impact on soil pH as a function of microplastic shape, polymer type, and exposure time. Polyamide (PA), Polycarbonate (PC), Polyethylene (PE), Polyester (PES), Polyethylene terephthalate (PET), Polypropylene (PP), Polystyrene (PS), and Polyurethane (PU). Fig.9 shows that the presence of microplastics significantly affected soil bulk density (A), water stable aggregates (B), and soil structure (C) in bulk soils (brown) and rhizosphere (green)

(a) Impact of microplastics on soil pH

Soil pH was affected by microplastic shapes, polymer types, and incubation time. Soil pH increased with foams and fragments and a slightly increase was observed with films. Regarding exposure time, overall, soil pH declined in the first 11 days and then increased. Soil pH over the time increased with polystyrene (PSfoams and PET (polyethylene terephthalate) fragments addition (Zhao *et al.*, 2021).

(b) Impact of microplastics on soil respiration

Soil respiration was slightly increased with foams. Soil respiration only increased with polyethylene foams that may increase soil aeration but overall, soil respiration declined over time, being more evident in soils with and without microplastics (Zhao *et al.*, 2021).

(c) Impact of low density polyethylene microplastic films on enzymatic activities in soil

Fei conduct a study and using TWO type LDPE micro plastic films like PE AND PVC and predict that three soil enzymes activities including urease, acid phosphatase and fluorescein diacetate hydrolase (FDAse) enzymatic in soil. Fig. 11 shows the changes of soil enzymatic activities over time during the incubation period the soil enzymatic changes with the addition of different types and concentrations of the MPs into the soil. The PVC and PE MPs increased significantly) urease and acid phosphatase activities in the soil, while they both decrease the

FDAse activity in the soil. In terms of MPs concentrations, increase of MPs concentration from 1% to 5% in the soil has no effects on the urease and acid phosphatase activities. Whereas the MPs concentration has a negative relationship with the soil FDAse activity. Using five treatment which is:

1) CK, 0% (w/w) of MPs were added to the soil;
2) PE1, LDPE was added into the soil with a content of 1% (w/w);
3) PE5, LDPE was added into the soil with a content of 5% (w/w);
4) PVC1, PVC was added into the soil with a content of 1% (w/w);
5) PVC5, PVC was added into the soil with a content of 5% (w/w).

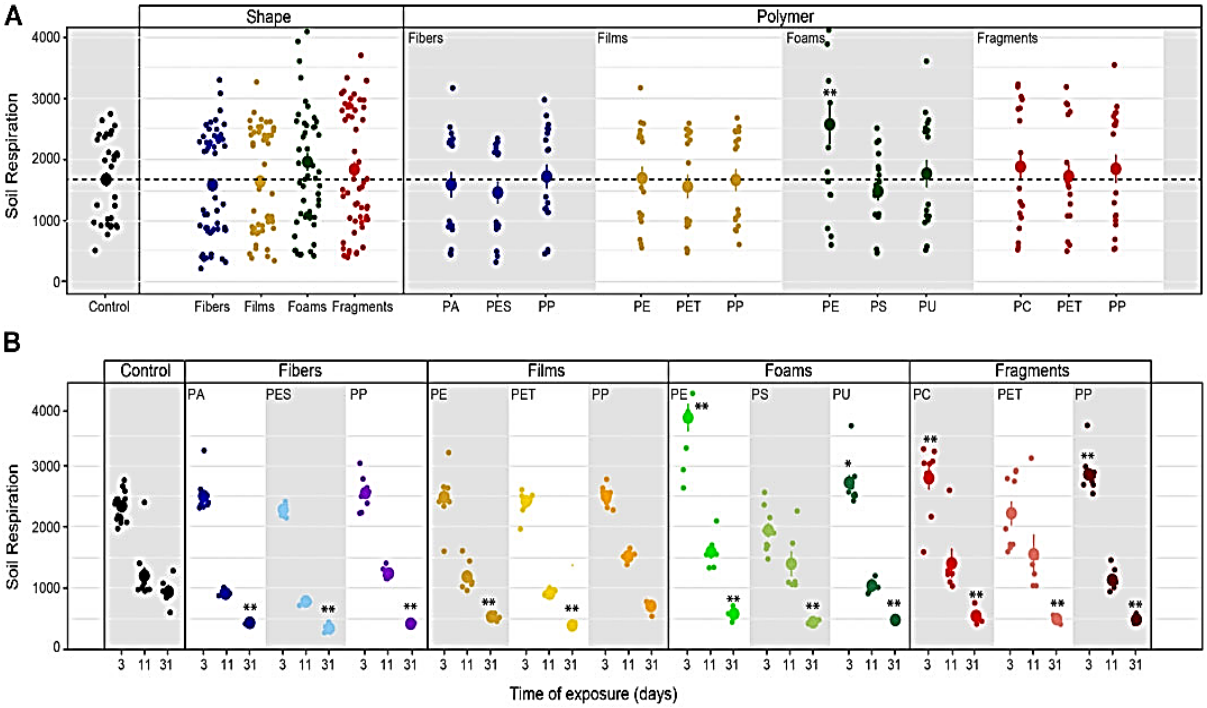

Figure 10: Microplastics increase soil microbial activities as a function of microplastic shape, polymer type, and exposure time. Polyamide (PA), Polycarbonate (PC), Polyethylene (PE), Polyester (PES), Polyethylene terephthalate (PET), Polypropylene (PP), Polystyrene (PS), and Polyurethane (PU)

The bacterial community richness and diversity were both declined owing to the addition of MPs, which is consistent to the decrease of FDAse activity in the soil. Urease and acid phosphatase activities are sensitive to soil moisture. Studies showed that a reduction of soil moisture by 21% led to the reduction of 10–67% and 31–40% in urease and acid phosphatase, respectively (Sardans and Peñuelas, 2005). We also observed higher volume of water loss in the soils absence of MPs than the soils presence of MPs at a same incubation period in the experiment. This indicated that acid phosphatase probably requires a considerable amount of nitrogen (Fei *et al.*, 2019).

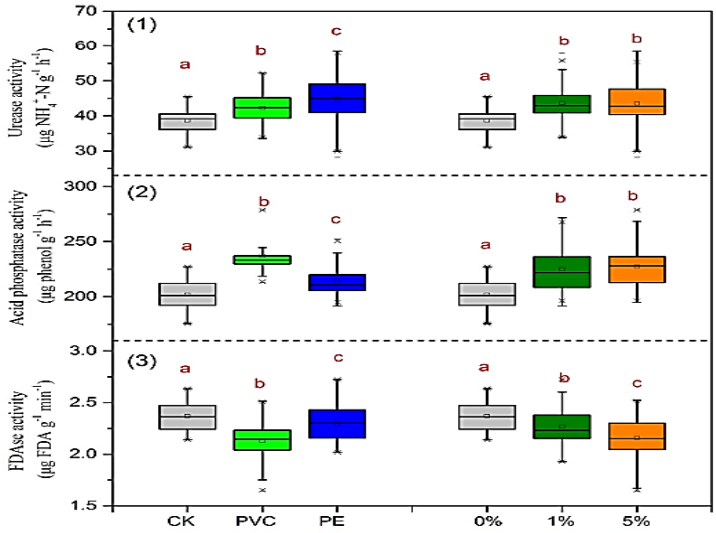

Figure 11: Box plot shows the comparison of soil enzyme activities based on the MP types and concentrations in the soil, (1) urease activity, (2) acid phosphatase activity, (3) FDAse activity

(d) Impact of MPs on relative abundance of bacterial OTU

Relative abundance of bacterial operational taxonomic unit (OTUs) counted in the different types and amount of MPs- huang and coworker conducted Soil incubation experiment:

1. CK, 0% (w/w) of MPs were added to the soil (Approximate 600 g soil);
2. PVC1, PVC was added into the soil with a content of 1% (w/w);
3. PVC5, PVC was added into the soil with a content of 5% (w/w).
4. PE1, LDPE was added into the soil with a content of 1% (w/w);
5. PE5, LDPE was added into the soil with a content of 5% (w/w);

In Fig.12 Column chart showing the relative abundance of bacterial Operational Taxonomic Unit (OTUs) counted in the different treatments. The top 21 orders were selected to displaying the taxonomic composition of the bacteria community which is change with changing the concentration of mps. There is no significant difference between the soil absent o fMPs (CK) and the soil addition of 1% PVC (PVC1) with respect to the bacterial community richness and diversity. The treatments of PE1, PE5 and PVC5 are all significant lower than that of the CK, and no significant difference is observed within the three treatments. That way is so that mps affect the relative abundance of bacertia. OTU's are used to categorize bacteria based on sequence similarity or closly realted individual (Huang *et al.*, 2019).

Boot depicted that germination rate and shoot growth of Lolium perenne (perennial ryegrass plant under differnet type of microplastic application. Like fibers (synthetic fibers), HDPE (1% w/w, PLA0. (1% w/w) , and control (control) and, The shoot growth of Lolium perenne after 30 days ranged between 140 and 172 mm, and was significantly different between

microplastic treatments with 19% shorter shoots when PLA was added compared to the control (Boots *et al.*, 2019).

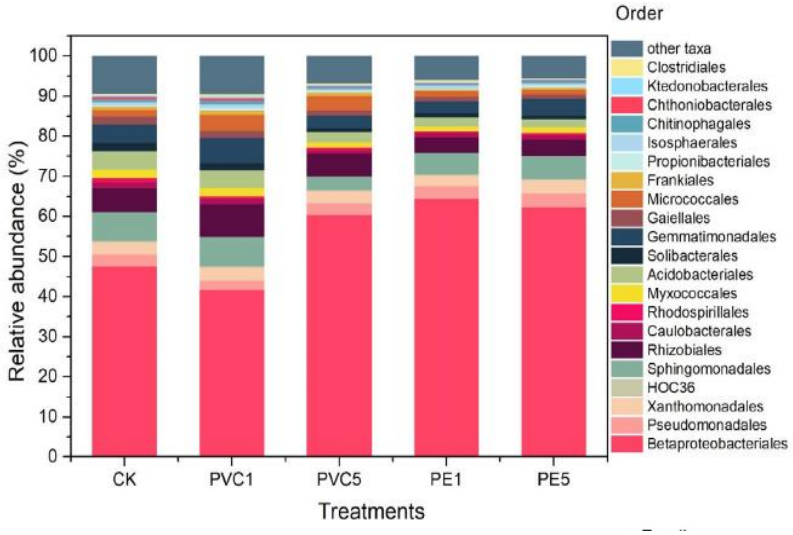

Figure 12: Column chart showing the relative abundance of bacterial OTUs counted in the different treatments. The top 21 orders were selected to displaying the taxonomic composition of the bacteria community

(e) Impact of microplastics on plant growth

Table 3: Germination rate (%) of *L. perenne*

Plastic	K (%)	M_0 (%)	R (day^{-1})
Control	81^{a}	1.75	4.44
Fibers	74^{b}	1.40	4.39
HDPE	$79^{a,b}$	1.77	4.59
PLA	75^{a}	1.56	4.50
ANOVA ($F_{3.16}$)	4.13	1.65	0.357
Plastic P<0.001	0.024	0.217	0.785

Table 4: Shoot growth (mm) of *L. perenne*

Plastic	K (mm)	M_0 (mm)	R (day^{-1})
Control	172^{a}	4.96	7.08
Fibers	$156^{a,b}$	4.27	6.79
HDPE	$158^{a,b}$	4.38	6.79
PLA	140^{b}	3.59	6.26
ANOVA ($F_{3.16}$)	4.50	2.53	2.10
Plastic P<0.001	0.018	0.094	0.140

(f) Impact of microplastic on chlorophyll-a and b content *l. perenne*

Table 5: Effect on chlorophyll-a and -b content and ratio between chlorophyll-a and -b in Lolium perenne shoots after 30 days of exposure to different types of microplastics

Plastic	Chl-a (mg g^{-1})	Chl-b (mg g^{-1})	Chl-a/Chl-b
Control	5.04	4.72	1.09^{a}
Fibers	5.93	4.44	1.34^{b}
HDPE	5.51	4.02	1.37^{b}
PLA	5.19	3.75	1.39^{b}
ANOVA ($F_{3.16}$)	1.86	2.25	11.67
Plastic P<0.001	0.177	0.122	-

Table 5 mention Effect on chlorophyll-a and -b content and ratio between chlorophyll-a and -b in Lolium perenne shoots after 30 days of exposure to different types of microplastics The mean diameter of the microplastic chlorophyll-A and b content (on average 4.23 ± 0.16 mg g−1 dry biomass) did not significantly differ between the treatments. However, the chlorophyll-a/chlorophyll-b (chla-a/chl-b) ratio, which ranged between 1.09 ± 0.08 and 1.39 ± 0.01, was significantly (F3, 16 = 11.67, P < 0.001) different between all microplastic treatments compared to the control (Boots *et al.*, 2019).

Microplastics pollution in soil; control measure and remediation

Now how can MPs pollution control in soil so with help of 3 method Legislative polices, Waste collection system, Recent technique like Pyrolysis Bacteria consortium Collembolan species use of Earthworm and Incorporation of microplastics can be helping to control measure and remediation of MPs.

1. Legislative polices
2. Recent technique
    - Pyrolysis
    - Bacteria consortium
    - Collembolan species
    - Earthworms
    - Incorporation of microplastics
3. Waste collection system

Reducing microplastics content in sewage sludge through pyrolysis

Ni and coworker reveled study on Microplastics mitigation in sewage sludge through pyrolysis: for this experiment they treated sewage and sludge 150,250,350,450,500 degree centigrade temperature and found that represent different temperature of pyrolysis and different type of micro plastic which is volatile or deformed there structure when increasing in temperature of pyrolysis. And second figure showing different type of dried sludge powder at

different type of pyrolysis Therefore it is one of the best method of remediation. For each sample, 0.2 g of polymer spheres (with a minimum diameter of 300 µm) was spiked into 2 g of dried sludge powder then pyrolysis in this graph 2. PE: polyethylene (Ni *et al.*, 2020).

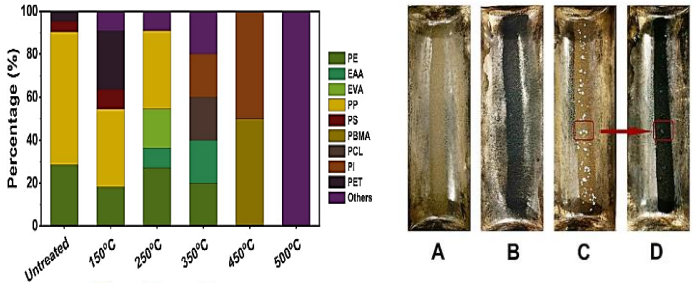

Figure 13: Characterization of microplastics in untreated Sludge samples pyrolyzed at different temperatures A: Dried sludge powder (size < 100 µm). B: Dried sludge powder (size <100 µm) after pyrolysis at 450^0 C for 30 min. C: Dried sludge powder (size < 100 µm) with spiked PE particles (size > 300 µm). D: Dried sludge powder (size < 100 µm) with spiked PE particles (size > 300 µm) after pyrolysis at 450^0 C for 30 min. Arrow: Spiked PE particles combined with sludge after pyrolysis

Transport of microplastics by two collembolan species

Transport of micro plastics by two collembolan species they used the two collembolan species. In this incubation study for seven days, four concentric circles of 1, 2, 3 and 4 cm diameter were placed around the feeding station and the amount of particles was counted in each ring (Fig. 1) in which showing inatial movement of microplastic and after 5 day movement of micropalstic . And analyzed the data with statiscal method(R version 3.3.1) The biggest differences can be seen between the species in regard to the distribution into ring 1, i.e. 1 cm diameter around the feeding station, with Folsomia candida distributing far more particles than the smaller species Proisotoma minuta (Fig. 2) A smaller but still significant difference can be observed at the 2 cm distance (Maaß *et al*., 2017).

Figure 14: Number of particles moved horizontally over the four defined rings (with ring 1 cm, ring 2 cm, ring 3 cm and ring 4 cm diameter) around feeding station by different collembolan species

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SILVER NANOPARTICLES: MICROWAVE ASSISTED SYNTHESIS, ENVIRONMENTAL APPLICATION FOR PHOTOCATALYTIC DEGRADATION OF TOXIC DYE-METHYLENE BLUE

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Introduction:

Water pollution by the presence of organic contaminants pores the major threat to human health. An organic dye belongs to an important class of materials widely used in textile and many other industries. The hazardous effects of organic dyes in waste water have been of great concern throughout the world. About 10000 different dyes are annually used in various industrial processes (Nethaji *et al.,* 2010). Extensive use of dyes in various industries and increase in environmental pollution due to discharge of industrial effluents containing toxic organic pollutants like dyes into the open landscapes and water bodies are one of the most serious issues of the country.

Fifteen percent of the total world production of dyes is lost during the dying process and released in textile effluents (Zollinger, 1987). A large amount of dyes are discharged to the wastewater effluent annually which severely pollute the water body and damage the aquatic life by increasing the COD, BOD and suspended solid of the water body. Color interferences with penetration of sun light into water, retards photosynthesis, inhibits the growth of aquatic biota and interferences with the gas solubility of water bodies (Shahryari *et al.,* 2010; Namaivayam *et al.,* 2001; Sharma and Upadhyay, 2009). The small amount of dye present in effluent is highly visible and undesirable (Robinson *et al.,* 2001). Because of the distinct nature, colour of water can be recognized at minute level of 1.0 mg L^{-1}. Dyes are also reported to possess a tendency to chelate metal ions resulting in micro-toxicity to aquatic fauna and flora (Hameed 2009; Ho and Mckay, 2003). The presence of dyes in industrial effluents is extremely undesirable as they are toxic, mutagenic and carcinogenic characteristics to both lower and higher concentrations and hence creates health hazard to human being and damage the aquatic life (Preethi *et al.,* 2006; Mittal *et al.,* 2005; Mittal, 2006). Even a trace amount of dye present in the aquatic system may cause several health problems to mankind as well as to animals. Under certain environmental conditions dyes may accumulate to toxic levels and cause ecological damage. In the past few decades concentrations of dyes increased in environment i.e. water and at many places it reached

upto toxic levels. When the concentrations of dyes are high in the environment, it is evident that inhabitant of that environment also accumulates dyes and it is well known that dyes have deterious effect. Some dyes at higher doses they may cause metabolic disorders and growth inhibition for most of the plant species and also creates health problems.

Continuous monitoring & controlling of pollution, identification of pollutants, development & utility of novel methods for removal of organic pollutants such as dyes is highly necessary. Strict environmental protection legislation and public environmental concerns lead the search for novel techniques to remove of toxic dyes from industrial waste water.

Different physical and chemical methods such as adsorption, oxidation, coagulation, membrane filtration been tried out for the removal of dyes from the effluents. Photo catalytic degradation is established as the most suitable and promising methods because of its cost effectiveness, operational simplicity, low cost and low energy requirement.

The pollutant of concern includes cationic dye affect the biosphere in many places worldwide. The cationic dye, methylene blue (Fig. 1) which has applications in a large number of industries to colour cottons, wools, sink, leather, paper etc. and which is toxic with many after effects on human beings. An exposure to methylene blue can cause breathing problem and produces a burning sensation during ingestion and many cause nausea, sweating, cyanosis, jaundice, shock and methemoglobinemia (Tan and Hameed, 2008). Studies also confirm that the products formed after the degradation is also not safe and have carcinogenic potential. Dyes are resilient to fading on exposure to light and water and it therefore difficult to be removed from waste water. Thus it becomes necessary to remove such a toxic dyes from waste water before it is released into aquatic environment.

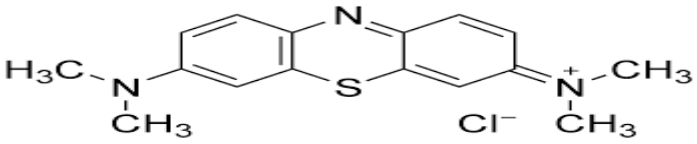


Figure 1: The cationic dye,methylene blue

Conventional treatment methods such as adsorption are often inadequate and inappropriate for removing large amounts of organic pollutants like dyes from waste water streams. It is also noteworthy that adsorption is a non-destructive method, which simply transfers pollutants from one phase or substance to another (Guo, *et al.*, 2003, Pal and Deb, 2012(a), Pal and Deb, 2012(b), Pal and Deb, 2012(c), Pal *et al.*, 2013)

An alternative for the removal of dye is photo catalytic degradation. This kind of process enables the complete destruction of the pollutant and has been studied thoroughly during the past many years (Prabha and Lathasree, 2017, Sivakumar *et al.*, 2015, Gharibe *et al.*, 2015, Satheeskumar *et al.*, 2015, Mesgari *et al.*, 2013, Topare *et al.*, 2013, Meena *et al.*, 2013). In contrast, the treatment method of photo-catalytic degradation has the capability of converting

toxic molecules into non-toxic compounds. In last decade photo catalytic degradation using metal nanoparticles has been shown to be effective for destruction of pollutants. The increasingly demanding request for new catalysts in terms of recovery, regeneration and reuse has attracted the attention of a significant part of the scientific community (Nath *et al.,* 2007). In this context, nanosized catalysts have recently become a hot topic of interest because of their high surface area that results in outstanding activity (Hussein *et al.,* 2010). As particle size decreases by reaching nanodimention, gradual transformation, from the bulk in the solid-state to the molecular level occurs.

A homogeneous catalysis where the catalyst is in the same phase as the reactants is generally accepted by chemists. One of their attractive properties is that all catalytic sites are accessible because the catalyst is generally a soluble metal. Homogeneous catalysts have a number of other advantages such as high selectivity, better yield and easy optimization of catalytic systems by ligands and metals. They are widely used in a number of commercial applications, but the difficulty of catalyst separation from the final product creates economic and environmental barriers to broadening their scope. Despite their advantages and their wide use in a number of applications, many homogeneous catalytic systems have not been commercialized because of the difficulty encountered in separating the catalyst from the final reaction products. Removal of trace amounts of catalyst from the end product is essential since metal contamination is highly regulated. Even with the extensive and careful use of various techniques such as distillation, chromatography or extraction removal of trace amounts of catalyst remains a challenge.

By tailoring the size and shape of metal nanoparticles, one can alter and enhance their intrinsic properties for diverse applications. Several nanoparticles have been used for photocatalytic degradation of organic pollutants in waste water (He *et al.,* 2003). The metal nanoparticles are known to exhibit good catalytic activity and selectivity towards degradation of dyes (Angus Shiue *et al.,* 2012). The preparation of metal nanoparticles is usually based on the reduction of a metal salt in the presence of a reducing agent and a stabilizer (Toshima *et al.,* 1992). Many types of nanoparticles such as metal nanoparticles have been prepared in solution and on solid supports to catalyse a multitude of reactions, including reduction, oxidation, cross coupling and hydrogenation with application ranging from organic synthesis to pollutant removal and energy production. Metal nanoparticles properties have been utilized in electronic, optical and catalysis applications.

Among the Nobel metals, silver nanoparticles are the most widely used metal nanoparticles because of their potential applications in different applications. Different methods have been employed to prepare silver nanoparticles with variation of morphologies (Rajkumar and Tamizharas, 2012). Method adopted includes single source precursor heat treatment at 550

^{0}C, solvothermal synthesis, photochemical, sonochemical, ultrasonic synthesis etc. However, the exciting methods have long procedures and processing times. It is therefore considered necessary to develop facile, energy-efficient and safe method for synthesis of silver nanoparticles.

Recently silver nanoparticles widely used for photo catalytic degradation of dyes (Sylvia Devi *et al.,* 2017, Meena *et al.,* 2015, Pal *et al.,* 2013).

The aims of the work were (i) To synthesize the silver nanoparticles (Ag (NPs)) by microwave assisted method. (ii) To study the environmental application for photocatalytic degradation of methylene blue dye using silver nanoparticles (Ag (NPs)) in aqueous solution.

Materials and Methods:

All the chemicals and reagents used were of analytical reagent (AR) grade. Double distilled water was used for all experimental work including the preparation of dye solutions.

1. Preparation of methylene blue dye solution

The dye, methylene blue (Chemical formula; $C_{16}H_{18}N_3SCl{\cdot}3H_2O$, IUPAC name: 3,7-bis (dimethylamino)-phenothiazin-5-ium chloride, a cationic dye, MW: 319.86, λ_{max}: 665 nm, Colour Index 52,015, Appearance: Dark green powder, solubility in water: 40 g/L at 20^{0}C) was purchased and used as adsorbate without further purification. The stock solution of 1000 ppm of methylene blue was prepared by dissolving 0.5 g dye in 500 cm^3 of double distilled water. Further desired test solutions of dye were prepared using appropriate subsequent dilutions of the stock solution. The desired pH of the dye solutions were adjusted with the help of dilute hydrochloric acid and dilute sodium hydroxide using digital pH meter (EQUIP-TRONICS, model no. Eq-800) using a combined glass electrode.

2. Preparation of silver nanoparticles (Ag NPs)

10 ml of the $AgNO_3$ solution (0.005 M) mixed with 2ml aqueous solution of glucose (0.5M) and 0.2 ml of PVA 1% (w/v), were added in a 100 ml beaker to obtain a homogeneous reaction mixture. Then the beakers were placed on the turntable of the microwave oven. The mixtures were irradiated at a power of 450 watt for a total of 3 min duration. However, the above irradiation process was carried out discontinuously in 30 s installments in order to prevent an increase of pressure. After complete irradiation, appearance of pale yellow color indicates the formation of silver nano particles (Ag NPs). The above prepared silver nano particles (Ag NPs) was cooled to room temperature and used for photo catalytic degradation study of methylene blue dye.

3. Experimental procedure

The method was employed at temperature (30^{0}C) to examine the photo catalytic degradation of dye, methylene blue using silver nanoparticles (Ag NPs) under UV light. The method was used to determine the degradation capacity, stability of photocatalyst and optimum degradation conditions. The parameters were studied by combining aqueous solution silver nano

particles (Ag NPs) with methylene blue dye solution in 250 ml separate beakers. The beakers were placed in a closed wooden box. Ultraviolet light from 15 W Hg Philip UV lamp (Philips India) irradiated on sample. The 5 cm^3 samples were removed at predefined time intervals, centrifuged and amount of dye in the supernatant solutions was determined by measuring absorbance using digital UV-visible spectrophotometer (EQUIP-TRONICS, model no. Eq-820). The following equation was used to compute the percent efficiency of the photo degradation (% Degradation) of dye,

$$\% \text{ Degradation } = \frac{(C_0 - C)}{C_0} \times 100 \qquad \text{----- (i)}$$

Where C_0 and C are the initial concentration and final concentration of the dye at time t in mg/L.

4. Photo degradation kinetics:

A solution containing dye, methylene blue prepared and the photocatalytic degradation studies were done with varying contact time from 0 minute to 180 minute to check the applicability of the kinetic model.

As aforementioned, a lumped analysis of photocatalytic degradation rate is sufficient to practical operation from a system design point of view. The commonly employed lumped kinetic equation, langmuri-Hineshlwood (L-H) equation is presented below,

$$\ln(\frac{C_0}{C}) = Kt \qquad \text{------ (ii)}$$

Where K is the apparent pseudo-first order reaction rate constant (min^{-1}) and t is the reaction time (min).

Results and Discussion:

1. Mechanism of photo catalytic degradation

The photo catalytic degradation was observed against methylene blue dye in the presence of UV light. The UV light absorbed by Ag NPs promoted the electrons from valence band (VB) to conduction band (CB). Electrons and holes are continuously generated when the UV light illuminate on the surface of GQDs.

$$\text{Ag NPs} + h\nu \rightarrow \text{Ag NPs} + h^+_{VB} + e^-_{CB}$$

The photo generated holes reacted with water and formed hydroxyl radical. The hydroxyl radicals were the most potent oxidizing agents. The degradation rate confirmed the potency of the hydroxyl radical. The photo generated electrons reacted with molecular oxygen presence in medium and produced peroxide radical anions (O_2^-). The peroxide radical anion (O_2^-) takes one proton to yield a superoxide (HO_2) followed by the formation of hydrogen peroxide (H_2O_2). Hydrogen peroxide again can be split to give hydroxide radical ($^\bullet OH$) and hydroxyl ion (OH^-). Theses reactive radicals are responsible for the degradation of methylene blue dye in aqueous solution.

$$h^+_{VB} + H_2O \rightarrow {}^\bullet OH + H^+$$

$$e^-_{CB} + O_2 \rightarrow O_2^-$$

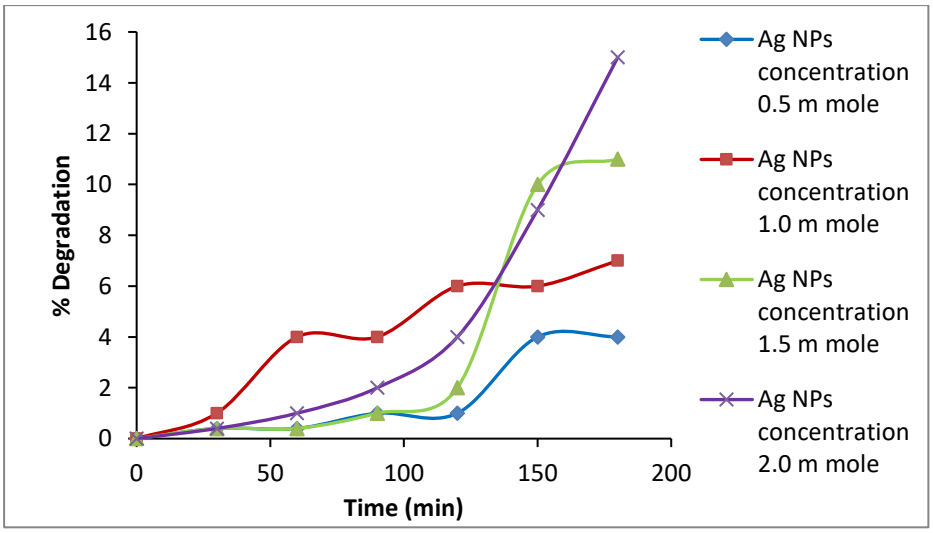
$O_2^- + H^+ \rightarrow HO_2$

$2HO_2 \rightarrow H_2O_2 + O_2$

$H_2O_2 + e^-_{CB} \rightarrow {}^{\bullet}OH + OH^-$

2. Effect of pH:

Wastewater containing dyes is discharged at different pH; therefore it is important to study the role of pH on photo catalytic degradation of dye. In order to study the effect of pH on the degradation efficiency, experiments were carried out at various pH values, ranging from 2 to 5 for constant dye concentration (5 mg/L). Fig. 2 (a) to (d) shows the degradation efficiency of methylene blue dye as a function of pH. It has been observed that the degradation efficiency increases with increase of pH and then decreases with increase in pH, exhibiting maximum rate of degradation (39 %) after 180 min irradiation of UV light, at pH 3 in case of catalyst loading (Ag NPs concentration 2.0 m mole), methylene blue dye concentration 5 mg/L and Temperature 27^0C.



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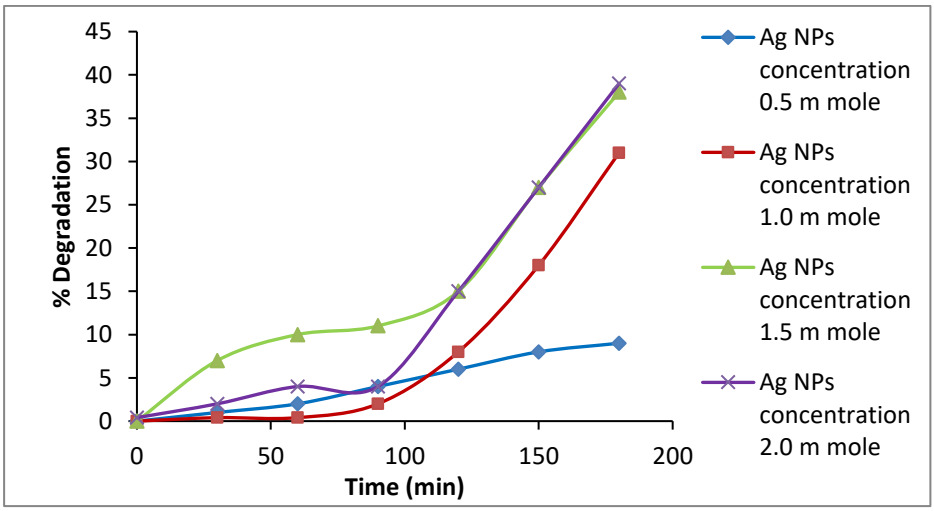

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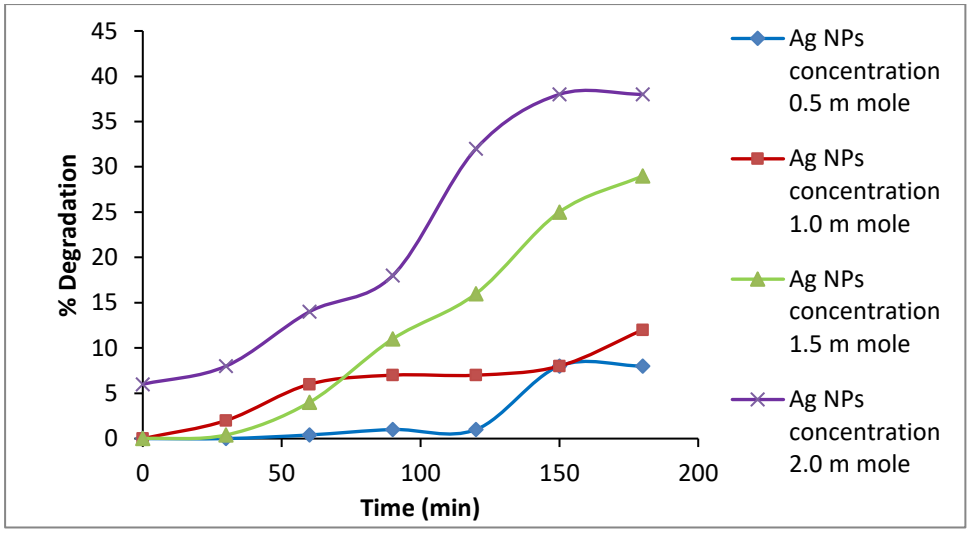

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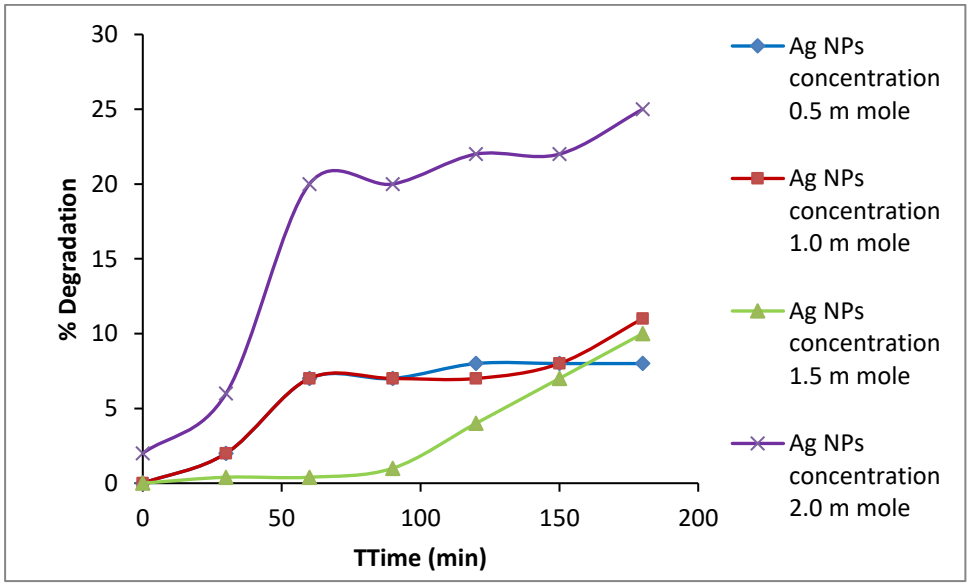


(d)

Figure 2: Effect of pH on photocatalytic degradation of methylene blue dye in aqueous solution (a) pH 2 (b) pH 3 (c) pH 4 and (d) pH 5 (catalyst loading (Ag NPs concentration from 0.5 m mole to 2.0 m mole); methylene blue dye concentration: 5 mg/L, Temperature: 27^0C, UV light irradiation time from 0 min to 180 min.

3. Effect of methylene blue dye concentration:

After optimizing pH, the photocatalytic degradation of methylene blue dye was carried out by varying the initial methylene blue dye concentration from 5 mg/L to 25 mg/L. It was observed that, as the concentration of methylene blue dye increases, the rate of degradation efficiency decreases. The possible explanation for this behavior is that as the initial concentration of the methylene blue dye increases, the path length of the photons entering the solution decreases and in low concentration the reverse effect is observed, thereby increasing the number

of photon absorption by the catalyst in lower concentration. Therefore the methylene blue dye concentration 5 mg/L was fixed for further studies.

4. Effect of amount of catalyst loading (silver nanoparticles) (Ag NPs)):

In order to study the effect of amount of catalyst loading (Ag NPs) on the degradation efficiency, experiments were carried out at various catalysts loading concentration, ranging from 0.5 m mole to 2.0.0 m mole for constant dye concentration (5 mg/L). Fig. 3 shows the degradation efficiency of methylene blue dye as a function of catalyst loading concentration. It has been observed that the catalyst loading is found to be dependent on initial solute concentration because with the increase in catalyst loading, total active surface area increases, hence availability of more active sites on the catalyst surface. At the same time, at high concentration of catalysts, increase in turbidity of the suspension occurs; there will be decrease in penetration of UV light and hence photo-activated volume of suspension decreases. Thus it can be concluded that higher catalyst loading may not be useful both in view of aggregation as well as reduced irradiation filed due to light scattering. The degradation efficiency increases with increase in catalyst loading concentration, exhibiting maximum rate of degradation (39 %) in case of catalyst loading (Ag NPs concentration 2.0 m mole) after 180 min irradiation of UV light, at pH 3, with methylene blue dye concentration 5 mg/L and Temperature 27^0C.

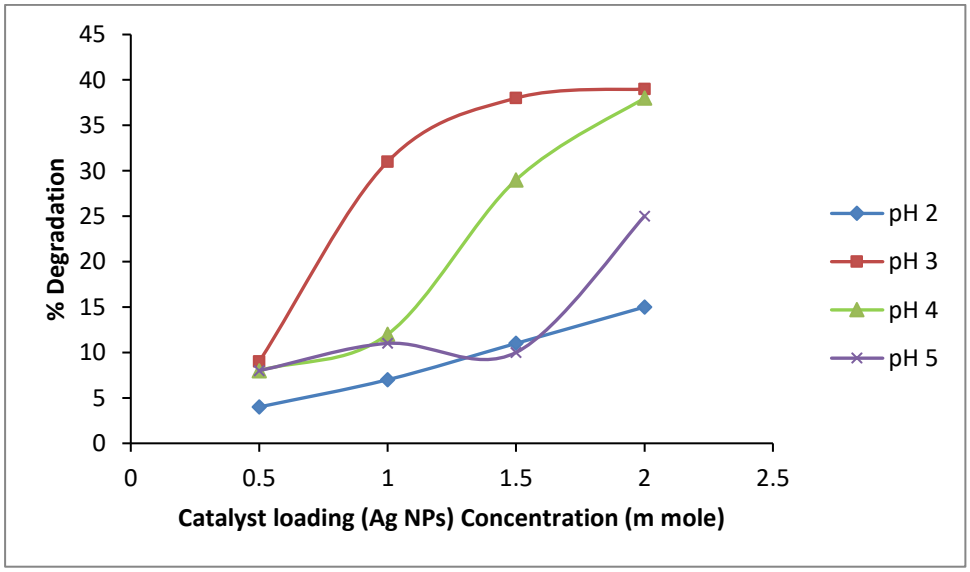
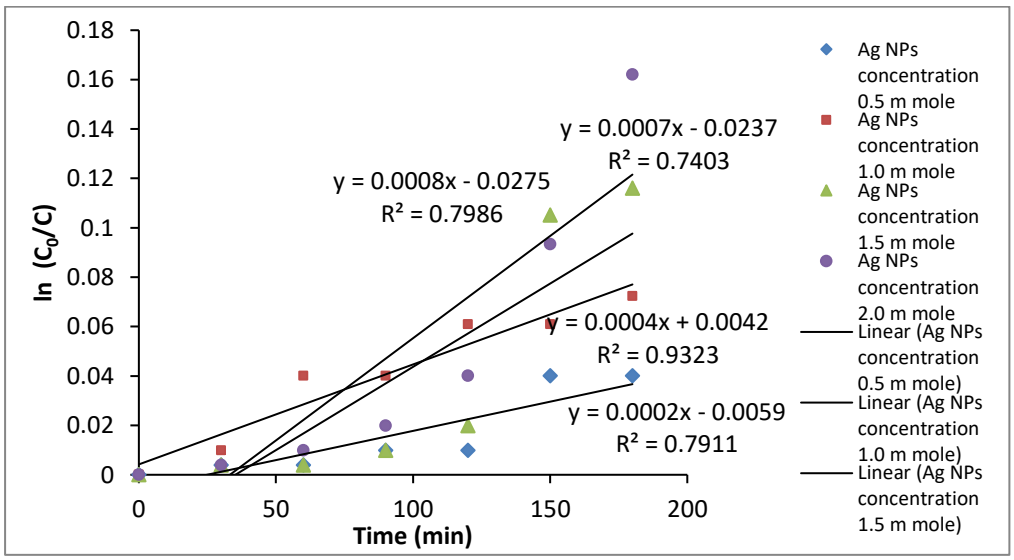


Figure 3: Effect of catalyst loading (Ag NPs) concentration on photocatalytic degradation of methylene blue dye in aqueous solution (pH: 2 to 5, methylene blue dye concentration: 5 mg/L, Temperature: 27^0C, UV light irradiation time: 180 min.)

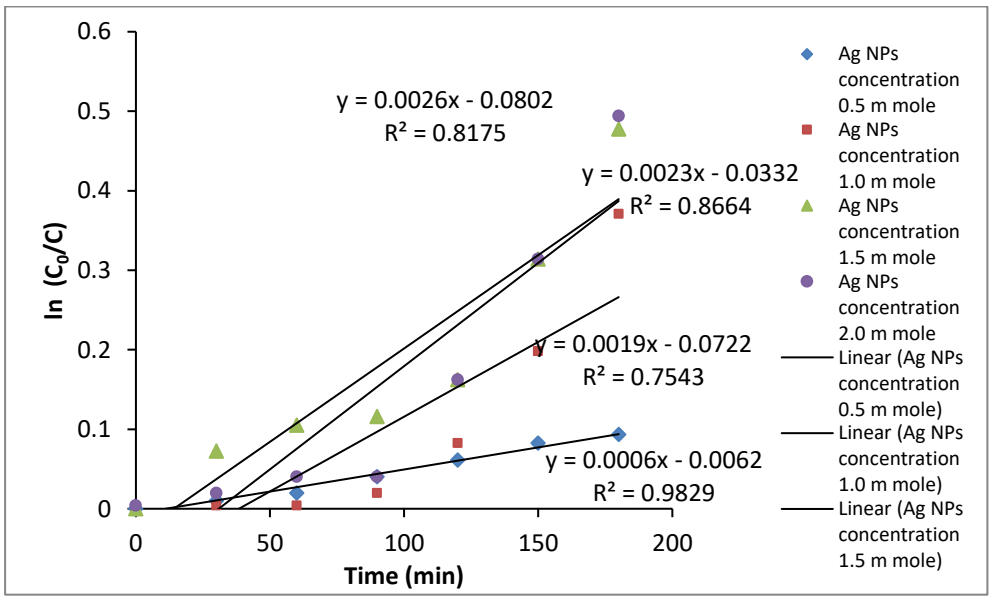
5. Kinetic study:

Photo catalytic degradation of methylene blue dye in aqueous solution at varying pH 2 to 5, catalyst loading (Ag NPs) concentration: 0.5 m mole to 2.0 m mole with fixed methylene blue dye concentration: 5 mg/L and Temperature: 27^0C studied under UV light irradiation time from 0 min to 180 min. The plot, ln (C_0/C) against irradiation time (t) is a linear straight light (Fig. 4).

This indicates that the photo catalytic degradation of methylene blue dye follows pseudo-first order kinetics according to langumiur-Hinshelwood model. The rate constant (*K*) for the reaction was determined using slope of the plot. Table 2 shows the values of rate constant (*K*) and regression coefficient (R^2). The regression coefficient values are approaches to 1.000 in case of catalyst loading (Ag NPs) concentration 0.5 m mole, 1.0 m mole, 1.5 m mole and 2.0 m mole at all pH values. It is observed that rate constant (*K*) values increases as the catalyst loading (Ag NPs) concentration increases at all pH values. At pH 3 highest rate constant (*K*) value was observed.



(a)



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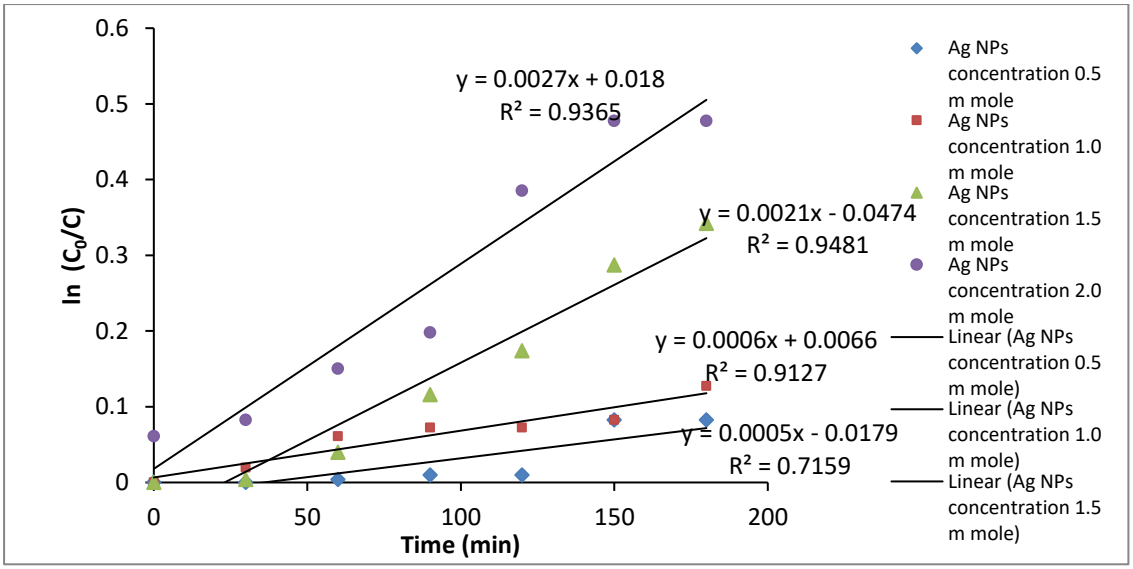

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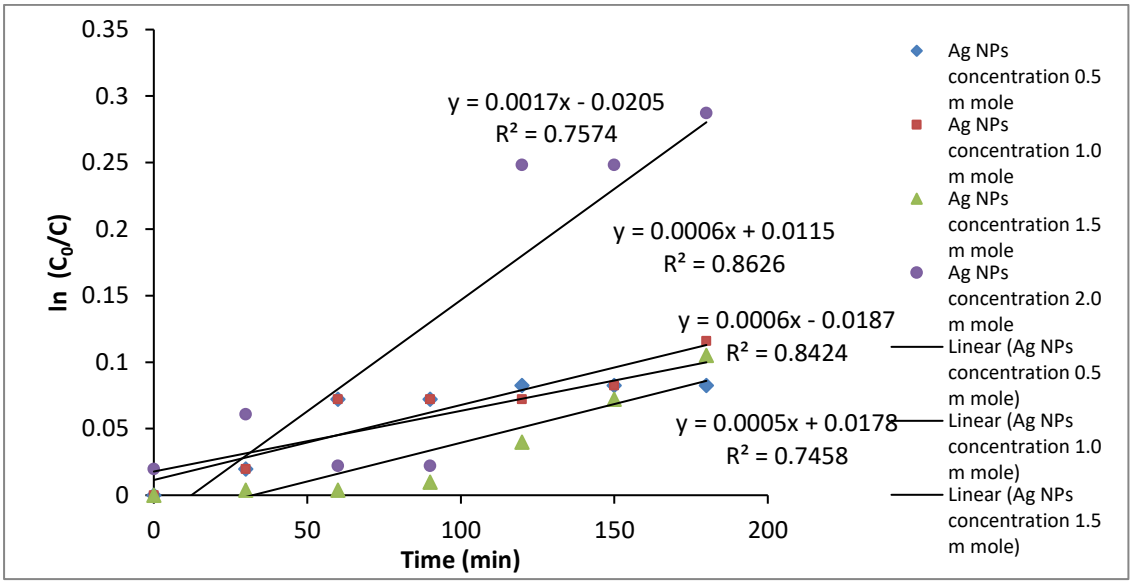

(d)

Figure 4: Pseudo-first order kinetics for photocatalytic degradation of methylene blue dye in aqueous solution (a) pH 2 (b) pH 3 (c) pH 4 and (d) pH 5, (catalyst loading (Ag NPs) concentration: 0.5 m mole to 2.0 m mole, methylene blue dye concentration: 5 mg/L, Temperature: 27^{0}C, UV light irradiation time: 0 min to 180 min.)

Table 1: Kinetic data for photo catalytic degradation of methylene blue dye in aqueous solution

Concentration of Ag NPs	*pH 2*		*pH 3*		*pH 4*		*pH 5*	
	K (min^{-1})	***R^2***	***K (min^{-1})***	***R^2***	***K(min^{-1})***	***R^2***	***K(min^{-1})***	***R^2***
0.5 m mole	0.2 ×10^{-3}	0.7911	0.6 ×10^{-3}	0.9829	0.5 ×10^{-3}	0.7159	0.5 ×10^{-3}	0.7458
1.0 m mole	0.4 ×10^{-3}	0.9323	1.9 ×10^{-3}	0.7543	0.6×10^{-3}	0.9127	0.6 ×10^{-3}	0.8424
1.5 m mole	0.7 ×10^{-3}	0.7403	2.3 ×10^{-3}	0.8664	2.1 ×10^{-3}	0.9481	0.6 ×10^{-3}	0.8626
2.0 m mole	0.8 ×10^{-3}	0.7986	2.6 ×10^{-3}	0.8175	2.7 ×10^{-3}	0.9365	1.7×10^{-3}	0.7574

Conclusions and future prospect:

In the present study, it has been demonstrated that silver nanoparticles (Ag NPs) is a very low cost, photo catalyst, easily prepared from silver salt in a microwave assisted procedure, can be successfully employed for the degradation of dye, methylene blue from aqueous solution. Process variables, such as pH, initial methylene blue dye concentration and catalyst loading (Ag NPs) concentration significantly affect the photo-activated process. These processes were efficient in the degradation of methylene blue dye. Experimental results indicate that the degradation of dyes facilitated in the presence of catalyst. The initial rate of degradation increased with increase in catalyst loading (Ag NPs) concentration. As the initial dye concentration was increased, the rate of degradation decreased. About 39 % of methylene blue dye was degraded in the presence of catalyst loading (Ag NPs) concentration 2.0 m mole after 180 min of UV light irradiation in optimized experimental conditions.

Kinetic results clearly indicated that the pseudo-first-order kinetics, according to langumiur-Hinshelwood model was found to be correlating the experimental data strongest. Ag NPs can be easily synthesized in laboratory by microwave method, it can be considered as an attractive alternative photo catalyst for degradation of methylene blue dye. This technology is having various advantages over to the more expensive technologies used in treatment of waste-water containing dyes.

The present study can be very useful for practical application for treatment of industrial waste-water containing dyes. The Ag NPs is a very efficient photo catalyst which can be useful for removal of dyes from industrial waste-water.

Acknowledgement:

Author is thankful to Prof. (Dr.) S. V. Rathod, Principal and Dr. (Kum.) Urmila B. Maru, Head, Department of Chemistry, Bhavan's H. Somani College for support. Thanks to Mr. Akshay Bharsing, M.Sc. student for cooperation and help.

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GREEN SYNTHESIS OF GRAPHENE QUANTUM DOTS AND THEIR APPLICATION FOR PHOTODEGRADATION OF METHYLENE BLUE DYE

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Introduction:

Water pollution creates significant environmental problems around the globe. Over the last decade environmental pollution remediation became a national and global priority. As a response, the development of newer eco-friendly methods of destroying these pollutants became an imperative task. Recent reports reveal that large amounts of wastewaters containing colored dye released into environment mainly by dyestuff and textile industry which lead to severe surface water and groundwater contamination. Several color causing substances are micro toxic to aquatic biota and adverse effect on the environment and are the dramatic sources of aesthetic pollution, eutrophication and disturbance in aquatic life due to their toxicity and persistence. As international environmental standards are becoming more stringent, technological systems for the removal of such dyes have been developed.

The textile effluents discharge causes serious stress on natural water bodies and land in the surrounding areas. High value of COD and BOD, presence of particulate matter and sediments which are dark in color leading to turbidity that causes depletion of dissolved oxygen, which had direct effect on the marine ecological system and indirect on human metabolic system. Textile industries produce large volume of colored dye effluents which are toxic and non-biodegradable. The contamination of water bodies by organic molecules is an increasing problem mainly because many of these molecules are not readily degraded by conventional methods for the treatment of effluents. This problem has increased with the development of the textile industry because many of the pollutants are dyes used by them. Besides causing visual pollution, this kind of pollutant has high levels of toxicity, non-biodegradability and resistance to destruction.

Various pollutants may be found in water, soil and air which exert deleterious effects on human health, plants and animals and thus affect the natural environment. Water contamination caused by various chemical substances produced in different plants and penetrated into the surface water, ground water or even the air, is a major threat to the environment and water contamination is one of the important challenges of the human life. Therefore, a wide range of activities are taking place to treat industrial effluents and remove their pollutants before entering to the environment (Fox and Dulay 1993, Shu *et al.*, 2010, Pradhan and Parida 2010, Mohabansi *et al.*, 2011). Large amounts of dyes are annually produced and applied in different industries

including textile, paper, cosmetic, leather, pharmaceutical and nutrition industries (Devi *et al.,* 2009). Dyes are one of the major environmental issues and should be treated well before discharging in the environment.

Elimination of persistent organic pollutants that remain for a long time in the environment is one of the most difficult processes of the effluent treatment. Many methods are employed to remove or destroy the pollutants of effluents and contaminating gases. Some destructive methods use strong oxidants which are harmful. On the other hand, currently used non-destructive methods bring also serious losses.

Air stripping method is a method used for the removal of volatile organic compounds from surface water or ground water in which air is blown into water and the contaminants are evaporated into air, converts water contamination to the air pollution. Carbon adsorption method is a method which eliminates volatile and non-volatile chemicals, produces a harmful solid which should be destroyed. One of the weaknesses of these old processes is that the pollutants are not destroyed but displaced from one phase to another. Therefore, methods for destruction of organic pollutants should be replaced with methods exerting less or negligible harms on the environment.

The degradation of the untreated effluents is an important process for reducing water pollution in the environment. There is a high priority to remove the dyes from industrial effluent before its discharge into surrounding environment. Most of the methods are recently used for chemical and physical effluent treatment process does not decolorize completely besides these are high expensive and have more practical difficulties. (Sharma *et. al.* 2009)

Nanotechnology might be a solution of such environmental issues. Nanomaterials exhibit novel physical, chemical and biological properties. They are multifunctional in nature due to their size (Yi *et al.,* 2005). The nano particles have more surfaces–to–volume ratio (Hines and Guyot-Sionest, 1996).

Now-a-days the scientific and engineering interest in the application of photocatalysis has grown exponentially. One promising technique for destroying organic contaminants in the textile wastewater is the application of photocatalysts. Photocatalysts has proved to be of real interest as efficient tool for degrading both aquatic and atmospheric organic contaminants. It involves the acceleration of photoreaction in presence of photocatalyst and one of the major applications is photocatalytic oxidation to effect partial or total mineralization of gas phase or liquid phase contaminants to benign substances. The term photocatalytic degradation usually refers to complete photocatalytic oxidation or photomineralisation of dye molecule to CO_2, H_2O, NO_3^-, PO_4^{3-} and halide ions. Some nanomaterials such as grapheme quantum dots have attracted extensive attention as a photocatalyst for the degradation of organic pollutants in water and air under UV irradiation.

Inspite of the fact that there are various routs for the fabrication of nanomaterials of different morphologies, green approaches have drawn must attention, owing to the growing need

for development of eco-friendly environmentally technologies, its high atom economy, less time consumption, simplicity for the experimental procedures, versatility etc.

The pollutant of concern includes cationic dye affect the biosphere in many places worldwide. The cationic dye, methylene blue (Fig. 1) which has applications in a large number of industries to colour cottons, wools, sink, leather, paper etc. and which is toxic with many after effects on human beings. An exposure to methylene blue can cause breathing problem and produces a burning sensation during ingestion and many cause nausea, sweating, cyanosis, jaundice, shock and methemoglobinemia (Tan *et al.,* 2008). Studies also confirm that the products formed after the degradation are also not safe and have carcinogenic potential. Dyes are resilient to fading on exposure to light and water and it therefore difficult to be removed from waste water. Thus it becomes necessary to remove such a toxic dye from waste water before it is released into aquatic environment.

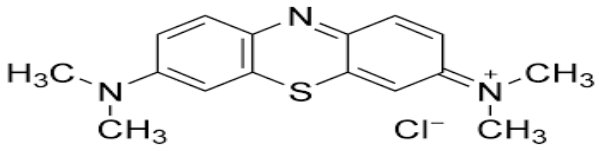


Figure 1: The cationic dye, methylene blue

Conventional treatment methods such as adsorption are often inadequate and inappropriate for removing large amounts of organic pollutants like dyes from waste water streams. It is also noteworthy that adsorption is a non-destructive method, which simply transfers pollutants from one phase or substance to another (Guo *et al.*, 2003, Pal and Deb 2012(a), Pal and Deb 2012(b), Pal and Deb 2012(c), Pal *et al.,* 2013) In contrast, the treatment method of photo-catalytic degradation has the capability of converting toxic molecules into non-toxic compounds. In last decade photocatalytic degradation using nanomaterials has been shown to be effective for destruction of pollutants. The increasingly demanding request for new catalysts in terms of recovery, regeneration and reuse has attracted the attention of a significant part of the scientific community (Nath *et al.,* 2007). In this context, nanosized catalysts have recently become a hot topic of interest because of their high surface area that results in outstanding activity (Hussein *et al.,* 2010). As particle size decreases by reaching nanodimention, gradual transformation, from the bulk in the solid-state to the molecular level occurs.

A homogeneous catalysis where the catalyst is in the same phase as the reactants is generally accepted by chemists. One of their attractive properties is that all catalytic sites are accessible because the catalyst is generally a soluble metal. Homogeneous catalysts have a number of other advantages such as high selectivity, better yield and easy optimization of catalytic systems by ligands and metals. They are widely used in a number of commercial applications, but the difficulty of catalyst separation from the final product creates economic and environmental barriers to broadening their scope. Despite their advantages and their wide use in a number of applications, many homogeneous catalytic systems have not been commercialized

because of the difficulty encountered in separating the catalyst from the final reaction products. Removal of trace amounts of catalyst from the end product is essential since metal contamination is highly regulated. Even with the extensive and careful use of various techniques such as distillation, chromatography or extraction removal of trace amounts of catalyst remains a challenge.

Graphene was first reported in 2004 and it is a material which generally has high thermal and electrical conductivities, thermal stability and mechanical flexibility. It is also environmentally friendly (Zhu *et al.*, 2010, Alexander and Balandin 2011, Hunag *et al.*, 2011). In recent years, numerous graphene-derived carbon materials have been synthesized and applied as molecular support and carrier platforms (Bao *et al.*, 2011), sensors (Liu *et al.*, 2012, Shao *et al.*, 2010, Song and Zhu 2013), aptamers (Hu *et al.*, 2012, Wang *et al.*, 2010) and electrodes (Wang *et al.*, 2008, Park *et al.*, 2012).

Graphene quantum dots (GQDs) are single carbon layer thick nano-materials; the sheets are generally smaller than 100 nm (Zhuo *et al.*, 2012) with oxygen-containing functional groups at the edges. Such a nano-materials have unusual optical and electronic properties partly arising from their quantum confinement and zig-zag edge effects (Jin *et al.*, 2013, Yan *et al.*, 2013, Zheng *et al.*, 2011, Bao *et al.*, 2011). Other useful properties include: chemical inertness, strong fluorescence, high photo-stability and low toxicity (Guettinger *et al.*, 2012, Li *et al.*, 2012, Zhu *et al.*, 2012, Shen *et al.*, 2012). There are many synthetic methods to make GQDs and in general these methods can be grouped into two classes, "top-down" and "bottom-up". The "top-down" method often needs special equipment and complicated procedures such as electron-beam lithography (Ponomarenko *et al.*, 2008), electrochemical exfoliation of graphite (Zheng *et al.*, 2009, Lu *et.al.* 2009) and hydrothermal cutting grapheme oxide (GO) (Pan *et al.*, 2010, Shen *et al.*, 2010). The "bottom-up" method involves the carbonization of selected organic precursors with the use of a thermal treatment (Yan *et al.*, 2010, Liu *et al.*, 2011). The "bottom-up" method is often preferred, because it is relatively easy to perform. It produces high quantum yields and it offers precise control over the morphology and size of the quantum dots. However, these "bottom-up" methods are time consuming and include the need to optimize the hydrothermal treatment, temperature control and object selection. Also the literature suggests that most carbohydrates with a C, H and O ratio 1:2:1 may be used as the source material for preparation of GQDs (Tang *et al.*, 2012).

A possible simple method to obtain the GQDs requires just the pyrolysis of citric acid (CA) (Dong *et al.*, 2012). This procedure does not require any surface passivation agents or inorganic additives. However, it does require the optimization of the pyrolysis reaction. This is important because the effect of heating time will influence the degree of pyrolysis and carbonization of citric acid (CA). During the pyrolysis, neighboring, dehydrated citric acid (CA) molecules react with each other to form GQDs and the functional groups, such as –OH, –CH_2–, –COOH and –COOR located at the edge of each GQDs act as a passivation layer at the surface.

This layer facilitates the uniform grouping of the sp^2 cluster in the GQD structure and these clusters are more or less isolated within the sp^3 matrix. It is also noted that the diameter of GQDs increased rapidly with the increase in heating time. Hence it is important to control the pyrolysis time.

The aims of the work were (i) to optimize the pyrolysis time and then synthesize the GQDs by pyrolyzing citric acid in a green approach. (2) to study the photocatalytic degradation of methylene blue dye using GQDs in aqueous solution.

Materials and Methods:

All the chemicals and reagents used were of analytical reagent (AR) grade. Double distilled water was used for all experimental work including the preparation of dye solutions.

1. Preparation of methylene blue dye solution:

The dye, methylene blue (Chemical formula; $C_{16}H_{18}N_3SCl{\cdot}3H_2O$, IUPAC name: 3,7-bis (dimethylamino)-phenothiazin-5-ium chloride, a cationic dye, MW: 319.86, λ_{max}: 665 nm, Colour Index 52,015, Appearance: Dark green powder, solubility in water: 40 g/L at 20^0C) was purchased and used for photo degradation study without further purification. The stock solution of 1000 ppm of methylene blue was prepared by dissolving 0.5 g dye in 500 cm^3 of double distilled water. Further desired test solutions of dye were prepared using appropriate subsequent dilutions of the stock solution. The desired pH of the dye solutions were adjusted with the help of dilute hydrochloric acid and dilute sodium hydroxide using digital pH meter (EQUIP-TRONICS, model no. Eq-800) using a combined glass electrode.

2. Preparation of Graphene Quantum Dots (GQDs):

The Graphene quantum dots (GQDs) which are derived from citric acid (CA) by pyrolysis procedure. 2.5 gm of citric acid (CA) were placed into a 50 ml round-bottomed flask and then heated to 200 ^{0}C using a sand bath. The citric acid (CA) melted within 5 min and the colorless melt turned firstly pale yellow and then orange after about 30 min. This indicated that GQDs formed. It should be noted that the orange liquid would finally turn into a black solid after 2 h heating. This indicates the formation of graphene oxide (GO). If this occurs then the procedure should be repeated because the required GQDs have been destroyed. In the case of thick orange liquid it was added drop-by-drop, with stirring into 100 ml 10 mg/ml NaOH solution. The pH of this solution was then adjusted to 8.0 and thus an aqueous solution of GQDs was obtained. The solution pH influenced the colour of GQDs. The GQDs were stored in a refrigerator at 4^0C, under these conditions; it was found that the GQDs remained stable for at least two months without any obvious change. The GQDs were used directly for photo catalytic degradation study of methylene blue dye without any further treatment and complicated modification.

3. Experimental procedure:

The method was employed at temperature (27^0C) to examine the photo catalytic degradation of dye, methylene blue using graphene quantum dots (GQDs) under UV light. The

method was used to determine the degradation capacity, stability of photocatalyst and optimum degradation conditions. The parameters were studied by combining aqueous solution of graphene quantum dots (GQDs) with methylene blue dye solution in 250 ml separate beakers. The beakers were placed in a closed wooden box. Ultraviolet light irradiated on sample. The 5 cm^3 samples were removed at predefined time intervals, centrifuged and amount of dye in the supernatant solutions was determined by measuring absorbance using digital UV-visible spectrophotometer (EQUIP-TRONICS, model no. Eq-820). The following equation was used to compute the percent efficiency of the photo degradation (% Degradation) of dye,

$$\% \text{ Degradation } = \frac{(C_0 - C)}{C_0} \times 100 \qquad \text{-------- (i)}$$

where C_0 and C are the initial concentration and final concentration of the dye at time t in mg/L.

4. Photo degradation kinetics:

A solution containing dye, methylene blue prepared and the photocatalytic degradation studies were done with varying contact time from 0 minute to 180 minute to check the applicability of the kinetic model.

As aforementioned, a lumped analysis of photocatalytic degradation rate is sufficient to practical operation from a system design point of view. The commonly employed lumped kinetic equation, langmuri-Hineshlwood (L-H) equation is presented below,

$$\ln(\frac{C_0}{C}) = Kt \qquad \text{------- (ii)}$$

where K is the apparent pseudo-first order reaction rate constant (min^{-1}) and t is the reaction time (min).

Results and Discussion:

1. Mechanism of photo catalytic degradation:

The photo catalytic degradation was observed against methylene blue dye in the presence of UV light. The UV light absorbed by GQDs promoted the electrons from valence band (VB) to conduction band (CB). Electrons and holes are continuously generated when the UV light illuminate on the surface of GQDs.

$$GQDs + h\nu \rightarrow GQDs + h^+_{VB} + e^-_{CB}$$

The photo generated holes reacted with water and formed hydroxyl radical. The hydroxyl radicals were the most potent oxidizing agents. The degradation rate confirmed the potency of the hydroxyl radical. The photo generated electrons reacted with molecular oxygen presence in medium and produced peroxide radical anions (O_2^-). The peroxide radical anion (O_2^-) takes one proton to yield a superoxide (HO_2) followed by the formation of hydrogen peroxide (H_2O_2). Hydrogen peroxide again can be split to give hydroxide radical ($^{\bullet}OH$) and hydroxyl ion (OH^-**)**. Theses reactive radicals are responsible for the degradation of methylene blue dye in aqueous solution.

$$h^+_{VB} + H_2O \rightarrow {}^{\bullet}OH + H^+$$

$$e^-_{CB} + O_2 \rightarrow O_2^-$$

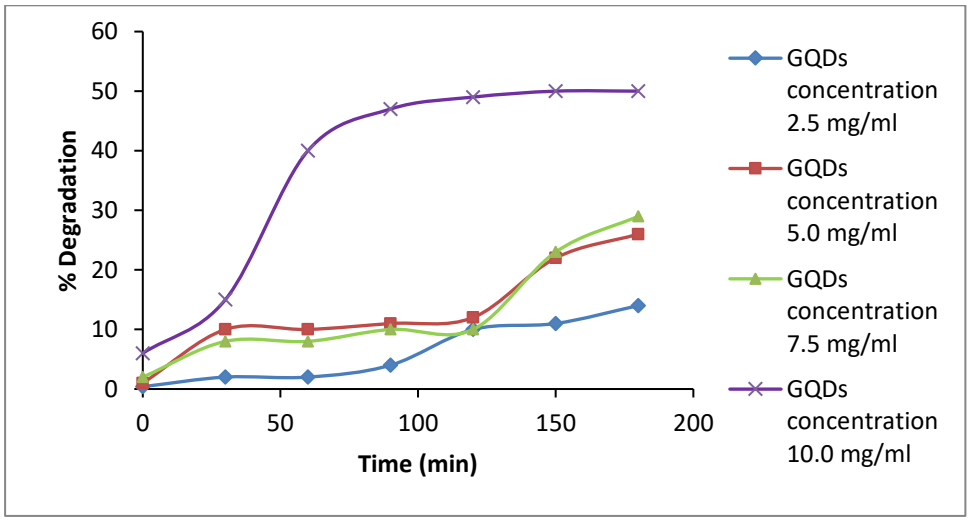
$O_2^- + H^+ \rightarrow HO_2$

$2HO_2 \rightarrow H_2O_2 + O_2$

$H_2O_2 + e^-_{CB} \rightarrow {}^\bullet OH + OH^-$

2. Effect of pH:

Wastewater containing dyes is discharged at different pH; therefore it is important to study the role of pH on photo catalytic degradation of dye. In order to study the effect of pH on the degradation efficiency, experiments were carried out at various pH values, ranging from 2 to 5 for constant dye concentration (5 mg/L). Fig. 2 (a) to (d) shows the degradation efficiency of methylene blue dye as a function of pH. It has been observed that the degradation efficiency decreases with increase in pH, exhibiting maximum rate of degradation (50 %) after 180 min irradiation of UV light, at pH 2 in case of catalyst loading (GQDs concentration 10 mg/ml), methylene blue dye concentration 5 mg/L and Temperature 27^0C.



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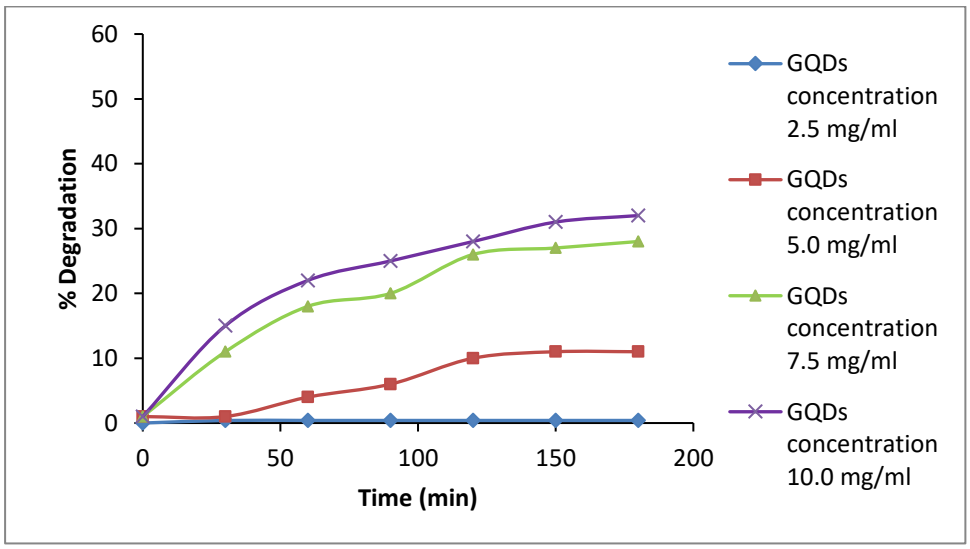

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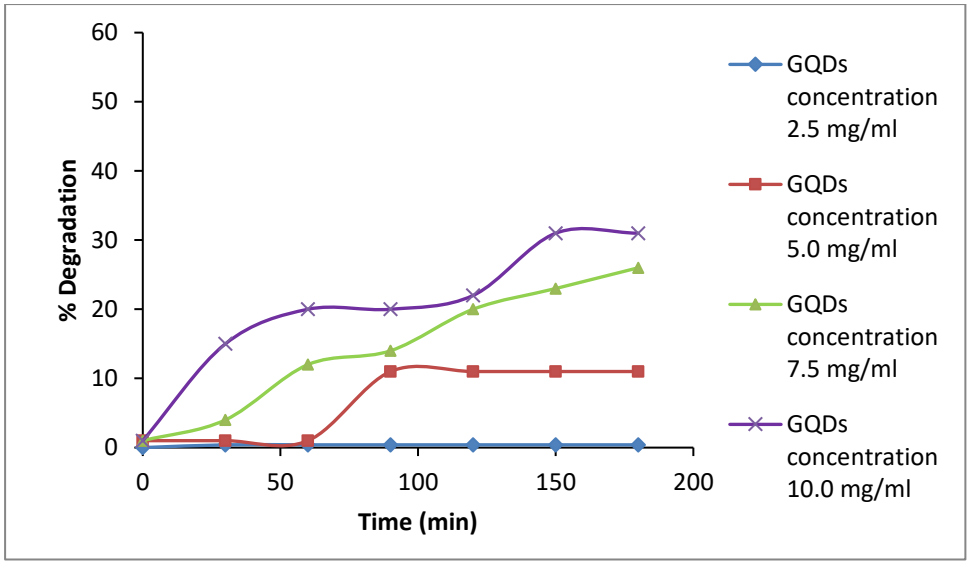

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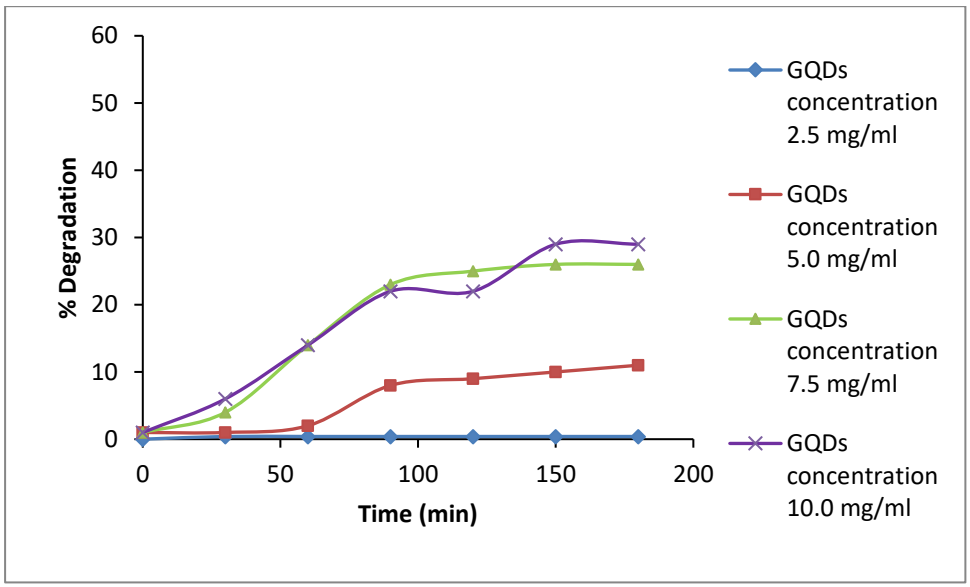


(d)

Figure 2: Effect of pH on photocatalytic degradation of methylene blue dye in aqueous solution (a) pH 2 (b) pH 3 (c) pH 4 and (d) pH 5 (catalyst loading (GQDs concentration from 2.5 mg/ml to 10 mg/ml); methylene blue dye concentration: 5 mg/L, Temperature: 27^0C, UV light irradiation time from 0 min to 180 min.

3. Effect of methylene blue dye concentration:

After optimizing pH, the photocatalytic degradation of methylene blue dye was carried out by varying the initial methylene blue dye concentration from 5 mg/L to 25 mg/L. It was observed that, as the concentration of methylene blue dye increases, the rate of degradation efficiency decreases. The possible explanation for this behavior is that as the initial concentration of the methylene blue dye increases, the path length of the photons entering the solution decreases and in low concentration the reverse effect is observed, thereby increasing the number

of photon absorption by the catalyst in lower concentration. Therefore the methylene blue dye concentration 5 mg/L was fixed for further studies.

4. Effect of amount of catalyst loading (GQDs):

In order to study the effect of amount of catalyst loading (GQDs) on the degradation efficiency, experiments were carried out at various catalysts loading concentration, ranging from 2.5 mg/ml to 10.0 mg/ml for constant dye concentration (5 mg/L). Fig. 3 shows the degradation efficiency of methylene blue dye as a function of catalyst loading concentration. It has been observed that the catalyst loading is found to be dependent on initial solute concentration because with the increase in catalyst loading, total active surface area increases, hence availability of more active sites on the catalyst surface. At the same time, at high concentration of catalysts, increase in turbidity of the suspension occurs; there will be decrease in penetration of UV light and hence photo-activated volume of suspension decreases. Thus it can be concluded that higher catalyst loading may not be useful both in view of aggregation as well as reduced irradiation filed due to light scattering. The degradation efficiency increases with increase in catalyst loading concentration, exhibiting maximum rate of degradation (50 %) in case of catalyst loading (GQDs concentration 10 mg/ml) after 180 min irradiation of UV light, at pH 2, with methylene blue dye concentration 5 mg/L and Temperature 27^0C.

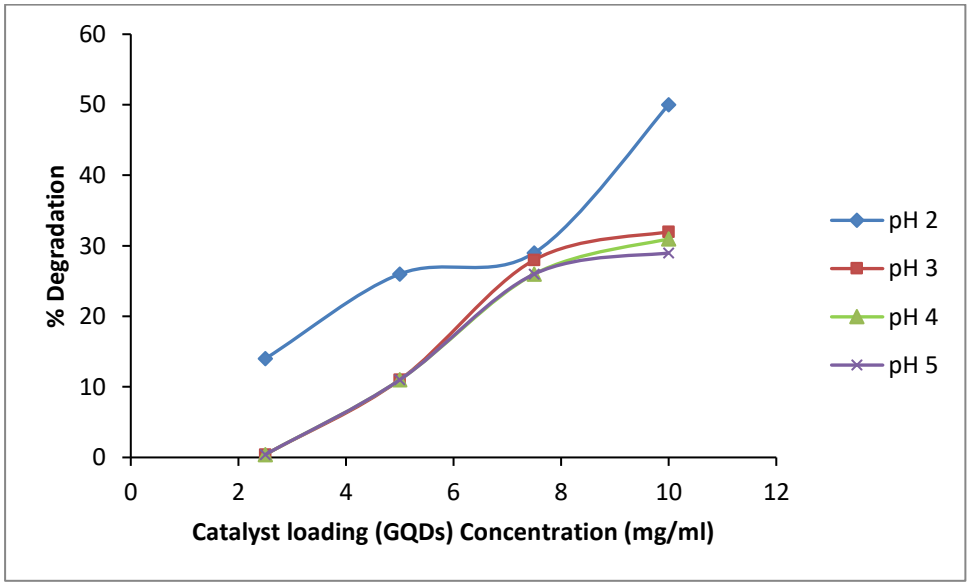
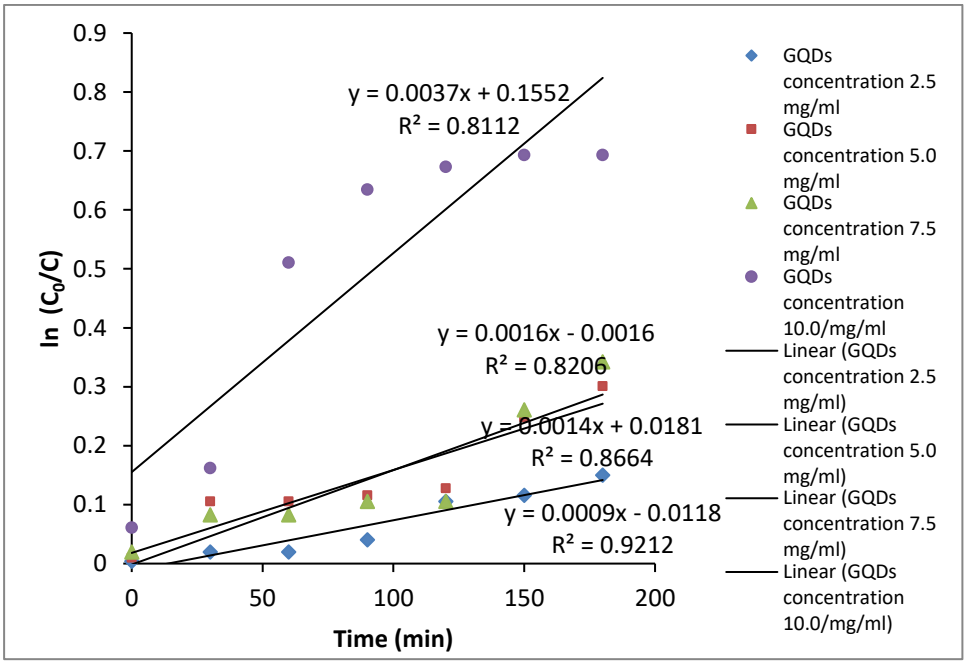


Figure 3: Effect of catalyst loading (GQDs) concentration on photocatalytic degradation of methylene blue dye in aqueous solution (pH: 2 to 5, methylene blue dye concentration: 5 mg/L, Temperature: 27^0C, UV light irradiation time: 180 min.)

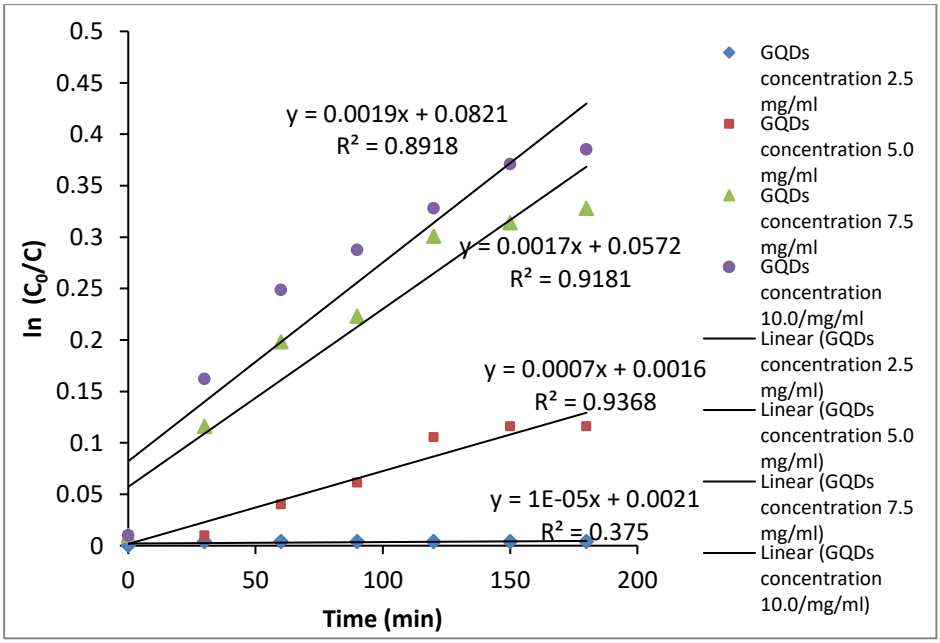
5. Kinetic study:

Photo catalytic degradation of methylene blue dye in aqueous solution at varying pH 2 to 5, catalyst loading (GQDs) concentration: 2.5 mg/ml to 10.0 mg/ml with fixed methylene blue dye concentration: 5 mg/L and Temperature: 27^0C studied under UV light irradiation time from 0 min to 180 min. The plot, ln (C_0/C) against irradiation time (t) is a linear straight light (Fig. 4.)

This indicates that the photo catalytic degradation of methylene blue dye follows pseudo-first order kinetics according to langumiur-Hinshelwood model. The rate constant (*K*) for the reaction was determined using slope of the plot. Table 2 shows the values of rate constant (*K*) and regression coefficient (R^2). The regression coefficient values are approaches to 1.000 in case of catalyst loading (GQDs) concentration 5.0 mg/ml, 7.5 mg/ml and 10.0 mg/ml, except at low concentration of catalyst loading (GQDs) (2.5 mg/ml), it shows less value. It is observed that rate constant (*K*) values increases as the catalyst loading (GQDs) concentration increases at all pH values. At pH 2 highest rate constant (*K*) value was observed.



(a)



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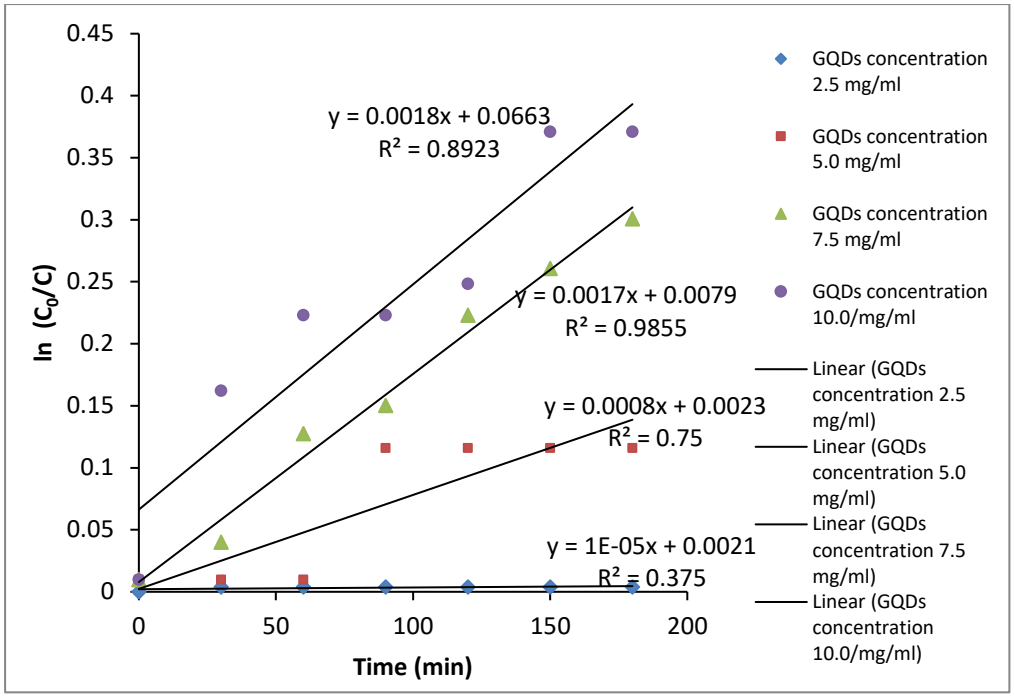

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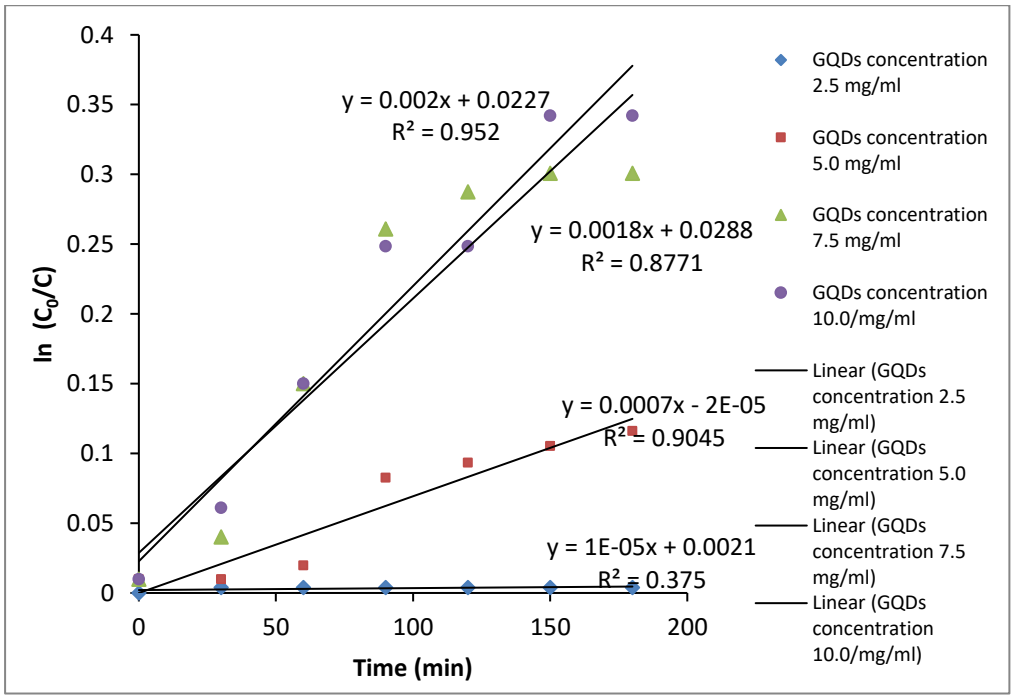

(d)

Figure 4: Pseudo-first order kinetics for photocatalytic degradation of methylene blue dye in aqueous solution (a) pH 2 (b) pH 3 (c) pH 4 and (d) pH 5, (catalyst loading (GQDs) concentration: 2.5 mg/ml to 10.0 mg/ml, methylene blue dye concentration: 5 mg/L, Temperature: 27^0C, UV light irradiation time: 0 min to 180 min.)

Table 1: Kinetic data for photo catalytic degradation of methylene blue dye in aqueous solution

Concentration of GQDs	*pH 2*		*pH 3*		*pH 4*		*pH 5*	
	K (min^{-1})	***R^2***	***K (min^{-1})***	***R^2***	***K(min^{-1})***	***R^2***	***K(min^{-1})***	***R^2***
2.5 mg/ml	0.9×10^{-3}	0.9212	0.01×10^{-3}	0.3750	0.01×10^{-3}	0.3750	0.01×10^{-3}	0.3750
5.0 mg/ml	1.4×10^{-3}	0.8664	0.7×10^{-3}	0.9368	0.8×10^{-3}	0.7500	0.7×10^{-3}	0.9045
7.5 mg/ml	1.6×10^{-3}	0.8206	1.7×10^{-3}	0.9181	1.7×10^{-3}	0.9855	1.8×10^{-3}	0.8771
10.0 mg/ml	3.7×10^{-3}	0.8112	1.9×10^{-3}	0.8918	1.8×10^{-3}	0.8923	2.0×10^{-3}	0.9520

Conclusions and future prospect:

In the present study, it has been demonstrated that graphene quantum dots (GQDs) is a very low cost, green photo catalyst, easily prepared from citric acid (CA) by pyrolysis procedure, can be successfully employed for the degradation of dye, methylene blue from aqueous solution. Process variables, such as pH, initial methylene blue dye concentration and catalyst loading (GQDs) concentration significantly affect the photo-activated process. These processes were efficient in the degradation of methylene blue dye. Experimental results indicate that the degradation of dyes facilitated in the presence of catalyst. The initial rate of degradation increased with increase in catalyst loading (GQDs) concentration. As the initial dye concentration was increased, the rate of degradation decreased. About 50 % of methylene blue dye was degraded in the presence of catalyst loading (GQDs) concentration 10.0 mg/ml after 180 min of UV light irradiation in optimized experimental conditions.

Kinetic results clearly indicated that the pseudo-first-order kinetics, according to langumiur-Hinshelwood model was found to be correlating the experimental data strongest. GQDs can be easily synthesized in laboratory by using citric acid (CA) in a green method, it can be considered as an attractive alternative photo catalyst for degradation of methylene blue dye. This technology is having various advantages over to the more expensive technologies used in treatment of waste-water containing dyes.

The present study can be very useful for practical application for treatment of industrial waste-water containing dyes. The GQDs is a very efficient photo catalyst which can be useful for removal of dyes from industrial waste-water.

Acknowledgement:

Author is thankful to Prof. (Dr.) S. V. Rathod, Principal and Dr. (Kum.) Urmila B. Maru, Head, Department of Chemistry, Bhavan's H. Somani College for support. Thanks to Mr. Rahul Yadav, M.Sc. student for cooperation and help. Author is grateful to University of Mumbai for financial support under Minor Research Project Scheme.

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RAINWATER HARVESTING AS A MEASURE TO CONSERVE WATER: A REVIEW

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Abstract:

Water is an essential commodity for survival of mankind and other living organisms of earth. It can be used lavishly or effectively but cannot be replaced. The growing scarcity of water has been the result of rapidly growing population, rising demand for food and cash crops increasing urbanization and rising standard of living. These will increase the acuteness of the problem of water scarcity in future. Rain water harvesting is the only feasible solution to recharge the depleted ground water aquifers and to restore the productivity values of lands and local water supply schemes. The Central Ground Water Authority is also issuing directives to the states and municipal bodies to undertake roof top rainwater harvesting and its recharge to ground water mandatory for every dwelling unit by amending city by laws. Harvesting rainwater not only reduces the possibility of flooding, but also decreases the community's dependence on ground water for domestic use.

Keywords: Water, depletion, rain-water, harvesting.

Overview:

Water is vital to every human community and is essential resource for economic development, agricultural productivity, industrial growth, and human well-being. The availability of a clean, safe & secure water source has been, and will always be, a major concern for human populations (Kierche, 2000).

The available water on earth is in a finite quantity that has not changed over millennia. This has to be juxtaposed against increasing demands form a growing population. The population of the world, currently around 6 billion, is expected to exceed 8 billion by the year 2050. Apart from sheer numbers, the processes of urbanization and development are also expected to vastly increase the demand for fresh water. This situation of finite supply and growing demand leads to the projections of water scarcity, which could be severe in some parts of the world.

Rainwater is a free source of nearly pure water. It can be used to supply potable (drinking) water and non- potable water. For non-potable uses, like watering landscapes, it is ready for use as it falls from sky. For potable uses, rainwater must be treated to remove or kill disease organisms that may be present. Rainwater is one of the purest sources of water available. Its quality almost exceeds that of ground or surface water. It is the first forms of water that we know in the hydrological cycle, hence, it is a primary source of water for us. Rivers, lakes and

ground water are all secondary sources of water. In present times, we depend mainly on such secondary sources of water. In the process, it is forgotten that rain is the ultimate source that feeds all these secondary sources and remain ignorant of its value. Water crisis situation occurs only because, effective collection and storage of rainwater has been ignored. The potential of rain to meet water demand is tremendous. Unless people are involved in conserving rainwater from individual households to big industries/institutions, it would be very difficult to meet the looming water crisis.

In general, water harvesting is the activity of direct collection of rain water. The rain water collected can be stored for direct use or can be recharged into the ground water.

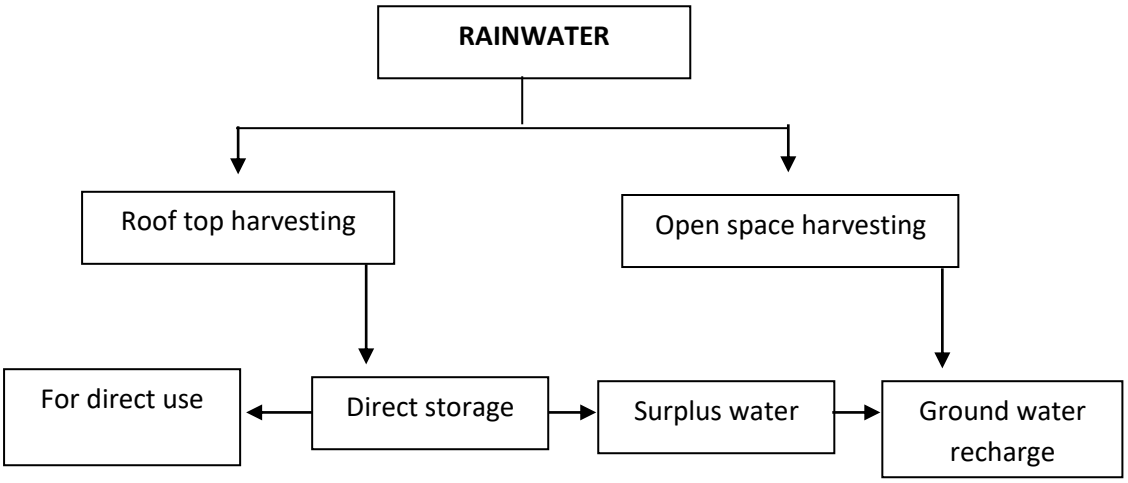

Figure 1: Rainwater Harvesting

As indicated above, rain water falling on the terrace of building can be collected through pipelines/drains and stored in a storage tank for direct use or diverted into an open well/borewell for ground water recharge. Rain fall over the open spaces around the building may also be diverted for recharge purpose.

Water: A natural resource

Water is an essential commodity for survival of mankind and other living organisms of earth. It is one among the fabulous gifts of nature for supporting its creations. Indian mythological evidences prominently indicate the great efforts of Bhagiratha in bringing water to the mother earth. Water is also described as one of the panchabhutas is our ancient vedas. But today, by ignoring these facts, man is indiscriminately polluting water in unknowingly provoking the nature for complex situations (Rao, 2001).

According to Sathe and Lokhande (2002) water is a vitally important substance with properties that are unique, interesting and wide ranging in potential impact. Several of those characteristics play mayor roles in determining water quality and causing changes in it, either through natural phenomena or impacts brought about by man-made activities. Water also plays important roles in microbiological life processes. It provides the basic environment within which

organisms live and contains the elements and chemical components that make their survival and growth possible.

Titus and Pereira (2003) portrayed that water is the critical element for survival of human being. In fact, water is the basis of all life. Life began in the water and continues to be the essence of all living beings. All biological elements are made up of water to the extent of 70 to 80% body weight. Water also plays a pivotal role in the weathering & soil formation. Nothing on earth can live without freshwater. A human being will die within three days without it. It is simply because water is life and life is water.

Sahoo reported in 2004, that water is all sources of life and without this life is unthinkable in our mother earth and that's why it is aptly known as life. Despite of its preciousness water has remained as a neglected issue till today. Water as supply freely by nature is taken for granted in India. This is the reason why in a less than half a century of independent existence, India a water rich country has been reduced to a water insecure nation. The acuteness is such that during 2025 there may be a water emergency era where less than 1000 cu.m. of precipitation is considered critical for human survival. This will be clear from the following statistics. Annual per capital availability of renewable fresh water:

1955 – 5277 cu.m.

1990 – 2464 cu.m.

2025 – 1000 cu.m.

It is extrapolated by Chelladurai (2005) that water is essential for survival of all living beings and also for socio-economic development of households, communities and nations all over the world. It is also necessary to maintain and enhance biodiversity and quality of environment. It is estimated that it accounts for 4 percent of the world's fresh water resources. This when India's share of 2.5 percent in the total land area of the world, seems more than adequate. According to the National water policy, water is a prime natural resource for humans and hence, a precious national asset. Now-a-days, it is hard to find fresh water due to growth of population agricultural and industrial activities and contamination of water resources. The country receives about 4000 Km^3 of precipitation patterns and mismanagement of it often leads to wastage. Therefore, water the most important natural resource, should be preserved for future generations.

It is researched by Somasundaram in 2005 that water is pivotal natural resource, which fulfills number of significant functions. It can be used lavishly or effectively but cannot be replaced. The source of water is unevenly distributed both spatially as well as temporally. India is one of the few countries in the world endowed with plenty of land & water resources. The average precipitation is 1250 mm. over 329m ha area (400 million hectare metre). The total water availability is about 2300 M^3/P/year and when the population reaches a level of 1640M (1640 Billion) in 2050 according to UN report per capita availability will be about 1400 M^3, based on this our country will be water stressed but not water scarcity. Most of the rainwater

goes as runoff. Scientific methods may help in harvesting rainwater in the best possible ways, they are conservation of rain water by harvesting structures, contour bunding, contour stone wall. Contour trenching, check dams in low rainfall area and construction of percolation ponds, irrigation tank and scheduling of irrigation. By adopting these technologies/methods we can improve the ground water availability in the low rainfall areas, water scarcity and more runoff area.

A study by Narula (2006) describes that water is finite resource. With only about 1,222 billion cubic meters presently estimated as the total annual utilizable water resource, the present per capita water availability in India is about 1,022 cubic meters. Water may be a God given resource but we must wake up to the fact that with demand rising exponentially, its price will also shoot up. Also, we must seriously look into replenishing our water resources so we can meet long-terms demands as well.

Depletion of water resources

Kanmony (2002) have explained that in India nearly 70% of inland water is unfit for human consumption. It is estimated that 90 to 95% of all domestic sewage and 75 percent of industrial wastes are discharged into surface water without any treatment. New technology, which has brought about Green Revolution, has also contributed to the indirect use of pesticides and chemical fertilizers which is the main cause for water pollution. Green revolution also favours the excessive utilization of ground water. It leads to ground water depletion and in turn causes excessive damage to the country's infrastructure and environment.

According to Nautiyal (2002), in one third of India’s agroclimatic regions, there is water scarcity already in terms of per capita demand and supply of water. This imbalance is bound to lead to conflicts at the local, state & the national levels. At present, thousands of Indian cities do not have sources of water and in future, it would have to be transported over larger distances as the water sources move much more away from the cities. The country’s current and future situation can be gauged by the trend in water availability. Presently, six of India’s 20 major river basins already fall into water scarce category. By the year 2025, five more river basins are feared to be water scarce. Even Brahmaputra, Barak & west following rivers will be water insufficient in the times to come. The glaciers of Himalaya are rapidly melting and it is feared that within next 50 to 80 years, most of the glaciers will disappear.

Rajvedi explored in 2003, that the fresh water sources which are finite and fragile are becoming scarce day by day. More than 1.5 billion people worldwide depend on ground water. The global water scenario is so grim that more than one third of world’s population is already living in countries moderate to high water stress. According to a report of global environment outlook, the global fresh water consumption has risen six fold between 1900 and 1995 which roughly twice the rate of population increases. This problem is assuming serious proportions in Africa and West Asia. Roughly 20% of world population lacks access to safe drinking water. Excessive withdrawal of ground water, more than recharge, has become widespread in many

parts of the Arabian Peninsula, China, India, Mexico former Soviet Union and the United States resulting in appreciable fall in water level. With rapid industrialization during the last century, excessive use of fresh water for different purposes is mainly responsible for present scenario. Over extraction of ground water has also affected its quality leading to saline ingress in coastal areas as in the case of Oman, Bahrain and India biological contamination in the form of faecal coliform count, chemical fertilizer and pesticide residue in Asia's rivers is 50 times higher than that of the WHO guidelines making the local population vulnerable to high risk level. The problem is not wide recognized because it is going underground. However, in many places the situation has already reached a crisis level and may be economically irreversible.

It is affirmed by Swanappan in 2003, that water is becoming scarce commodity and it is considered as liquid gold in the desert part of the country. The demand of water is also increasing day by day not only for agriculture but also for household purpose. It is estimated that water need for drinking and other municipal uses will increase from 3.3 MHm to 7.00 MHm in 2020/25. The rainfall is abundant in the world and in India. But it is not evenly distributed in all places. India being monsoonic country, the rain falls only for 3 to 4 months in a year with high intensity, it results in more runoff and soil erosion. If the availability of water is 1700 M^3/P/Y there will be occasional water stress, and if it is less than 1000 M^3/P/Y it is under water scarcity condition. Though India is not under water stress, Tamil Nadu is already under water scarcity condition, but there is no need for panic since it is possible to manage this condition as in the case of Israel where the availability is about 450 M^3/P/Y by means of water harvesting, water conservation and water management. Hence, to mitigate water problem/drought etc., there is an urgent need to follow our ancestral way of water harvesting and the latest technologies adopted in Soil and Water Conservation measure on watershed basis including roof water harvesting etc.

Chand (2004) observed that in developing countries like India, inadequate sanitation adds to the microbial contamination of drinking water and food, leading to an increased number of carriers and causes. Person to person spread of diseases result because of poor hygienic practices or ignorance about them. The microbial contamination of drinking water from its abstraction till consumption is to be especially avoided because of its high degree of simultaneous infection in the community.

In the year 2004, Garg and Totwat studied that rapid industrialization and urbanization have led to discharge of industrial effluents which in turn pollute the ecosystem. The disposal of effluents has become a serious techno-economic problem particularly due to rising cost of disposal and growing awareness of pollution hazards. It is also reported by Raheem (2004) that as an area develops and population increases, the volume of wastewater increases, resulting increase in the deleterious substances leaching into local aquifers. Eventually the water will get contaminated and reach a state, where it will be either unsafe or unaesthetic for use. It then becomes necessary to exploit a new aquifer at a deeper level, than the one initially used and contaminated.

Water scarcity is now the single biggest threat to global food production. Just two decades ago, serious water problems were confined only to small pockets of the world. Today, it exists in every continent and is spreading rapidly 22 of world's countries at present have renewable water supplies of less than 1000 M^3/Year. The World Bank estimates that by the year 2025 one person in three, or 3.25 billion people in 52 countries will live in conditions of water shortage. The supply of water for human use entails not only the problem of quantity but also one of quality, since all human activities impair the natural quality of water. Beyond a certain degree of pollution, water becomes unusable. The result is a reduction in the supply of usable water and problems with the disposal of the polluted water. Under these circumstances, to overcome the demand of water is crucial in the coming years (Sivanappan, 2005).

Water management is therefore a major challenge for town planners, builders and architects today, not just in terms of availability of water, but most important is its quality.

Rain water collection and harvesting

In the year 2000, Rao expressed that it is possible to provide water to every people in India by rainwater harvesting. All rainwater which falls on the ground should be properly harvested and used for all domestic purposes, it should be possible to cultivate 1.2 hectares of land with just 100 m.m. of rainwater. People must be encouraged to de-silt ponds, tanks and wells in the village and towns, so that all rainwater is collected which can be used for drinking and irrigation. People need to be educated and made aware that water is a limited natural resource and must be used carefully.

Singh (2000) emphasized that, poorly managed water harvesting systems may cause soil erosion and soil instability. Therefore, water harvesting catchments in Rajasthan require proper maintenance to keep them in good conditions. Balaji *et al.* (2001) stated that rain water harvesting is the only feasible solution to recharge the depleted ground water aquifers and to restore the productivity values of lands and local water supply schemes. The present era of erratic monsoon rainfall has forced the farming community and other gross consumers of water to make a paradigm shift of spending water like money rather evaporating money like water which is the central concept of any rain water harvesting strategy.

Pai (2002) expressed that technologies used in rainwater harvesting is region specific depending upon various aspects such as physiographic environmental, technical and socio-economic etc., apart from type of soil, rainfall, topography of catchments and operational control systems. Water harvesting can be undertaken at individual household or community level.

In the year 2002, Rao compiled information that, though India is one of the wettest regions in the world with an annual average rainfall of 117 cubic meters over the plains, water scarcity continuous to haunt various parts of India with varying intensity. As it is, India's rainfall is characterized by its diversity, both by the geographical division and seasons of the year. Added to this diversity in space and time, there are large variations in each geographic region from one year to another, resulting in flood in some areas and droughts in others. Against this

backdrop, water resources experts have stressed on the need to revive the traditional water harvesting techniques to end the nagging water shortage in an economically viable and ecologically sustainable fashion. Each region of the country has its own water harvesting technique, reflecting the geographical peculiarities and cultural uniqueness of the community. Indians, for hundreds of years now, have been using a variety of techniques to harvest every possible form of water – rainwater, streams, springs, rivers and floodwater.

Meanwhile, development strategists point out that growing interest in traditional water harvesting systems will give a big boost to people's empowerment for ending rural poverty and speed up the process of development in all its manifestations. As things stand now, India can hope to end its nagging water famine by investing time, money and energy on reviving the local water harvesting techniques in lieu of building big, costly and sophisticated dams which involves massive expenditure, human displacement and destruction of forest stretches and other eco-assets. Rainwater harvesting provides a powerful and decentralized solution to the crisis as historical evidences have highlighted the effectiveness of rainwater harvesting.

D'Souza (2004) squeezed out from study that rainwater harvesting begins with a simple idea. Rain gutters are already collecting the water that falls on your roof. To harvest that water all that is needed is to change the direction of the flow so that instead of running on to the ground, the water flows into a storage tank. The quality of the water itself makes the investment worthwhile. Rainwater typically has very low hardness levels, which reduces the use of soap and detergents and eliminates the need for a water softener. Stored rainwater is also a good standby in times of emergencies such as power outrages or during periods of extreme drought and because it does not have to be treated, pumped or distributed through a complex network, rainwater harvesting saves energy and many state governments have already made rainwater harvesting mandatory for all new buildings.

Nair revealed in 2004, that at a micro level, rainwater harvesting is also being taken up. Some state governments have already amended buildings by-laws to make rain water harvesting mandatory for new buildings.

Water deficit can be reduced by water saving methods, rainwater harvesting and wastewater recycling. Tamilnadu State Govt. is promoting rainwater harvesting enthusiastically in each and every part of the state. In the first phase of the promotion, the government has made rainwater harvesting structure mandatory in each house. In the second phase, it is planning to implement rainwater harvesting in the tanks, ponds and other water bodies (Velavan, 2004).

According to Devi (2005), water is the life blood of the environment, without water no living being can survive, water plays a unique role in the traditional economy and culture of the native people. Life possesses us with so many contradictions. Despite being one of the wettest countries of the world, India's growing water shortage has reached alarming proportions. More than 200 million people would live under conditions of high water stress by the year 2050, according to the UNEP (United Nations Environment Programme), which warns that water could

prove to be a limiting factor for development in a number of regions in the world. About one fifth of the world's population lacks access to safe drinking water and with the present consumption patterns, two out of every three persons on the earth would live in water stressed conditions by 2025. To tackle this problem, the Ministry of Water Resources has drawn up a programme for rainwater harvesting and recharge. A Rs. 45 crore plan has been earmarked for rainwater harvesting and recharge in the Ninth Plan. The ministry has sanctioned Rs. 25 crores for the Central Ground Water Board Programme, which involves states and user agencies in rural and inaccessible areas. The Central Ground Water Authority is also issuing directives to the states and municipal bodies to undertake roof top rainwater harvesting and its recharge to ground water mandatory for every dwelling unit by amending city by laws.

There is a need to recharge aquifers and conserve rainwater through water harvesting structures. In urban areas, rainwater will have to be harvested using rooftops and open spaces. Harvesting rainwater not only reduces the possibility of flooding, but also decreases the community's dependence on ground water for domestic use. Apart from bridging the demand-supply gap, recharging improves the quality of ground water, raises the water table in wells/bore-wells and prevents flooding and chocking of drains. One can also save energy to pump ground water as water table rises. These days rainwater harvesting is being taken up on a massive scale in many states in India. Substantial benefits of rainwater harvesting exist in urban areas as water demand has already outstripped supply in most of the cities (Kumar *et al.,* 2005).

According to an estimate of the Central Ground water Board, if we continue to exploit our ground water resources indiscriminately, then in the next 20 years, 15 states of the country may face auto shortage of underground water. Government has recognized water harvesting as a thrust area with more allocation of money. Higher budgetary support should be given to rain water harvesting and watershed schemes to recharge our underground water sources. To tide over the present crisis, we have to keep in mind that we cannot make more rain, so we have to manage water better. Water harvesting will avoid wastage of the precious national resource (Gautam and Kumar, 2005).

Mittal exponded in 2005, that rainwater harvesting largely depends on quantity and distribution of rainfall and will, therefore, be more successful in areas where rainfall is sufficient. Besides, rainwater harvesting depends on several other factors including topography, soil type and depth, slope and vegetative cover in the catchment areas. For the rainwater harvesting programmes to be successful, it is essential that moderately large catchments and sufficient storage facilities are available in the vicinity of the villages. Rainwater harvesting structures (RWHS) can meet multiple needs of the society such as drinking, domestic water requirements, livestock etc.

Rain water harvesting from rooftop of the houses

Bhagyalakshmi (2001) found in a research that rooftop rainwater harvesting and its recharge to underground through existing wells or borewell or by constructing new wells, shafts

or spreading basins and other methods to capture run-off in the catchments, recharging treated urban and industrial effluent underground by using it for irrigation or through recharge ponds are some of the methods and techniques which are recommended and are being popularized. So, the emphasis now is given on harvesting rainwater. Water recharging methods are part of sustainable development, which means to have resources adequately for the present without depriving the future generations of the same.

Availability of rainwater from roof tops is so high in the urban areas and if properly diverted and used, artificial recharges will not only increase the ground water availability but also help in reducing the water scarcity problem of cities and towns. Rainwater harvesting will go a long way in conserving ground water and augmenting natural infiltration of water into under ground formation. Roof top rain water harvesting structures are less expensive and very effective and if implemented in spirit by each household it will help in augmenting the ground water storage (Arunadevi and Padmakumari, 2003).

According to Madley (2005) rooftop harvesting has been practiced since ages, and even today it is practiced in many places throughout the world. As we know the rainwater collected from the terrace is free from any bacteriological contamination (except small amount of dust and other silt particles which can be filtered) it can be diverted to the existing wells/borewells.

In the year 2005, Raphael conveyed that community roof water harvesting is basically the revival of traditional wisdom wherein conserving the available rainwater is the main method of water conservation. Termed as Homestead Watershed Approach (HWA), it involves allowing the rainwater that falls on rooftops to percolate down to the soil to recharge the homestead wells.

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INFLUENCES OF NATURAL DYES TO ACHIEVE SUSTAINABLE DEVELOPMENT

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Abstract:

Natural colours obtained from vegetables and animals have been used in food, leather as well as textile since ancient times. There is a revival of natural dyes due to the toxic and allergic reactions of synthetic dyes. Many new developments are taking place especially after COVID-19 since people have started to return back to nature. The chemicals from synthetic dyes can harm our skin and internal organs. Such chemicals are absent in natural dyes. Research and mass awareness about natural dyes globally among the people will increase the demand and consumption of naturally dyed materials. This paper provides an overview of the emerging influences of natural dyes to achieve ethical sustainability.

Keywords: Natural dyes, Sustainable, Eco-friendly, Synthetic dyes, Natural colour, Environment.

Introduction:

Natural dyes are prepared from plants, mineral, and animal products. This includes vegetables, fruits, root, stem, barks, leaves, flowers, lichen, nuts and kernels as well as creatures like shellfish etc. Besides being ecofriendly and protective to skin, natural dyes are cheap, easily obtainable, decomposable and plenty in nature. Shades created by natural dyes are normally harmonious offering great sensual experience (Islam *et al.*, 2020).

Indians have been considered as forerunners in the art of natural dyeing. There is evidence of madder-dyed textiles at Mohenjo-Daro nearly 5,000 years ago. Synthetic dyes were invented less than 200 years ago. India is well known for its biodiversity with more than 450 plants yielding dyes and pigments. Many of the plants used for extraction of dyes exhibit antimicrobial effect (Saxena and Raja, 2014). They have to be fully explored for their potential in dyeing.

In 1856, the first synthetic dye, Mauveine, was introduced by William Henry Perkin. Since then consumption and application of natural dyes for textiles got reduced substantially. The use of natural dyes has diminished over generations due to lack of documentation and precise knowledge of the extracting and dyeing techniques (Saxena and Raja, 2014). Hence natural dyes are not commercially successful yet.

Pros and cons of natural dyes

Natural dyes have many inherent advantages including easy extraction and purification, no effluent generation, very high sustainability, mild dyeing conditions with no health hazard etc. However there are some technical issues and disadvantages like poor fastness properties and reproducibility of shades, lack of standard colour recipes and methods, use of non-eco-friendly metallic mordant and limited applicability to natural fibers like cotton, silk etc.(Pereira and Alves, 2012).

Cost considerations

Synthetic dyes are intensely colored and a much smaller amount is sufficient to produce good coloration. Natural dyes are not yet compatible with industrial dyeing machines and hence the dyeing process is labor intensive. The cost of the natural dye material itself may be more as sometimes it is already in use for other purposes such as medicine, food ingredients etc. However, if the hidden cost of synthetic dyes in terms of pollution caused and its harmful effects on the environment and expenditure incurred on effluent treatment is also considered, the gap substantially narrows (Zarkogianni *et al.*, 2011; Saxena and Raja, 2014).

Social concerns

Entry of partially treated synthetic dye effluents into water bodies has altered the physical, chemical and biological nature of it. This has impacted the whole ecosystem and has raised social concerns. Recently, many commercial dyers have started using natural dyes to overcome the environmental damage caused by synthetic dyes. Also, synthetic dyes such as azo dyes are reported to be carcinogenic and can cause allergic reactions. So countries like Germany, Netherlands, India etc. have put ban on production and use of numerous specific azo dyes (Saxena and Raja, 2014).

Economic concerns

Selling of natural dye materials and their extracts is, done at a small industry level by many manufacturers in the United States, India, China, and other countries with the help of internet. Natural dyeing is currently done at the level of 1% by traditional artisans and small entrepreneurs. The traditional process of preparing, testing and using natural dyes is labor-intensive and it locally supports the indigenous artisan. Thus in developing countries like India where the population is high, employment opportunities could be expanded along with the economic growth of the country (Cana and Camarero, 2010; www.naturaldyes.io)

Research and developments

The use of biomordants is replacing the toxic metal salts as modrants. Several researchers had proposed different dyeing methods and process parameters. However the information is inadequate to achieve good colour fastness to washing and light. Thus there is a need of research

to develop some standard dye extraction technique and standardisation of the whole process of natural dye (Bechtold *et al.*, 2003; Cana and Camarero, 2010).

Natural dyes need to be increased in a sustainable manner by utilizing the by-products and wastes from agriculture and agro processing industries. In the case of plants source, other parts of that plant may have their uses too, leading to waste reduction. Dye-bearing plants can be grown on wastelands. Also increasing the production of natural dyes from microbes and promotion of genetic engineering will bring down their cost. Natural dyes disposal requires less water when compared to synthetic dyes (Agarwal *et al.*, 1993; Samanta and Agarwal, 2009; Cana and Camarero, 2010) Thus they are a sustainable option for all the small-scale dyeing units which lack the financial resources to maintain effluent treatment plants.

UNESCO in collaboration with many countries like Indonesia, Jordon etc. is organizing training programs and workshops to empower the applications of natural dyes. In this fast changing world of technological and digital revolution, expansion of such empowerment programs will create inclusive job opportunities and has an incredible potential to achieve sustainable development goals (www.unesco.org, www.theguardian.com, www.naturaldyes.io).

Conclusion:

In the current scenario, organization of workshops, symposia, webinars and virtual conferences will form a network for sharing knowledge and technology of natural dyes beyond boundaries. Effective prevention and control strategies and bans on synthetic dyes will enable to combat all kinds challenges posed by artificial dyes effectively. A very strong research and development work adapted worldwide to improve the quality of natural dyes in terms of low cost, use of natural mordent etc. will widespread the applications of natural dyes. Timely collaborative efforts and collection of spectral data of natural dyes will help in the reproduction of any given shade. Although research needs to be developed further, steps like financial incentives and funding offered to small manufactures of natural dyes will revive and regenerate natural dyes to achieve human, social, economic and environmental sustainability.

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URBAN HORTICULTURE – A TOOL FOR FOOD SECURITY THROUGH SUSTAINABLE ENVIRONMENT

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Abstract:

Ever increasing population and decline in available land are some of the major concerns in recent times. To feed the entire population, the food production has to be increased drastically but the major constrain being limited resources. The estimated population rise is about 9 billion by 2050. Asian countries are the most affected in this aspect with respect to both land unavailability and food and nutritional insecurity. Urban horticulture, the cultivation of food crops in available spaces of buildings and other areas is gaining importance. This not only provides food but ensures employment, reduces urban – rural imbalance, conserves diversity, reduces harmful climate change and acts as a mean of sustainable production. This chapter helps to review the salient features of contemporary urban horticulture along with a brief information on both traditional and modern cropping systems being adopted.

Keywords: Urban Horticulture, Social Challenge Mitigation, Cropping Systems

Introduction:

An evaluation states that, 10 % of the present land will become unavailable for crop development for every 1 degree rise in temperature. This also poses a risk of complete unavailability of land for cultivation in near future. Around 80 % of land under cultivation has already been used and a major portion of it has turned out to be depleted or no longer usable (Anonymous, 2011). Urban horticulture involves the cultivation in cities and its surroundings were there is competition of land. It involves the cultivation of fruits, vegetables, tubers, herbs, mushrooms and so on Franceso *et al.* (2013). Although it includes area for recreational purpose, the main aspect of urban horticulture is production of horticultural crops. Efforts has been made by researchers and government officials to utilize vacant lands in cities for the production of food. As horticultural crops are considered to have short production cycles, utilize reduced land, provide more yield per unit area and nutrient dense they are considered very ideal for this dynamic cultivation (Chandran, 2020; Dubbeling *et al.*, 2010). This cultivation aspect also creates a positive attitude towards nature and natural habitats Artmann and Sartison (2018).

Why emphasis on urban horticulture?

Supporting about 16.7 % of world population, India occupies only about 2.4 % of the entire world Kumar (2012). The world population has been on a drastic increase and has reached

8 billion by November. This led to the utilisation of maximum lands for industry, residential and commercial purposes ultimately diminishing the cultivable land. The negligence of key components of environment during demographic change results in catastrophic havoc throughout the world Suman and Bhatnagar (2019). Food insecurity is an important factor for mal and under-nutrition which is also a consequence of environmental change resulting in decreased space for crop cultivation in urban areas. The conflict between food crops and energy crops is another challenge imposed on food security Suman and Bhatnagar (2019)**.** Urban population is highly affected by deficiencies caused by both vitamins and micronutrients like Vitamin A, iron, zinc and iodine. Recently, the outbreak of COVID-19, has created greater havoc and disrupted the food chain. Transportation interruptions, labor shortages and limited market access have led to food loss and waste Beltrami (2020). Moreover, the major threat in developing countries apart from virus outbreak is hunger, as more people were about to die of hunger rather than the disease (Madagow, 2020; Chandran, 2020). Under all these conditions, urban horticulture comes handy as a solution. Horticulture in urban vicinity acts as a ray of hope for providing a neutralized food security and eco-friendly environment. This not only provides food of high nutritional and health value, but also offers livelihood.

Challenges mitigated through urban horticulture:

Source of income generation

The demand for healthy and safe food is under intense pressure, in cities where there is an increased population especially in developing countries. In these areas, to generate employment opportunities and also to act as a source of local food production urban horticulture plays an imperative role De Bon *et al.* (2010). In Africa, about 40 % of urban citizens are involved in urban horticulture which acts as a major source of income generation Zezza and Tasciotti, (2010). Urban horticulture provides work opportunities to those who have the least employment opportunities, and is a way for the unemployed, as well as day-wage earners, to become self-reliant entrepreneurs Kekana (2006).

Mitigation of environmental pollution and waste management

Urbanization and industrialization have led to an ever-increasing environmental pollution. The emission of harmful gases like carbon dioxide, carbon monoxide, sulphur dioxide contributes to global warming and on a broader view is detrimental to urban inhabitants. Plants cultivated in urban horticulture absorb the soil and air pollutants and this green vegetation reduces air pollution, dust particles and nitrogen dioxide Harris and Manning (2010). Waste management, on the other hand is yet another serious hazard that can be minimized by integrating horticultural plants into urban landscape Buechler *et al.* (2006). Organic waste from household such as fruit and vegetable peels can be utilised for composting which in turn is used as a natural soil amendment for fresh crop production Aprilia *et al.* (2013). These biosolids also improves the urban soil quality Kumar and Hundal (2016).

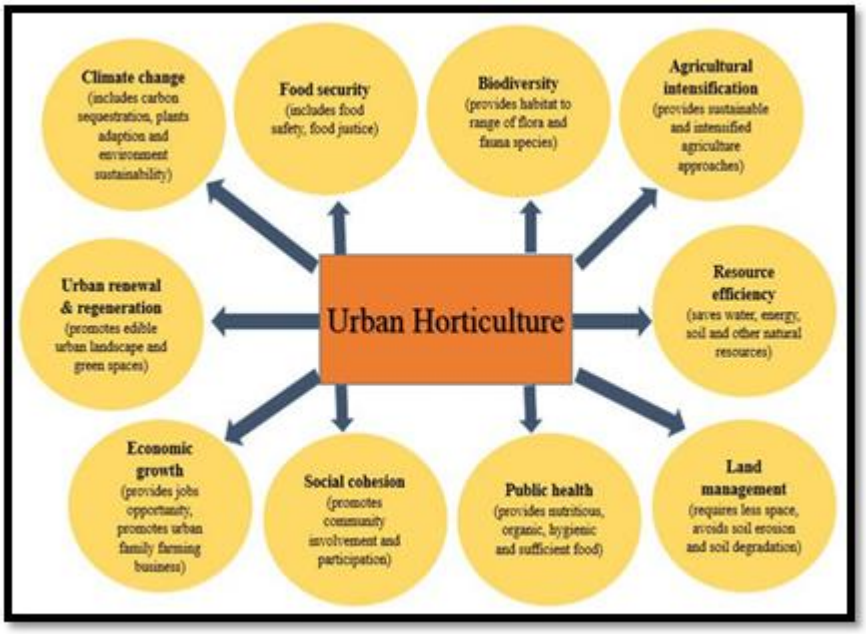

Figure 1: Challenges mitigated through urban horticulture

Food security

Climate change, natural disasters, refugee crisis, worsening inequality and conflict between countries poses high risk to consistent food supply. Due to COVID 19 pandemic and lockdown policies being implemented, production, processing, marketing and transport of food commodities have gone down the drain. It has been estimated that by 2030, the global food production will rise to 43 % FAO (2011). Inclusion of edibles in urban horticulture enables continuous food flow with high food safety standards. In Wuhan, a project named "Vegetable basket" is being implemented to enable uninterrupted food supply FAO (2020). In Singapore, 35.5 % of vegetables are obtained from rooftop farms and gardens being maintained by people Astee and Kishnani (2010). If urban dwellers opt for self-production of food, it may help augment food security.

Enhancement of microclimate

Deforestation, emission of greenhouse gases, heat and smoke emanation from vehicles and industries inflated the pollution levels. As many people are concerned about rising temperature, erratic rainfall patterns, reduction in crop yields Hatfield *et al.* (2011) due to climate change and sustainable food production in urban areas, they are moving towards urban horticulture (Hardman and Larkham, 2014; Martellozzo *et al.* 2014). Urban vegetation assists in reducing solar radiation, dust particles thereby increasing humidity and modifying the microclimate. Tall trees, shrubs, mulches and grasses has been found to bring about a cooling effect Deelstra and Girardet (2000).

Biodiversity conservation

Increase in environmental pollution has affected the natural cycles, ecological patterns and processes Nilon *et al.* (2017). Biological ecosystem has been disrupted by human activities which influence the flora and fauna species negatively. The green spaces in urban areas are often used as a refuge site for natural habitats Goddard *et al.* (2010). In order to enhance biodiversity in urban areas, establish a better place for the survival of flora and fauna in natural habitats organic farming has been considered as an essential tool.

Source of recreation

A trend for more urban horticulture is on the raise, where people adopt this technology as a hobby or recreational activity. This has been shown helpful in reducing mental stress, promotes social association and cultural activity. It also helps to reduce gender inequalities because 65 % of participants are women ultimately leading to women empowerment (Galhena *et al.* (2013). It promotes public health by providing relief, reducing stress and improving physical and mental health. It also increases the longevity of senior citizens Takan *et al.* (2002).

Cropping systems in urban horticulture:

Urban and peri-urban horticulture is inclusive of various approaches such as large-scale commercial farms, community gardens, allotments for self-consumption and edible landscapes. There are two types of cropping systems in urban horticulture *viz.,* Traditional and Modern innovative cropping systems. Traditional systems include home gardening, community gardening and edible horticulture landscapes. Modern systems are inclusive of soilless culture like hydroponics, aquaponics, organoponics; rooftop gardens and greenhouses and living edible walls.

Traditional systems:

Home gardening

Home gardening also known as backyard or kitchen gardening is a global phenomena in both rural and urban agriculture. Some of the ways through which crops are cultivated include backyards, balconies, vacant spaces or any small garden. The major advantage is that it provides fresh vegetables and saves income spent on food Olouch et al. (2009). This is particularly valuable in developing countries where 60 to 80% of family's income is spent on food Nugent (2000). Provided it also acts as source of food, exercise, shade and aesthetic value.

Community gardens

Community garden represents a collective cultivation of plants in a shared area by a group of people. This area is usually utilised by the municipality. In order to overcome resource shortage and insufficient infrastructure facility in home gardens, community gardens have been widely adapted. These are often supported by private organizations and government officials through supply of inputs. It strengthens communities, educate people and make city greener.

Figure 2: Community garden

Figure 3: Living edible walls or Vertical farming

Edible horticulture landscape

Edible landscaping is a holistic approach, where fruits and vegetables are cultivated. In certain cities, this practice varies from small to large scale. The main intention is to enhance food security and provide food for rural areas Lovell, (2010).

Modern cropping systems:

Indoor growing system

Indoor cultivation methods are generally termed as Z- farming *i.e* zero acreage farming. Roofs of schools, shopping malls, hotels, supermarkets are the most ideal places for cultivation Caplow (2009). This includes indoor farms, vertical green houses, rooftop greenhouses, roof top gardens and edible green walls. It has been a ray of hope in Europe, Canada and United States.

Living edible wall

It provides an alternative green system in which plants are supported along a vertical wall. It creates a healthy, vigorous and long-lasting greener systems which enable noise reduction and air purification. These vertical systems enable year round cultivation.

Rooftop gardens

In roof top garden, the roof of the building is covered with substrate into which shrubs, trees and other plants are grown. The technology was first adopted in Germany whereas 70% of apartment roofs were converted green in Switzerland Grayson and Campbell (2004). It prevents heat lose, provides increased cooling and also have increased the lifespan of roofing membranes up to 40 – 50 years.

Soilless culture

Soilless culture includes the cultivation of plants in organic or inorganic substrates instead of soil. Cultivation systems include hydroponics, aquaponics and aeroponics. They require less water, reduced pesticide use, controlled environment and provides a constant production throughout the year AlShrouf (2017).

Hydroponics:

This technique involves around the principle of cultivation of plants in nutrient enriched water instead of soil. This has become the most adopted technology in areas where food cannot be cultivated during cold winter months. Here, relative humidity and temperature are automatically controlled which reduces the risk of harmful pest and disease-causing organisms (Goddek *et al*. 2016; Anonymous, 2016). As nutrient and pH availability is easily manageable this is a labor and time saving technology. This has become one of the best alternatives for cultivation in urban areas where fertile land is a limitation.

Aeroponics:

It requires 90% less water compared to hydroponics. Vegetables, fruits, flowers are grown in a system where mist is applied to the living roots Boston (2014). They have high nutritional quality due to higher absorption rates.

Aquaponics:

It is a combination of both hydroponics and aquaculture. Aquaponics uses only 2% of the water used in conventional systems. As it is a closed loop system, the reuse of water from fish is used as a fertilizer for the plants. The exchange filters aids in the removal of harmful acids, chemicals and gases McCollow (2014).

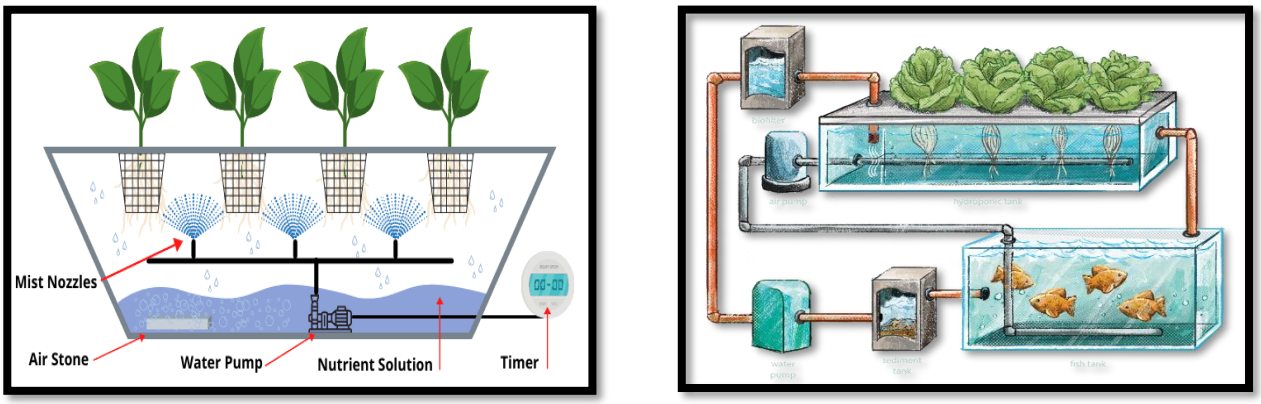

Figure 4: working systems of aeroponics and aquaponics

Organoponics:

Organoponics is the cultivation of plants using organic substrates, by forming a seedbed consisting of a mixture of soil and organic matter. Because of its eco-friendly nature, it is highly suitable for urban horticulture.

Conclusion:

For a society to progress at a rapid phase, urban and per-urban horticulture seems to be an emerging factor which provides nutritious food, aesthetic recreation and socio-economic importance for city dwellers. It also aids in horticultural business entrepreneurship. Well-managed urban horticulture acts as a tool to improve environmental management, reduce poverty and improve economic development. This inclination towards urban horticultural techniques

opens up new vistas of production like roof top gardening, greenhouses etc., which not only provides nutritional food but also enhances sustainable livelihood in cosmopolitan areas.

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GREEN FINANCE FOR SUSTAINABILITY: AN OVERVIEW

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Abstract:

These days, protecting the environment and addressing environmental challenges are top priorities. Green finance refers to investments in cleaner forms of industrial and economic development that also reduce emissions of greenhouse gases and other environmental pollutants. Green finance seeks to achieve the sustainable development objectives by increasing the flow of money from financial institutions to economic activities engaged in environmentally friendly initiatives and actions. Green financing fosters more equitable development of the economy. Investments in environmentally friendly initiatives have the potential to lower both short- and long-term carbon emissions. This paper discusses about need of green finance, benefits, challenges to green finance. Increasing and promoting a company's participation in green financing may increase the company's market value. Green finance, as an effective weapon of sustainability, is rising in prominence as the world urgently seeks to promote sustainable development. More and more investors are considering their social responsibilities alongside their financial ones.

Keywords: Green Finance, Sustainability, Environment, Investors

Introduction:

These days, protecting the environment and addressing environmental challenges are top priorities. The instability of society and the environment may be threatened by the global environmental stress brought on by human activities, which can in turn slow economic growth and even create conflicts. The United Nations has proclaimed the "red code of humanity" owing to global warming, and the problem of climate change is and will be a significant for political and economic concern for many years. Responding to the climate problem, people all around the world are focused on a decarbonization plan to combat global warming and keep it below 1.5 degrees Celsius. To reduce greenhouse gas emissions and assist businesses in adapting to the effects of climate change, economy will need a substantial infusion of fresh capital, notably in the form of green financing.

There has to be an effort toward green funding from every country, both established and developing. The concept of "green credit" is based on "green finance," an environmentally sound financial strategy. Commercial banks and other financial organisations are mandated through a set of administrative measures to participate in ecological conservation and restoration by doing

research and development on pollution management facilities. Loans are made available to assist relevant enterprises and institutions, and concessionary low interest rates are implemented; however, new project investments by polluting enterprises are restricted, along with some punitive interest rates, in order to encourage a shift toward less wasteful practices.

The term "green finance" refers to the practice of raising and allocating capital for ecologically sound projects that also provide enough financial returns to financier. Green finance seeks to achieve the sustainable development objectives by increasing the flow of money from financial institutions to economic activities engaged in environmentally friendly initiatives and actions. The worldwide community has committed to combating climate change by signing the Paris Agreement, a binding international treaty.

Review of Literature:

Using a high-dimensional time-series model and data from the last ten years, Su and Liao (2019) determined that the common components of stock return on the company which is energy efficient undergo three distinct transitions over time, whereas the idiosyncratic components undergo no such transitions.

Sustainable development over the long term has been the focus of Illic and Stojanovic (2018) work on the market mechanism and designing policy of green financing. Green finance is a relatively new topic of finance that may be used to help balance ecological and monetary considerations. The phrase encompasses a broad variety of environmentally friendly technology, initiatives, and companies.

Research by Jena and Dhruba (2020) highlights the rising need to educate India's banking industry on green finance's advantages. They also imply that an accepted formal definition of green finance is the first step toward accelerating green capital flows in India. Other initiatives include the creation of rules to incentivize green financing and to charge penalties for projects that are carbon-intensive.

Mohammad and Kaushal (2018) looked at Green Finance as a way to balance the needs of the environment and the economy, discussed the different types of Green Financial Instruments and initiatives for sustainability in India, and came to the conclusion that the country has a lot of untapped potential in terms of developing the green infrastructure necessary for Green Finance.

Green Financing, which includes green investments, green banking, green projects, financial technologies, etc., needs to be accelerated to achieve the sustainable development goals, according to an analysis by Sachs et al (2019). This is because declining investment in renewable and energy efficiency threatens the expansion of green energy.

Objectives of study:

1. To discuss about green finance.

2. To know the benefits of green finance.
3. To know the challenges to green finance.

Research methodology:

This is descriptive-analytical study for which data is collected from secondary sources such as online annual reports, journals, and dailies etc.

Green Finance:

In the context of climate change adaptation, "green finance" is a strategic method to include the financial sector in the transition to low-carbon, resource-efficient economies. Green financing is the provision of resources to encourage environmentally responsible development, with the ultimate goal of lowering emissions of greenhouse gases and other air pollutants. In this context, "green growth" refers to economic expansion that doesn't compromise environmental standards. Green finance refers to investments in cleaner forms of industrial and economic development that also reduce emissions of greenhouse gases and other environmental pollutants. The world economy has three major challenges right now: climate change, energy shortages, and the present financial crisis. Green finance poses a serious threat to the established norms of national financial legislation. Since the 1990s, environmental concerns have played an increasingly important role in the project financing industry, changing institutional practices that determine loans. Water pollution and shortages, Air pollution, river infractions, incorrect disposal of wastes from industries, hospitals, and household, deforestation, biodiversity and open space loss are only some of the environmental degradation issues that green finance seeks to address. It has to be sustainable and effective in fighting poverty. Carbon emission reductions that may be sold for financial gain are the final goal of the Clean Development Mechanism (CDM), which entails cutting greenhouse gas emissions using green technology.

Need of green finance for sustainability:

The significance of green financing has made it a topic of interest. Smart city development is aided by green financing in the long term. Green financing fosters more equitable development of the economy. Investments in environmentally friendly initiatives have the potential to lower both short- and long-term carbon emissions. Institutional investors that are keen on impact investment would gain from green finance. Investors may profit from green financing's diversification features. Financing for environmentally harmful fossil fuel operations may be curtailed if green investment levels rise.

Benefits of green finance:

Investment in ecologically sound technologies, such as renewable energy, may assist reduce their prices and speed up their broader dissemination. Due to the fact that a large portion of green investment goes into infrastructure development, developing nations may sidestep the "expand first, clean up later" growth paradigm. In this case, a nation may make great strides in

establishing an environmentally friendly infrastructure. And thus it falls on governments to provide the frameworks for more efficient resource management over the long term, which boosts national competitiveness and directs private money into local green sectors.

The challenges posed by climate change and other environmental and economic issues, low-carbon green development may soon transit from its present, voluntary character to a mandated approach. As environmental regulations get harsher, a competitive advantage may be gained by increasing green financing now.

Increasing and promoting a company's participation in green financing may increase the company's market value. As a result, businesses may distinguish themselves from competitors and appeal to environmentally sensitive customers and investors by making their company more sustainable.

It improves the economy's long-term prospects by fostering the development of domestic markets for alternative resources and technologies to be used in the event that conventional ones become depleted. By exploring untapped areas with substantial opportunity for new job creation, it boosts their economic outlook even more.

Challenges to green finance:

An activity specific and general barrier for private investments for green development in the underdeveloped nations is one of the challenges. Risk management and return on investment are impacted negatively by certain country-specific obstacles. The level of attractiveness of private investments in green growth compared to other options, both local and foreign, will determine the rate at which these investments are increased. Governments may need to adopt a number of public initiatives to create green investment prospects more appealing to foreign investors who may search across borders for opportunities.

The success of a nation in attract private investors depends on its entire investment and policy climate. Risks associated with green growth are not being adequately priced by finance markets in certain nations. The market's inability or unwillingness to accurately price these risks is a significant obstacle. Uncertainty about emerging technology and procedures, as well as issues with domestic policymaking's stability, clarity, and planning, are all examples of such threat.

Investment in green energy will struggle to generate attractive returns for investors so long as the market price of energy is distorted by subsidies for fossil fuels and the inability to absorb environmental externalities. The restricted availability of green financing products and trading venues further exacerbates the problem.

Private investors want the greatest possible risk-adjusted profits, public green financing providers want the most environmental improvement feasible, and host-country officials want the best possible growth prospects.

Many businesses, the lack of cash on hand and access to credit are a significant barrier to entry into the environmentally friendly finance market. Another key barrier to private investments is the short-sightedness of the dominant corporate strategies, which do not account for the long-term advantages of green sectors. Further complicating matters, there just aren't enough professionals in the field who are up to speed on the interplay between environmental concerns and the stock market.

The carbon market is frequently used as an example of a government-launched and developed green market. An emission trading programme has often been established initially in many countries, along with the enactment of laws to regulate membership, conditions of trading, and market monitoring for carbon trading.

Conclusions:

Turning to environmentally friendly "green" alternatives is a widespread movement aimed at reducing human impact on the planet. Overestimating the sustainability of their current way of life, people everywhere are starting to think about the effects on the environment. A serious and timely issue, climate change has emerged in recent years. Existing "green" bonds and "green" investment funds in certain nations are not expected to be sufficient to meet demand for capital.

Green finance, as an effective weapon of sustainability, is rising in prominence as the world urgently seeks to promote sustainable development. More and more investors are considering their social responsibilities alongside their financial ones. Raising awareness about the necessity of safeguarding environment and growing financing of green initiatives has provided a broad range of options in the domain of green finance. To prevent misleading of investors, a proper regulatory framework must be established for assessing green initiatives. Green financing is a powerful weapon for long-term sustainable growth provided it's handled correctly.

Suggestions:

Establishing an appropriate regulatory framework appropriate regulatory framework is required to assess green finance initiatives and to safeguard investors' interests.

Laws should be implemented that severely penalize market players who exploit and take undue benefits of the green projects.

Initiatives should be taken to promote study in the area of green financing, which will bring together technological advances and the financial sector to produce the novel green investment products, effective green projects, and appropriate policy actions essential to full development and growth.

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ZERO HUNGER CHALLENGES FACED BY INDIA

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Abstract:

Sustainable development goals 2 on achieving zero hunger. Many Countries facing zero hunger as challenged for here government Egypt, Tanzania, India, Brazil etc. Hunger varies from person to person and depending upon what is there requirement of food or Nutrition in their body. The world is not track to achieve zero hunger by 2030. There are so many people who affected by hunger. This paper focusing on zero hunger challenges faced by India or suggestions to overcome zero hunger.

Introduction

Sustainable development is development that meets the needs of the present, without compromising the ability of future generations to meet their own needs. The sustainable development can be interpreted in many different ways but at core an approach to development that looks to balance different and often competition needs against ab awareness of the environmental social and economic limitations we face as a society. In India final energy demand grows foster than the development of its own national resources. Beyond one can observe a regular growth in the intensity of polluting energy emissions of the economic activity. This is worsened by the Misallocation of resources due to pricing policies, management systems, and more generally, policies that

Induce a lot of inefficiency and waste. To tackle the long run constraints of the present demand and supply trends drastic changes in the management of the sector are required. Implementation of reform began in 1991. In 1972 the then prime minister of India. Mrs. Indira Gandhi emphasize at The UN conference on human environment at stock, that the removal of poverty is an integral part of the goal of an environment strategy for the world. They apply equally to the shared and inter linked responsibilities of environment

Protection and human development. History has led to vast inequalities leaving almost three fourths of the world s people living in less developed countries and one fifth below the poverty line. The long-term impact of past on people's, And environment. The problem are complex and the choices Difficult. Our common future can only be achieved with a better understanding of our common concerns and shared Responsibility.

The sustainable development Goals are:

- No poverty
- Reduce inequalities

- Zero hunger
- Good health and wellbeing
- Quality education
- Gender equality
- Clean water and sanitation
- Affordable and clean energy
- Decent work and economic growth
- Industry, innovation and infrastructure
- Sustainable cities and communities
- Responsible consumption and production
- Climate action
- Life below water
- Life on land
- Peace, justice and strong institutions
- Partnership

These are goals of sustainable development.

Hunger is a subjective concept; its definition varies from person to person depending upon perception and understanding of requirements and objective of life availability of resources. Hunger exists when a person's have lack of nutrients in the body. The term hunger including malnutrition, starvation. Hunger also denotes the scarcity of food in a country. And in India hunger is one of the critical problems though it is always assumed that hunger stem from stems from lack of food it's not completely true as hunger can stem from food mismanagement or wastage.

What is zero hunger?

It is a mission which aims bringing together all stakeholders to communicate the important of food security nutrition in our body. The official wording is: End hunger and promotes sustainable agriculture. SDG2 highlights the complex interlink between food security nutrition rural transformation and sustainable agriculture. One in every nine people goes to bed hungry each night including 29 million people currently at risk of famine in South Sudan Somalia Yemen and Nigeria. SDG 2 has eight target and 14 indicators to measure process. The zero hunger challenges were launched by United Nations Secretary-General Ban Ki-moon in 2021at the UN conference on sustainable development in Brazil in June 2012. This requires comprehensive effort to ensure that every man, women and child enjoy their right to adequate food; women are empowered and priority is given to family farming. It requires a renewed focus on how to respond to crises while all the time building capabilities and resilience within individual and communities long term and proactive strategies that deliver for people and plants. Five elements from within the SDHs which taken together, can end hunger, eliminate all forms of malnutrition, and build inclusive and sustainable food system. Sustainable food system delivers food security and nutrition for all in such a way that the economic social and environment bases to generate food security and nutrition for future generations are not compromised.

What cause zero hunger in India?

Poverty

Poverty and hunger go hand in hand. Families trapped in the Cycle poverty usually can't afford nutrition food leading to undernourishment. In turn undernourishment make it difficult for people to earn more money so that they can afford healthy food. India has a 27. 9 percent intensity and 45.9 percent incidence of multidimensional poverty with large number facing overlying deficiencies in health. If you are poor, you can't afford nutritious food. This makes it difficult to work or earn a living and often means that people remain in a poverty trap. Conflicts disrupt farming and food production. Families living in poverty might also sell off their livestock or tools to supplement their income. This buys short-term relief, but perpetuates a longer-term pattern of hunger and poverty that is often passed down from parents to children.

Food shortages

There are the times of years when food supplies from the previous harvest are exhausted but the chance to replenish supplies is still some time off. This leaves families forced to skip one meals each day. Across regions like the Sahel and the Horn of Africa, farming families experience periods before harvests known as "hungry seasons.

These are the times of year when food supplies from the previous harvest are exhausted, but the chance to replenish supplies is still some time off. This leaves families forced to skip one (or more) meals each day in the period before the next harvest – which could be months away.

Gender inequality

Economic growth alone does not ensure that prosperity is broadly shared. Every country, regardless of its wealth, has discrimination woven into its social fabric. Disadvantaged groups tend to be left the furthest behind. In most countries, evidence shows that hunger and poverty disproportionately impact women, communities of color, and rural communities.

Among all of these groups, women and girls are more disadvantaged than their male counterparts. Discrimination is why women farmers in developing countries labour with fewer productive resources than their male counterparts, why women in all sectors of the economy earn less than men, and why girls are pulled out of school to work or to marry.

Gender discrimination is often a cause of persistent hunger. Sixty percent of the world's hungry people are women and girls. Empowerment of women and girls is essential in ending hunger, extreme poverty, and malnutrition around the world and in the U.S., Research has shown that giving women greater control of their income and assets leads to widespread improvements in a country.

Climate change

Hunger due to climate change. Too little- Or too much- rainfall can destroy harvests or reduce the number of animals pasture available. These fluctuations are made worse by the El

Nino weather system, and are likely to increase due to change in climate. The world Bank estimates that climate change had the power push more than 100million people into poverty over the decade. Climate change plays a role in increasing natural disasters. Climate change disrupts food production more frequent and more intense natural disasters destroy crops. Drought, flood or simply unpredictable weather pattern make it very hard for farmers to plan for a successful harvest.

Poor economy

Much like the poverty hunger cycle, a count economic resilience has direct effect on its nutritional resilience.

Poor nutrition

Hunger isn't simply a lack of access to food: It's a lack of access to the right nutrients. In order to thrive, humans need a range of foods providing a variety of essential health benefits. Families living in poverty often rely on just one or two staple foods (like corn or wheat), which means they're not getting enough critical macronutrients and vitamins, and may still suffer the effects of hunger. A lack of nutrition is especially important for pregnant and breastfeeding women and young children: Nutrition support during pregnancy and up to the age of five can help protect children for their entire lives. Proper nutrition reduces the likelihood of disease, poor health, and cognitive impairment.

Food waste

According to the government program, one third of all food produced over million tonnes of it is never consumed. What more producing this wasted food also uses other natural resources that when threatened have a ripple effect in the countries that are already hit hardest by hunger poverty and climate change. In marriages and party's people waste the food.

Suggestion to overcome zero hunger:

Reduce food waste

The main reason why millions of people are hungry is because thousands of tons of food is being wasted world wide. To put an end to this it is essential tips reduce the amount of food being wasted. As the saying charity begins at home we should start incorporate the act of reducing foot waste at our homes. This way even the future generations would understand the seriousness of the issue and respect food.

Food donation drive

Various NGOs like feeding India have partnered up with online food giants like zomato to make sure the needy are fed. Schools, college and corporate could organize these food donation drive and feed the hungry. Every time a large amount of food is left over donate the food to orphanage and home less people, shelter home instead of dumping the food.

Government policy

There are five hunger fighting initiative taken by the government including National Nutrition Mission, zero hunger programs, eat right India movement and effort towards food Fortification. Ending food waste would be a radical shift, but it's one that you can be a part of by simply reducing your own food waste. It's especially important in countries like the United States (which contribute more to climate change but feel the effects less than more vulnerable countries) to take these steps towards climate justice. You can also ask your representatives to commit to policies that reduce waste and better the whole food systems.

Improving food storage systems

What if you have plenty of food, but lack the storage solutions to make it last? This is another problem that, when solved, can make a big difference in closing the hunger gap. Sometimes this requires big interventions, like building or rehabilitating grain stores. Other times, this is a change that can happen at the household level. One innovation Concern has introduced into exposure women's self-help groups around the world are solar dryers. Sun-drying vegetables, a traditional practice, preserves micronutrients and prolongs shelf lives. Solar dryers, which operate by (you guessed it) to sunlight are eco-friendly devices that accelerate this process, while also reducing contamination and minimizing nutrient loss.

Support hygiene and sanitation

Sometimes, people (especially children) eat enough. But if they live in an area with insufficient sanitation or poor hygiene practices, they may be susceptible to diarrhoea or other waterborne illnesses that prevent them from absorbing those nutrients. Making sure that drinking and washing water are uncontaminated can save a life — in more ways than one.

Zero Hunger Programme

The programme was initiated by the ICAR (Indian Council of Agricultural Research) along with the ICMR (Indian Council of Medical Research) and the M.S. Swaminathan Research Foundation with BIRAC (Biotechnology Industry Research Assistance Council). State governments will also be involved in the initiative.

- The programme aims at making farm interventions and incorporates among others:
- Organising the farming system for nutrition.
- Setting up genetic gardens for bio fortified plants.
- Initiating zero hunger training.
- These districts will act as models of integrated approach in dealing with hunger and malnutrition by adopting appropriate agricultural and/or horticultural practices.
- The initiative is in tandem with India's Sustainable Development Goals (SDGs), one of which is ending hunger by 2030.
- The programme was announced by eminent scientist Dr. M S Swami Nathan.

Conclusions:

The world community has the mastery and all that is needed to prevent and fight hunger and poverty yet people are hungry even when there is enough food because it is not equally distribution and due to political unrests providing aid food foot the hungry is not an ever last it solution to tackle poverty and hunger. We need to find a sustainable solution to eradicate hunger and poverty. We need to address the issues such as poor farming deforestation, over cropping and overgrazing that are exhausting land fertility and cause hunger. Wars are another underlying issue to poverty and hunger that need to be addressed as million of people get displaced every from their home leading to hunger and poverty. We need to find better way of fighting hunger and poverty by addressing the issue at a stage. Food insecurity remains an alarming issue due to such entitlement failures in India. While the government has rejected the findings of the Global Hunger Index as "unscientific", we cannot ignore the dismal ground realities. India faces a malnutrition challenge that is not only large but worsening. It is time for the government to face up to these inconvenient truths and pursue the means and mechanisms needed to improve the situation. A safe and bright future for our children will translate into a safe and bright future for the country.

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CHANGE THE FOOD TO SAVE THE EARTH

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Introduction:

The major food resource of human being until they began to lead a settled mode of life by deserting nomadic life were mainly fruits and tubers. The shorter shelf-life period and seasonal availability of these food resources are the two important factors that forced the human society to lead the nomadic mode of life in ancient time. The beginning of agriculture especially cultivation of cereals supported human beings to settle at convenient geographical area. First and foremost, favorable factor provided by cereal cultivation to the settled mode of human life in the beginning was the prolonged dry storage life of dried cereals and its agricultural residues such as hay, husk, bran etc. as food and fuel recourse for man and fodder to their livestock for a long time. This helped the man to settle in fertile land on the banks of rivers and to flourish cereal based agriculture system. And, they could produce food more than that to satisfy their existing requirements by exploiting the favorable edaphic and climatic factors in each season and store it for future. The storability of cereals seeds for a long period as a propagule for rising next generation has also performed a key role in the evolution of permanent settlement of human beings. Seeds storage is the unique and unavoidable process of preservation of seeds in viable condition from the stage of collection until using for rising next crop. Holmes and Buszewicz (1958). In short, the fruit and tuber-based food system of human being was transformed to cereal dominated one on the onset of agriculture.

Need of change

In the initial stages, the quality and quantity of fertile land and fresh water for agriculture were more than enough to satisfy the limited population. However, by the development of agriculture the ancient human society could enjoy their life with more free time. This step was a paradigm in the socio-economic and cultural phase in the anthropological history because both agriculture and human population bloomed in a positive correlation. The sufficient supply of food resources had set a favorable environment for the population growth. During that time there was no resistance from the environment for the growth and development of both the human population and agriculture because compare to the size of human population the carrying capacity of agriculture land was very high. The carrying capacity is defined as the maximum level of potential of a specific environment or ecosystem to sustain the maximum population

size of a biological species by providing the food, habitat, and other basic resources essential survival. Arrow *et al.* (1995).

But the blooming of human population was not in accordance with the sustainable potential level of natural resource. The area of land on the earth can never be increased but the population can. The carrying capacity of the environment, especially of densely populated third world countries shows negative correlation with the potential of natural resources needed to produce the required quantity of cereals. The regenerative capacity of most of the natural resource exploited for agricultural practice, especially for the cultivation of cereals has been degraded drastically during the last couple of decades. The only feasible way to tackle this environmental crisis is the revolutionary transformation of our cereal dominated food system to fruits and tuber-based food system as early as possible.

However, changing the food system from cereal dominated one to a menu with fruits and tuber based one is not an easy task for common man. Potential ways to raise the production of fruits and tubers in a required level is to be sorted out. In terms of land availability, non-irrigatable sterile arid land can be utilized for the cultivation of fruit yielding trees. Apart from these, land near the national high ways and other roads, railway lines, banks of the river and canals, seashore, barren land in the deforested areas and discarded mines, area which was once used for quarrying, etc. can also be considered for this.

Fruits are nature's wonderful gift to the mankind. In fact, they are life-enhancing medicines packed with vitamins, minerals, anti-oxidants and many phyto-nutrients etc. They are an absolute feast to our sight, not just because of their colour and flavour but for their unique nutrition-profile that help human body free from diseases and keeps us healthy.

Health benefits of fruits

- Fruits are low in calories, sodium, and fat and are a source of simple sugars, vitamins, etc. which are essential for optimizing our health.
- Fruits provide plenty of soluble dietary fibre, which helps to ward off cholesterol and fats from the body and to help in smooth bowel movements as well as offer relief from constipation ailments.
- Fruits compose of many anti-oxidants with high ORAC (Oxygen Radical Absorbent Capacity) such as *poly-phenolic flavonoids, vitamin-C, and anthocyanins* which help human body against oxidant stress, diseases, aging and cancers.
- Fruits has the capacity of rejuvenating power which protect human being from wrinkling of skin, hair-fall, age-related macular degeneration (AMRD) of the retina in the eyes, Alzheimer's disease, weak bones (osteoporosis), etc.

- Eating fruits such as banana and orange which is rich in potassium as part of an overall healthy diet may lower blood pressure, and may also reduce the risk of developing kidney stones and help to decrease bone loss.
- Vitamin C is important for growth and repair of all body tissues, heal wounds, and keeps teeth and gums healthy. Folate (folic acid) rich in fruits helps the body form red blood cells.
- Glycemic index (GI) of fruits such as Jack fruit (52.5), Cherry (22). Plum (24), Apple (34), Coconut (45), Orange (40), Mango (60), Fig (61), Papaya (60) is very low or medium.

The low GI could be due to the collective contributions from dietary fibre, slowly available glucose and un-gelatinised (intact) starch granules in the seeds. *Glycemic index is a ranking of carbohydrates on a scale from 0 to 100 according to the extent to which they raise blood sugar levels after eating. (High-70 to 100, Medium- 56 to 69, Low- 0 to 55) Foods with a high GI are those which are rapidly digested and absorbed and result in marked fluctuations in blood sugar levels. Low-GI foods, by virtue of their slow digestion and absorption, produce gradual rises in blood sugar and insulin levels, and have proven benefits for health. Low GI diets have been shown to improve both glucose and lipid levels in people with diabetes (type 1 and type 2). They have benefits for weight control because they help control appetite and delay hunger. Low GI diets also reduce insulin levels and insulin resistance. In 1999, the World Health Organisation (WHO) and Food and Agriculture Organisation (FAO) recommended that people in industrialised countries base their diets on low-GI foods in order to prevent the most common diseases of affluence, such as coronary heart disease, diabetes and obesity*

Do we really need cereal consumption?

There are some drawbacks of cereals when it comes to excessive consumption. Most of the commercial varieties of cereals have plenty of salt, sugar, and fat, nevertheless, the high-bran products often lead to discomforts in abdomen, bloating and intestinal gas flatulence. Too much consumption of these products decreases body's capability of absorbing iron, zinc or other minerals. Most grains are acidic in nature; thus, they can produce acidic state within the tissues and blood. Uncontrolled cereal consumption can lead to premature aging and increase the chances of certain diseases like arthritis. Grains are comparatively more difficult to be digested than salads, fruits, sprouts or vegetables, so it is always recommended to have cereals in moderate amounts to avoid chronic disease conditions. Even then, cereal grains are advised to be consumed after mild cooking. Excessive heat destroys the minerals, enzymes and vitamins of cereals, so baking or steam cooking is preferred in most cases.

There may be a possibility for the shortage of starch content in the diet, especially in the case of lay man with very limited income. This can be overcome by utilising seeds of various fruits like mango, jack fruit, Cycas etc. and tuber crops like diaschoria, colocasia, elephant foot yam etc. as the source of starch. Seeds normally are discarded or steamed and eaten as a snack or used in some local dishes.

Fruit crops – a panacea for the problem

Kerala, the Agro-biodiversity paradise is rich with numerous fruit yielding plants. Some of them is indigenous and others are exotic which are well adapted to our climate. The fruits often classified as minor fruits are neglected by us. We hardly realize the value of these fruits. Hence many of these plants are facing extinction. Ancient medicine systems like Ayurveda, Siddha, Yunani etc. have recognized the qualities of these fruits and included them in many medical preparations. Modern studies are also revealing the properties of these miracle foods.

By growing trees on sides of the roads and banks of river and canals it can be protected in a natural way without wasting money and natural resources like sand, rock, cement, metal etc. If the indigenous fruit yielding trees are utilising for this purpose, it will be the biggest field gene bank for the RET species. (R-Rare, E- Endangered, T- Threatened). Usually, the indigenous species will have more resistance potential against the pests and pathogen because they are naturally evolved one by passing through the process of struggle for the survival for a long period and have been developed favorable adaptive mechanisms which is very much suitable for the existence in that habitat. So, the application of hazardous pesticides and other chemicals can be avoided fully or at least minimised. Indigenous varieties can survive in soil with minimum mineral and water resource. So, the additional supply of nutrients or fertilisers (Organic or Chemical) is not necessary for the growth and development of these plants in optimum level. Kenneth *et al*. (2004). This approach can help to minimize the indiscriminate siphoning of fertilizer residues of nitrogen and phosphorus to the water bodies which cause transformation of living water bodies to dead one with high BOD (Biological Oxygen Demand) and this phenomenon is known as eutrophication. Asthana and Asthana (1998). If the responsibility of planting the seedlings, maintaining the trees are assigning to the local community in a mutualistic way i.e., the growers will get 50% of income and the remaining 50% will go to the State or Local Self Government. So, the government not only need not find out source of fund for this programmed, but it will serve as sustainable source of income which can be utilised for the environment protection and awareness creation activities.

Green canopy can help to reduce the global warming by absorbing atmospheric carbon di oxide and fixing it as biomass (carbon fixation) through photosynthesis. Dense canopy can reduce sound pollution and pollution caused by dust and aerosols. In addition to this the green canopy can be exploited in the aesthetic aspect of tourism by providing natural green shade and

tree house to the tourist. As the trees will serves as shelter and food resource for a large number of birds, lizards, insects, flies, ants, lichens etc. the floristic and faunistic diversity of that area will be nourished. The entangled mass of roots of trees helps to prevent of soil erosion in considerable rate. Soil is the earth's fragile skin that anchors all life on Earth and it takes 500 to thousands of years to create an inch of topsoil. But the rain fall in one year is more than enough to run away this soil, if the surface soil is exposed to rain or wind. Vegetation acts as an interface between the atmosphere and the soil and prevent soil erosion. It increases the permeability of the soil to rainwater, thus decreasing runoff. It shelters the soil from winds, which results in decreased wind erosion, as well as advantageous changes in microclimate. The roots of the plants bind the soil together, and interweave with other roots, forming a more solid mass that is less susceptible to both water and wind erosion. Excessive or accelerated erosion causes both 'on-site' and 'off-site' problems. On-site impacts include decreases in agricultural productivity and ecological collapse because of the loss of the nutrient-rich upper soil layers. In some cases, the eventual end result is desertification. Off-site effects include sedimentation of waterways and eutrophication of water bodies, as well as sediment-related damage to roads and houses. Blanco *et al.* (2010). The loss of soil fertility due to erosion is further problematic because the response is often to apply chemical fertilizers, which leads to further water and soil pollution, rather than to allow the land to regenerate (Terrence *et al*., 2002).

The wood from the trees can be used for fuel wood which will be helpful in reducing import of petroleum products used for cooking and there by self-reliance and stable economy of the country can be maintained. As wood furniture industry can provide large number of self-employments the rural economy, socio-economic status of people in that locality can be improved. The scarcity and unaffordable cost of wood forced the common man to desert the traditional eco-friendly system of construction and to opt the concrete-based construction which is harmful to the environment in various ways like rising the atmospheric temperature by releasing infra-red radiations (IR), using more water at the time of construction, usage of non-reusable or non-recyclable type of construction material etc. Sufficient supply of quality woods in an affordable rate for the construction of houses and furniture will be definitely possible by exploring the arboriculture in waste land management and thereby we can go back to our traditional system of architecture.

Value added food products can be prepared by using the fruits and vegetables collected from the trees. This can also helpful to strengthen the local economy. Fruits and vegetables obtained from the trees can be utilised to improve the health of rural people by increasing the food diversity index (FDI) nutritional level in their diet. These natural food items help the people to discard the junk food habit and they walk toward healthy way of life. Vegetative parts of trees can be utilised to improve the livestock potential which will empower the socio economic and

health condition of the people directly or indirectly in that area. The excreta of the livestock and agriculture residues can be utilised for the biogas production and sustainable organic farming.

The cultivation of cereals requires fertile land, fresh water for irrigation, supply of additional nutrients in the form of fertilizers to maintain the productivity of the soil, application of pesticides and weedicides, skilled labour etc. The cereal crops are easily susceptible to microbial and pest attack. Conversion of barren land to cultivable type requires time and labour. The preparation land for agriculture to in the hill sides with slop 30 degree or more for cereal cultivation is not advisable as it will cause the natural disaster like land slide. In the cultivation of cereals, skilled labour is essential part from sawing to harvesting. The craze towards white colour job due to various sociological reasons and lower wage has forces the skilled labours to forsake the employment opportunity in the paddy cultivation.

Water, the blue gold of the "only one earth "is very much precious natural resource. The exploitation of ground water resource for the cultivation of cereals is not economically and environmentally feasible one. The virtual water content of cereals is very much higher than that of fruits produced by trees. Production of food is extremely water intensive. Virtual water content of rise is 2497 litter per kilogram. (Apple-822 litter/kg, Banana – 790 litter/ kg.). Virtual water is the total volume of water needed to produce and process a commodity or service. The virtual water content, which represents the volume of water content the product has consumed throughout its growth cycle, gives an interesting perspective of the flow of water from major agricultural countries in terms of production to those relying mostly on import. Konar *et al*. (2011). So, in the aspect of Virtual water trade (also known as trade in embedded or embodied water) and water foot print value the cultivation of cereals for the purpose of exportation is not a beneficial type of trade especially those countries face scarcity for fresh water.

Conclusion:

The resources in the earth are not only for the present generation of human being, but for the future generation too. We do not have the right to consume the resources preserved for the whole species of living being to be come to our earth in the future. So, the practice of the principle of maximum utilisation of minimum resources is necessary to save our nature. So, as part of minimisation of natural resource utilisation, we should minimise the consumption of cereals and steps to be taken to incorporate the fruits, vegetables and tubers in different stages on our day-to-day meals for the conservation of nature in a sustainable manner.

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BIODIVERSITY AND ITS CONSERVATION

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Abstract:

Biodiversity is all the different kind of life in one area. They work together to maintain balance and support life Healthy and good biodiversity indicate good ecosystem, includes pure water, pure air, good climate. Therefore, biodiversity conservation play an important role in the quality o life of all living organisms. The management of biodiversity of resources are called biodiversity conservation. A threat to biodiversity posses a threat to humankind. It can be the cause of various problem for economic and various life support reason it is very important to protect and preserve biodiversity. Biodiversity is all the different kinds of life find in one area, the variety of animals, plants, fungi and even microorganism like bacteria. It is essential for the processes that support all life on Earth including humans. Without a wide range of animal, plants and microorganisms, we cannot have the healthy ecosystem that we rely on to provide us with the air we breathe and the food we eat. Bio-diversity is the variety and variability of life on earth. Bio-diversity is a measure of variation at genetic, species and ecosystem level. Bio-diversity is the most complex feature of our planet and it is the most vital. Without bio-diversity there is no future of humanity.

Introduction:

Biodiversity is necessary to human survival. Ecosystem diversity is crucial to ecosystem, integrity which in turn enables our life support giving us a livable climate, breathable air and drinkable water. Food-crop diversity and pollinating insect and buts allow agriculture to support our populations when diseases strike a food-crop, only diversity can save the system from collapse. Plant and animal diversity prove budding blocks for medicine both current and potential almost half of the pharmaceuticals used in the United States today are manufactured using natural compound, many of which cannot be synthesized. They also provide critical industrial product used to build our hoes and businesses from wood and rubber to the fuels, even coal and oil are the product of ancient plant matter and preserved Zooplankton remain.

Conservation of biodiversity:

Our broader user's planet is threatened by unprecedented pressure from land use change overexploitation, pollution, climate change and invasive species driven mostly by human activities. Hence its conservation is mmt. Biodiversity conservation is the protection and management of bio-diversity to obtain resources form sustainable development. Biodiversity

conservation protects planet, animal, microbials and genetic resources for food production agricultural and ecosystem functions such as fertilizing the soil, recycling nutrient, regulating pests and disease, controlling erosion and pollinating crops and trees while unsustainable agricultural production and use of wild species for food or fuel can reduce biodiversity.

Biodiversity conservation is vital for economic growth and poverty reduction. It helps to address the effect of climate change. Conservation habitats can reduce the amount of carbon dioxide released into the atmosphere. Conservation repair damage done by humans and maintain the environment for future. Physical health can also be improved. Trees which can filter out air pollution and improve air quality are produced by animals, or plants. So, by protecting nature we also protect the lifesaving drugs including anti-cancer drugs. We cannot be healthy 9in an unhealthy environment. The exploitation of the natural world threatens our capacity to provide food and water for people on earth. We conserve biodiversity by using resources and environment s to attain sustainable fields. We can also protect and can serve bio-diversity by following government legislation reducing invasive species, habitat restoration, captive breeding and seed banks. Research reduces climate change and by purchasing sustainable products.

Conclusion:

Biological diversity is the conservation of biological diversity, obtained develop national strategies for conservation and sustainable use of biological resources, to establish protected area ex-Sit conservation. Establish training and research programme promote public education and research programme, promote and biotechnology transfer to developing countries. Biodiversity conservation is important because biodiversity provides certain service and resources that are essential for life on earth. Biodiversity also provides social benefits.

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SUSTAINABLE DEVELOPMENT GOALS AND 5P'S

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Abstract:

Sustainability encompasses three elements; economic, social, and environmental. Sustainable development aims to reduce impacts of all three elements. The SDGs integrate the 5P's: People, Planet, Prosperity, Peace, and Partnership and clearly stress the need for all stakeholders to collaborate to create a sustainable world. The Sustainable Development Goals (SDGs), otherwise known as the Global Goals, are a set of objectives within a universal agreement to end poverty, protect all that makes the planet habitable, and ensure that all people enjoy peace and prosperity, now and in the future. To sum it up, sustainable development continuously seeks to achieve social and economic progress in ways which will not exhaust the Earth's finite natural resources. Thus, we must all develop ways to meet these needs so that our future generations can inherit a healthier and greener planet. It can be said that sustainable development brings out stability in the requirements of the environment. It makes the resources available for use for the future generations. Sustainable development is an amazing way to conserve the resources provided by nature.

Indroduction:

Sustainable development refers to the development that meets the needs of the present without compromising the ability of the future generations to meet their own needs.

- The concept of sustainable development can be interpreted in many ways,
- But as its core is an approach to development that looks to balance different, and often competing, needs against an awareness of the environmental, social, and economic limitations we face as a society.
- All too often, development is driven by one need, without fully considering the widen or future impacts.

Types of sustainable development

- Economic Sustainability- Economic sustainability is about achieving long-term economic growth without damaging the environment or depleting resources. It's about balancing what we need and what we have.
- Environmental Sustainability- Economic sustainability entails evaluating the environmental impact of economic activity and devising sustainability goals to create a more liveable future.

- Social Sustainability- Social sustainability is a quality of societies. It signifies the nature-society relationships, mediated by work, as well as relationships within the society related institutional arrangements.

17 Goals of Sustainable Development

1. No Poverty
2. Zero Hunger
3. Good Health and Well-Being
4. Quality Education
5. Gender Equality
6. Clean Water and Sanitation
7. Affordable and Clean Energy
8. Decent Work and Economic Growth
9. Industry, Innovation, and Infrastructure
10. Reduce Inequalities
11. Sustainable Cities and Communities
12. Responsible Consumption and Production
13. Climate Action
14. Life Below Water
15. Life on Land
16. Peace, Justice, and strong Institutions
17. Partnerships for the goals

Sustainable development goals and 5Ps

First goal of Sustainable Development is No Poverty it is related to People in 5Ps. We must target those living in vulnerable situations, increasing access to basic resources and services, and support communities affected by conflict and climate-related disasters end the poverty. Second goal of Sustainable Development is Zero Hunger it is also related to People in 5Ps which taken together, can end hunger, eliminate all forms of malnutrition, and build inclusive and sustainable food systems. Third goal of Sustainable Development is Good Health and well-being it is related to Prosperity in 5Ps, aspires to ensure health and well-being for all, including a bold commitment to end the epidemics of AIDS, tuberculosis, malaria and other communicable diseases by 2030. It also aims to achieve universal health coverage, and provide access to safe and effective medicines and vaccines for all. Another goal of Sustainable Development is Quality Education, it is related to People in 5Ps, it aims to that education serves as important role in sustainable human development, and education helps in reducing poverty and improve economic growth. Next goal of Sustainable Development is Gender Equality, it is related to Peace in 5Ps, and gender equality is when people of all genders have equal rights, responsibilities, and opportunities. Everyone affected by gender inequalities and it impacts people of all ages and backgrounds. Another Goal of Sustainable Development is clean water and sanitation, it is related to Planet in 5Ps, goes beyond drinking water, sanitation, and hygiene to also address the quality and sustainability of water resources, which are critical to the survival of people and the planet. Another goal of Sustainable development is affordable and clean energy, it is related to Planet in 5Ps, focuses on a concerted global effort. Clean energy refers to energy generated from recyclable sources without emitting greenhouse gases that gas which is environmentally friendly. Eighth Goal of Sustainable development is decent growth and economic work, it is related to Prosperity in 5Ps, and Sustained and inclusive economic growth

can drive progress, create decent jobs for all and improve living standards. Next goal of Sustainable development is industry, innovation, and infrastructure, it is related to Prosperity in 5Ps, can unleash dynamic and competitive economic forces that generate employment and income. Another Goal of sustainable development is reduced inequalities, it is related to Prosperity in 5Ps, reducing inequality requires greater efforts to remove hunger and poverty and invest more in health, education, social protection, and decent jobs. Next Goal of Sustainable development is sustainable cities and communities, it is related to Prosperity in 5Ps, support positive economic, social, and environmental links between urban, per-urban, and rural areas by strengthening national and regional development planning. Twelveth Goal of Sustainable development is responsible consumption and production, it is related to Planet in 5Ps, a driving force of the global economy rest on the use of the natural environment and resources in a way that continues to have destructive impacts on the planet. Another Goal of sustainable development is climate action, it is related to Planet in 5Ps, climate action plays vital role in human lives and health such as clean air, safe drinking water, nutritious food supply and safe shelter. Next Goal of Sustainable development is life below water, it is related to Planet in 5Ps, the water bodies like oceans, rivers, lakes are very important for our survival. The oceans provide natural resources including food, materials, substances, and energy and the Earth habitable for humankind. Fifteenth Goal of Sustainable development is life on land, it is related to Planet in 5Ps, we should save and protect our terrestrial ecosystems, sustainably manage forests, and that land turn into desert, and reverse land degradation and halt biodiversity loss. There are so many species in Red-book for endangered species. Another goal of sustainable development is peace, justice, and strong institutions, it is related to Peace in 5Ps, promote just, peaceful, and inclusive societies and that are strong enough to control the problems of crimes and maintain peace. Conflict, and weak institutions, and limited intend of justice remain a great threat to sustainable development. Seventeenth Goal of Sustainable Development is Partnerships for the goals, it is related to Partnerships in 5Ps, that means of implementation and establishment of the global partnership for sustainable development. This goal combines the sources and complete the needs of all the SDGs goal in appropriate way.

There are five critical dimensions of sustainable development: **People**, **Prosperity**, **Planet**, **Partnership** and **Peace**, also known as the 5Ps.

The 5 Ps highlight that how the SDGs are combine and intertwined framework instead of a group of goals. All the SDGs goals are related Progress on one P must balance and support progress on another. Refocusing on the “5 Ps” feels particularly relevant clear and intentional alignment with the all goals. Let us look.

1. **People:** We are determined to end the problems face by human in their countries such as poverty and hunger, in all their forms and dimensions, and to ensure that all human beings can fulfil their potential and requirement in dignity and equitable way and in a healthy

environment. The SDGs declare the world's determination in the problems and to ensure that all human beings live their life happily and satisfied manner. We have five SDGs goals related to people are no poverty, zero hunger, good-health and well-being, and gender equality. But it increasingly difficult to that three percent of extreme poverty in the world. The speed of global progress has slowed as poverty becomes increasingly concentrated in a handful of countries in Africa, where today almost 75 percent of the world's people in extreme poverty live. Africa is extremely poor continent leads to hunger. People living in Africa considered malnourished. The world is to meet a longstanding goal of ending extreme poverty because of the effects of extraordinary shocks to the global economy, including the coronavirus pandemic and the war in Ukraine.

2. **Planet:** We are determined to protect our planet from degradation, including through sustainable development goals and production, sustainably managing its natural resources and taking urgent action on climate change, so that it can support the needs of the present and future generations. The SDGs such as clean water and sanitation, affordable and clean energy, climate action and life below these goals set a goal to protect the planet. Climate change can put lives at risk and heat is one of the deadliest weather phenomena. Climate changes in planet are already harming health trough air pollution by breath and forced displacement by natural and man-made calamities. Warming is expected to decrease crop yields in many areas around the world, food insecurity, malnourished, and stunting in poor communities.

   In the world countries like the United Kingdom, Chile, Finland, and the Marshall Islands, have developed concrete and detailed plans to reach carbon neutrality by 2050 according to *Net zero emissions*. With Planet, companies can now identity, monitor, and quantify their environmental and social impact like never before, in areas such as supply chain monitoring, sustainable resources usage, and climate resilience.

3. **Prosperity:** We are determined to ensure that in prosperity all human beings can enjoy prosperous and fulfilling lives and that economic, social, and technological progress occurs in harmony with nature. There are five SDGs that are based on prosperity in 5Ps are affordable and clean energy, decent work and economic growth, industry, innovation and infrastructure, reduced inequalities, and sustainable cities communities. Economic prosperity and progress on climate change can be achieved together most of the countries successfully economic growth from greenhouse gas emissions while also reducing their carbon. At the global level, the carbon intensity of world output is falling, meaning we produce fewer emissions to generate each unit of GDP, but total emissions are still growing.

4. **Peace:** We are determined to make our country and world peaceful, just, and inclusive societies which are free from fear, crimes, and violence. People have peaceful life with their rights of living. The SDGs are possible when there can be no sustainable development

without peace and no peace without sustainable development. Therefore, they set out goals to foster peaceful, just, and inclusive societies. For all the goals we need peaceful and calm mind to implement it. But, around the world the conditions for civil society have been increasingly restricted. The basic tenants of association, peaceful assembly, and expression have been challenged. While these statistics are sobering, there is a huge opportunity to drive progress on the SDG agenda by focusing on peace and justice for all people.

5. **Partnerships:** We are determined to the implement this Agenda of SDGs through a Global Partnership for Sustainable Development for all goals, focused on the needs of the poorest and most vulnerable and with the participation of all countries and developed countries also, all people of the world require to maintain these goals. The SDGs call this element of partnership as a spirit of strengthened global solidarity. Problems that can tackle are cross geographies and sectors require collaboration that does as well. The good news is that we are seeing a variety of players step up for the SDGs, from youth activists striking for climate action to cities embracing sustainable living conditions to corporations embedding sustainability into their core plans generally youths are very aware about our planet and for our future generations.

How can an individual contribute to Sustainable development goals to preserve 5P's?

- Donate what you do not use: Clothes, books, furniture, food. By donating you also contribute to other goals aiming towards no poverty, zero hunger and reduced inequalities.
- Waste less food: Take food how much you need and do not throw food in dustbins. Plan your meal. Freeze fresh products and leftovers if you do not have the chance to eat them before they go bad also your take away food.
  Eat less meat, poultry, and fish. Producing meat takes a lot more resources than producing plants. Buy and eat seasonal produce from local growers.
- Get yourselves and your family vaccinated: Be aware about your health and do regular check-ups in your locality hospital.
- Help educate children in your community: Encourage youth to work and get an education and being able to provide yourself and your family. Show value in contributing to society.
- Empower women and girls around you and promote equality: Educate girls is the only way to educate whole country. If women are educated whole family is educated.
- Avoid wasting water: Take short showers and save water for our future generation.
- Use energy-efficient appliances: Turn off the light and take advantage of the natural light instead electric bulb and tube light.
- Create job opportunities, if applicable: Provide jobs, trainee spots and internships. Inspire youth by showing the value of having a job, earning your own money

- Use public transport or cycles: to control air pollution use public buses or rickshaw.
- Recycle: Shop second-hand or trade clothes with colleagues, friends, or family. Use refillable water bottles and coffee cups.
- Avoid using plastic: Use reusable cloth bags rather than plastic and use fabric bags.
- Plant trees around you: Planting trees are very vital for environment and humans to survive on earth.
- Act now to stop global warming: It is no secret that our planet is under huge pressure and that Environment and Sustainability are important subjects to be discussed when it comes to ensuring our future life on earth. Just follow all the above contributions.

Conclusion:

All countries around the world came together to create the SDGs are universal call to take action to end poverty, protect the planet and improve the way of living for everyone and everywhere that can be a human, or fish living in water. All living creature have right to live in peace and prosperity manner. We are approaching that "decade of delivery" in the remaining 10 years we will going to achieve the US Sustainable Development Goals.

Sustainable development always encourages us to conserve and enhance our resources, by gradually changing the manners in which we develop and use technologies. All countries' people have right to live their life with full of dignity should latest meet their basic need food, clothes, and shelter. Everybody is rightful to a healthy, safe, and clean environment.

Sustainable development refers to the development that meets the present era without compromising the ability of the future generations to meet their needs in proper ways. With utmost consideration of immediate and long-term benefits for our planet and the humans who live on it.

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INDIVIDUAL AND COMBINED IMPACT OF SOIL MICROORGANISMS AND NANOPARTICLES IN MITIGATION OF HEAVY METAL STRESS INDUCED TOXICITY IN CROP PLANTS

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Abstract:

Pollution of Heavy metal (HM) has grown to be a significant issue worldwide because of their persistence in the environment due to their non-biodegradable nature. Although HM are regarded as the toxicants of the soil and they may seriously harm the soil and plants when they are present in large quantities. Higher percentage of heavy metal in the soil absorbed by the crop plants, badly affects their photosynthesis, growth, and overall yield. Several soil microorganisms take part in the regulation of HM stress in crop plants. They have the capacity to build up, alter, or purge HM. The advantages of these soil microorganisms may generally have a significant influence on the health of plants. Similarly, nanoparticles (NPs) can also be used to efficiently reduce HM stress in plants because of their special physiochemical properties. The practical use of microorganisms and nanoparticles alleviate heavy metal stress in plants, thereby notably enhanced plant biomass, growth, development, higher crop yield, low oxidative stress, and enhanced activities of enzymes. Therefore, this chapter describes how to alleviate the heavy metal stress induced toxicity in different crop plants through the individual and combined impact of microorganisms and nanoparticles.

Keywords: Heavy metal, Stress, Impact, Soil Microorganisms, Nanoparticles, Crop Plants.

Introduction:

Food security is a global issue for both qualitative and quantitative worldwide sustainable development. The new emerging concerns of food security have gained international attention due to their close connection to human health due to the harmful effects of HM toxicity which reduced both food security and human health (Rai *et al.,* 2019). In order to fulfil the growing requirement of foodstuffs for the expanding human populations in the developing countries, heavy metal toxicity of agricultural soils becomes a serious issue (Wei and Yang, 2010) due to rapid and extensive use of synthetic pesticides and fertilizers are used to increase agricultural productivity (Akhtar *et al.,* 2009).

HM contamination is a serious global environmental problem due to rapid urbanisation, industrialization, and land use change, particularly in developing nations with exceptionally high population densities, like United States, China and India (UN-HABITAT, 2004). Elevated concentrations of heavy metals in the soils lead plants to take in and retain them, transferring them into humans via the food supply chain (Zhuang *et al.,* 2014).

HM contaminated soils removed through plant-microbe associations particularly through Rhizospheric microbes such as rhizobacteria which play an important function in mitigation of Heavy metal stresses in crop plants through accumulation, transformation, or detoxification HM. HM detoxification in contaminated soils is principally based on the phenomenon of phytoremediation and rhizoremediation (Mishra *et al.,* 2017). Enhancement of plant development in soils with heavy metal pollution are thought to rely mostly on two processes: (i) reduction of ethylene stress inside the plant, causing to extend the roots (Burd *et al.,* 1998) a more effective examination of the soil (Berta *et al.,* 2002); and (ii) production of siderophores, enabling plant to find the right amount of iron for optimum growth and development of plants (Burd *et al.,* 2000).

Nanotechnology brings up new areas for interdisciplinary applications such as in electronics and information technology, every day material, processes and energy, biomedicines, agriculture and food safety, environment remediation, biosensors (Kulzer and Orrit, 2004). Plants are subjected to wide variety of environmental stresses, such as salt stress, heavy metals stress, thermal stress, and drought stress etc. Application of nanoparticles have been employed in agriculture which aims at sustainable crop production by reducing nutrient losses, alleviating various environmental stress including heavy metal toxicity and thus increasing the crop production (Ahmad et. al., 2019).

Individual impact of soil microorganisms in mitigation of heavy metal stress induced toxicity in crop plants

Microorganisms have capacity to remove harmful heavy metals from the environment, and throughout this process they did not produce any harmful by products (Sharma et. al., 2021). The main strategies used by microorganisms were sequestration, exclusion, detoxification, and complexation (Ferreira *et al.,* 2020). When it comes to stress tolerance for enhancing plant growth and achieving sustainable agriculture, rhizobacteria that promote plant growth and development (PGPR), a collection of microorganisms presents in the plant's root system and rhizoplane, have been shown to be the most ecologically safe and superior alternative to synthetic agrochemicals and other standard agriculture practices (Nagargade *et al.,* 2018). One of the main ways PGPR combat stress by hydrolyzing ACC i.e., 1-aminocyclopropane-1-carboxylic acid, being done by the enzyme ACC deaminase. Ethylene hormone in plants is directly preceded by ACC. It is to believe that some PGPR have the ACC enzyme, which convert to ammonia and α-ketobutyrate and lowering the amount of C_2H_4 in the plants (Raghuwanshi and Prasad, 2018). As a result, Plant growth promoting rhizobacteria having ACC deaminase enzyme may be able to reduce the generation of ethylene caused by abiotic stress and the resulting negative impact on plants.

Similarly, it has been noted that certain fungal species interact physiochemically and transport heavy metals to the cell's surface (Sharma and Rath, 2021). The ability of the fungus to

sequester metal is enhanced by large concentration of cell wall content, which includes the presence of several functional groups for metal binding. Toxic heavy metals were removed using a variety of fungal species, including *Aspergillus sp., Botrytis sp., Neurospora sp., Penicillium sp., Saprolegnia sp.,* and *Trichoderma sp.* (Gururajan and Belur, 2018). *Saccharomyces cerevisiae* successfully removed lead (Pb) and cadmium (Cd) from contaminated soils. In 30 days, 65-79% of heavy metals were reported to have been biosorbed (Mishra *et al.,* 2019). There have been reports that a variety of bacterial and fungal species, including *Pseudomonas aeruginosa, Paenibacillus jamilae, Bacillus subtilis, Aspergillus sp., Botrytis sp., Neurospora sp., Saprolegnia sp., Penicillium sp., and Trichoderma sp.,* actively metabolise and reduce various heavy metals (Desoky *et al.,* 2020). Several bacterial strains from the genera *Pseudomonas, Alcaligenes, Variovorax, Bacillus, and Rhodococcus* that express the enzyme ACC deaminase have been recovered from the rhizoplane of India mustard and pea that have been grown in sewage sludge or heavy metal-polluted soil (Belimov *et al.,* 2001). When exposed to Cd (300 mmol/L $CdCl_2$), these strains increased extensive roots in canola and Indian mustard. Several native bacterial strains have been identified to enhance the development of *Brassica juncea (L.)* Czern. (India mustard) and *Brassica rapa var. campestris (L.)* (common mustard) in Ni-polluted soil (Burd *et al.,* 1998). One of these bacterial strains, *Kluyvera ascorbata* SUD165, was noted for generating siderophores resistant to nickel, growing at low temperatures (i.e., 5–10 °C), and manufacturing ACC deaminase (Burd *et al.,* 1998). Additionally, strain SUD165 enhanced tomato and canola plant development in a range of experimental circumstances involving high Ni concentrations (Ma *et al.,* 2001). *Zea mays L.* (corn) plants infected with a combination of 4 bacterial strains enhanced Zn, Cr, Pb, and Cu accumulation by 3.9, 2.7, 1.9, and 16 times, respectively, compared with uninoculated plants (Abou-Shanab *et al.,* 2008).

Individual impact of nanoparticles (nps) in mitigation of heavy metal stress induced toxicity in crop plants

Plants interact with Nanoparticles (NPs) to improve the heavy metal response in plants. The following NPs are used to treat plants to help them cope with adverse climatic issues such as titanium dioxide, zinc oxide, cerium, cobalt, copper oxide, selenium, silver, silicon oxide, iron oxide, calcium and magnesium oxide etc. These nanoparticles were employed to boost plant tolerance to abiotic stress conditions, which increased agricultural output (Arif *et al.,* 2020), by increasing plants resistance to abiotic stressors by regulating a variety of physiological, biochemical, and molecular processes. NPs are utilised to carry proteins, specialised compounds, and nucleotides to the desired spot (Rastogi *et al.,* 2019). According to several studies, NPs may enhance plant seed germination, photosynthesis, oxidative stress resistance, rhizome growth and development, crop production, and crop quality (Palchoudhury *et al.,* 2018). On the other hand, NPs are used as nano fertilizers and nano pesticides, which have the benefits of being easily absorbed by plants and slowly released in the environment in comparison to standard fertilisers

(Li *et al.,* 2020), respectively. By increasing the activity of antioxidant enzymes, NPs (such CeO_2, TiO_2, and Mn_3O_4 NPs) can lessen the buildup of reactive oxygen species (ROS) in plants, reducing plant stress and enhancing quality and production (Usman *et al.,* 2020; Wang *et al.,* 2020). Through foliar application, silicon and selenium NPs reduced Cd and Pb stress in rice (Hussain *et al.,* 2020). The NPs have the capacity to take up and alter heavy metal inside soil, lowering its mobility and biological availability. Fe_3O_4 NPs, as an illustration, reduced the mobility of Cd and other HMs in the soil (Sebastian *et al.,* 2019). CeO_2 NPs (100 and 200 mg/kg) also improved the physiological parameters of *Brassica napus* L. under salt stress (100 mM NaCl) (Rossi *et al.,* 2016). Cao *et al.,* 2017 found that CeO_2 NPs (100 mg/kg), both uncoated and PVP coated, may improve rate of photosynthesis and accelerate plant development in soybeans, however 500 mg/kg CeO_2 Nanoparticles lowered net rate of photosynthesis by 36%. Activating the plant's oxidative defence system is another method for reducing HM stress. Plants often emit ROS as a result of particular metabolic processes (Wu *et al.,* 2017). Excessive ROS formation under stressful circumstances is detrimental to proteins, cell membranes, and other biological components (Wu *et al.,* 2017). Superoxide dismutase, catalase , ascorbate peroxidase, glutathione reductase, glutathione peroxidase etc. all antioxidant enzymes are primarily responsible for scavenging reactive oxygen species (ROS) in plants. Additionally, non-enzymatic low-molecular weight metabolites such polyphenols, vitamin C, and vitamin E may scavenge ROS (Zhao *et al.,* 2020). Application of Nanoparticles with antioxidant enzyme activity, such as CeO_2 NPs, Fe_3O_4 NPs, Mn_3O_4 NPs, and C_{60}, might therefore improve plants' capacity to decrease ROS and, as a result, limit impacts on crop growth and yield losses (Guo *et al.,* 2019).

Wang *et al.* (2010) discovered that adding TiO_2 NPs to the nutrient medium boosted the antioxidant potential in maize tissues. Singh et al. (2016) found that after adding TiO_2 NPs to soil, the physiological parameters and photosynthetic rate of soybean plants rose, thereby minimising Cadmium toxic effects to soybean plants. As of result, TiO2 NPs have a significant potential for usage in relieving plant oxidative stress produced by HM.

Corn cultivated in Cd-contaminated soil, Titanium dioxide Nanoparticles (100 and 250 mg/L) were administered by soil mixing and foliar spray. Soil application retarded absorption of Cd by maize and increased the plant biomass, whereas foliar spray enhanced Cd absorption by corn and significantly reduced biomass. To reduce Cd stress damage to maize, foliar application of TiO_2 nanoparticles boosted superoxide dismutase and glutathione transferases activity and upregulated various galactose, alanine, aspartame acid, and other metabolic pathways. In order to lessen Cd toxicity in maize, foliar application of TiO_2 NPs is more efficient than soil mixing. The outcomes showed that the relief effect was significantly impacted by the application manner (Lian *et al., 2020*).

The use of Fe_2O_3 NPs as Fe-containing fertilisers in the production of peanuts has been suggested, but further research is needed to fully understand the possible dangers (Rui *et al.,*

2016). Hussain *et al.,* 2019 showed that applying Fe_2O_3 NPs (5, 10, 15, and 20 ppm) to wheat undergoing Stress condition (bioavailable Cd 0.93 mg/kg) reduced leaf electrolyte leakage and Cd concentration in grain while increasing activities of antioxidant enzymes and wheat dry weight. Additionally, they discovered that applying Fe NPs by foliar spraying is preferable than applying it via soil application since the absorption of Fe in the soil can be influenced by a variety of variables, including pH and the interaction of the mineral with other minerals. When using a combination approach, adding biochar to the soil improved the relieving effects of iron Nanoparticles through foliar treatment on Cd stress in rice (Rizwan *et al.,* 2019). It implies that combining the use of nanoparticles with other substances may be a fruitful strateg y for reducing HM in plants.

ZnO NPs (50 mg/L) seed soaking enhanced glycolytic metabolism and cell wall biosynth esis,boosting corn seed germination and the development of roots and embryos (Luying *et al.,* 2020). According to Ali *et al.,* the treatment of adding ZnO NPs or biochar alone was less successful at relieving the Cd stress than the combined application of ZnO NPs (foliar spraying) and biochar (soil application) (Bashir *et al.,* 2020). It implies that combining the application of NPs with other materials may be a fruitful strategy for reducing HM in plants. ZnO NPs and Zn^{2+} both considerably decreased the arsenic level of rice roots and shoots (Ma *et al.,* 2020).

Different ZnO NP concentrations (25, 50, and 100 mg/L) were administered to wheat under Cd stress by foliar spray and soil application, and Hussain *et al.,* 2018 discovered that both treatments of ZnO NPs encouraged wheat growth, photosynthesis, and grain production . To increase grain production and lower Cd content in grains, foliar treatment was, nevertheless, more effective than soil application.

Si NPs treatments enhanced wheat growth while reducing the effects of drought (35% of soil water holding capacity) and Cd (bioavailable Cd 1.21 mg/kg) stress in composite stress conditions. According to Hussain *et al.,* 2019 foliar application of Si NPs (10 and 20 mg/L) significantly reduced Cd buildup in grains and boosted yield. Additionally, they showed that the application of Se NPs (20 mg/L) and Si NPs (10 mg/L) together significantly decreased Cd (62%) and Pb (52%) in rice grains.

Combined impact of microorganisms and nanoparticles in mitigation of heavy metal stress induced toxicity in crop plants

Under, HM-contaminated environments, nanoparticles (NPs) or plant growth-promoting rhizobacteria (PGPR) may help plants develop faster by increasing nutrient availability and absorption as well as through controlling plant growth regulators (Gulzar and Mazumder, 2022). The combined application of ZnO NPs (500 mg/kg) along with arbuscular mycorrhizal fungi (AMF) significantly promoted soybean growth (Lihua *et al.,* 2015). Fatemi observed that Si NPs and Pb-resistant strains of microbes were more efficient in reducing the Pb toxicity to coriander than either of them alone (Fatemi *et al.,* 2020) in the realm of combined application of NPs and

microorganisms. A combined application of silicon nanoparticles (Si-NPs) and lead (Pb) resistant microorganisms might enhance the growth characteristics of coriander (*Coriandrum sativum* L.) plants under lead stress. Following the isolation of two Pb-resistant microbe strains at various Pb concentrations, these strains were examined for a variety of characteristics. Si-NPs (1.5 mM) were foliar sprayed at various periods after the strains were inoculated in the Pb-spiked (500 mg/kg) soil (three times, two-week interval). Plants under Pb stress had better growth, photosynthesis, and antioxidant enzyme activities, which was evidence that Si-NPs treatment or bacterial inoculation had reversed the toxicities caused by Pb in plants (Fatemi *et al.*, 2020). The combined impact of chromium-resistant bacteria *Staphylococcus aureus* and iron nanoparticles (FeNPs) on rice plants grown in chromium-saturated media was investigated. Fe NPs was administered directly in concentrations ranging from 0 to 20 mg/L to raise the total chlorophyll contents from 2.8 to 3.9 at a chromium level of 100 mg/kg. *S.aureus* treatment increased the chlorophyll levels from 4.4 to 5.4, respectively. Plant growth, biomass, yield, and photosynthetic activity were all considerably enhanced by Fe NPs by increasing chlorophyll levels and reducing oxidative damage. By improving the bioavailability of micronutrients to the plant, application of Fe NPs also decreased Cr absorption and accumulation in the plants. The Fe NPs reduced oxidative damage and improved enzymatic and non-enzymatic activity in the plant to survive Cr stress. The beneficial effects of Fe NPs were further boosted by the inoculation of rice plants with the chromium-resistant bacterium *S. aureus*, which converted the poisonous form of chromium (Cr^{6+}) into a less toxic form of chromium (Cr^{3+}). Chromium ion levels dropped as a result of the bacterial inoculation reduction of plants ability to absorb Cr through the adsorption of Cr ions (Alharby and Ali, 2022).

A case study was conducted to determine the effectiveness of cerium dioxide nanoparticles and *Staphylococcus aureus* in reducing chromium metal toxicity in *Helianthus annuus* plants. This was done in light of the positive roles that nanoparticles and bacteria have in reducing metal stress in plants. CeO_2 nanoparticles (0, 25, and 50 mg/ L) and *S. aureus* were used to treat sunflower plants that had been cultivated under chromium polluted soil (0, 25, and 50 mg/ kg). In the sunflower plant cultivated under chromium stress, the administration of cerium dioxide Nanoparticles (CeO_2 NPs) dramatically increased plant growth and biomass output, decreased oxidative stress, and promoted the enzymatic activities. The use of *S. aureus* improved the usefulness of nanoparticles in reducing metal-induced toxicity even more. Plants that were exposed to both nanoparticles and *S. aureus* showed greatest improvement. The effect of organic zinc oxide nanoparticles (ZnO-NPs) (5-10 mg/L) and bacillus species (*Bacillus cereus* and *Lysinibacillus macroides*) on the physiological and biochemical activities of rice seedlings in HM-polluted water. In contaminated water, the combined effect of bacteria and ZnO NPs reduces HM stress and improves seed germination by 70%, root-shoot length (9.93 and 11.82 cm), fresh shoot-root weight (0.125 and 0.131 g), dry shoot-root weight (0.0532 and 0.042

g), Chl a, Chl b, and carotenoid (18.8, 13.9 mg/g, and 17.1 g/g), TSS (57. 651 mg/g), and TSP (47.990 mg/g) content (Akhtar *et al.*, 2022).

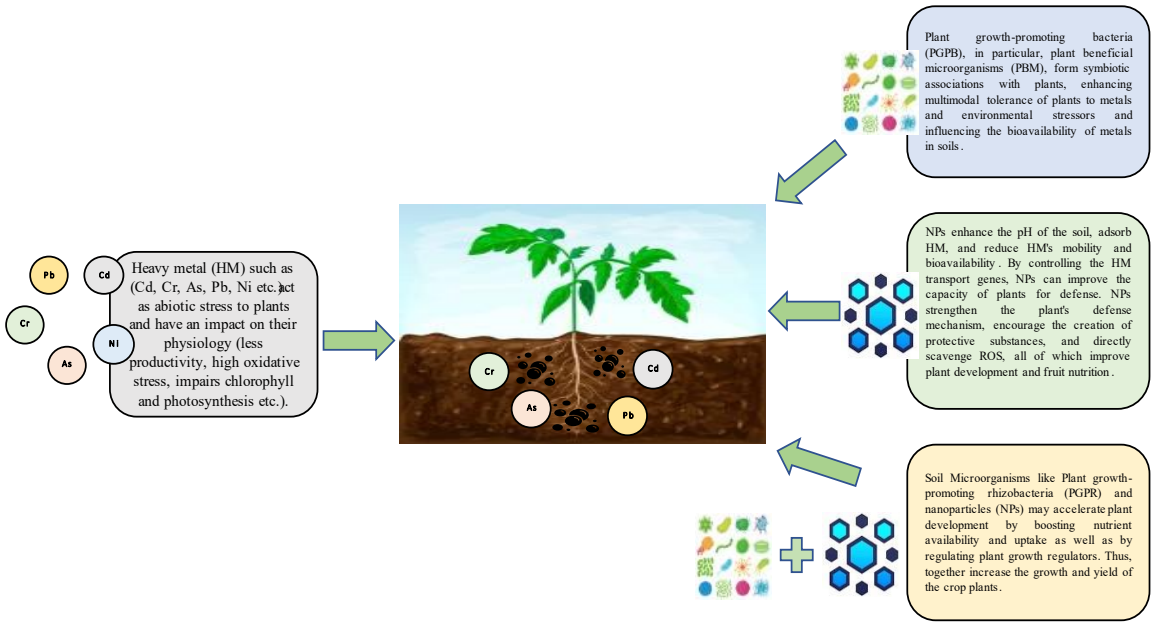

Figure 1: Shows General Diagrammatic representation of the Individual and Combined Impact of Soil Microorganisms and Nanoparticles on Alleviation of Heavy Metal (HM) Stress in Crop Plant

Conclusion:

From the above literature, it can be concluded that heavy metal stress problem among various crop plants (such as rice, mustard, soyabean, wheat etc.) now can be alleviate through single and combined applications of microorganisms and nanoparticles. Microorganisms present in rhizosphere region such as PGPR overcome stress in plants by hydrolyzing 1-aminocyclopropane-1-carboxylic acid (ACC). Soil microorganisms helps plant in alleviation of heavy metal stress by reducing heavy metal accumulation inside plant tissues through phytoremediation approaches. Extracellular resistance, dynamic metals ion transport (efflux), extracellular absorption, intracellular absorption, and metal ion reduction are different basic mechanisms of microorganisms (such as bacteria) for heavy metal resistance. In similar way, nanoparticles help crop plants to overcome heavy metal stress by improving their soil texture, pH and availability of nutrients to plants. Nanoparticles such as Silicon dioxide, Titanium dioxide, Zinc oxide, Iron oxide etc. enhance seed germination, improve physiological, biochemical and molecular processes, plant resistance to abiotic stress, increased photosynthesis leading to better crop quality and higher crop yields. In this, way a variety of soil microorganisms and nanoparticles can be utilized singly or in combination for mitigation of heavy metal stress induced toxicity in different crop plants.

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SUSTAINABLE MANAGEMENT OF FRUIT FLIES IN FRUIT CROPS WITH RECENT ADVANCES

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Abstract:

Insect pest and diseases lower the production and deteriorate the quality of fruits which leads to huge economic loss to the growers. Among different insect pests, fruit flies (Diptera: Tephritidae) are considered as the world's most serious pests due to their huge economic impact as females oviposit inside the fruits and subsequently young larvae feed on the pulp, thus leave the economic part unmarketable and unpalatable. It has distributed to most of regions of the world and attack many economic fruit crops. In India, the loss in fruit yield by fruit flies in major fruit crops ranges from 1 to 31% in mango, upto 80% in guava and 80 to 100% in ber. There is need of new and safer control strategies for sustainable management of fruit flies to avoid harmful environmental impact of synthetic insecticides. This chapter aims to briefly update the research community and students on the most important conceptual and practical advances in the broad field of sustainable management of fruit flies, and to review the fruit fly management strategies currently being developed or utilized.

Keyword: fruit fly, *Bactrocera* spp., fruit crop, management, life cycle

Introduction:

Fruit and vegetable production is one of the fastest growing sectors of horticultural industry. Improving productivity and quality of fruit and vegetable enhances food security, employment and trade opportunities. But several biotic and abiotic factors constrain the production of fruit crops. Insect pest and diseases lower the production and deteriorate the quality of fruits thus leads to huge economic loss to the growers. Among insect pest, fruit fly is a major pest which cause huge losses to many fruit crops. Fruit flies are considered as one of horticulture's most serious pests. These fruit flies cause direct damage to fruits which can lead up to 90-100% yield loss depending on the locality, variety, fruit fly population and season. Fruit flies (Diptera: Tephritidae) are recognised as one of the most serious pests of horticultural crops due to their direct economic impact on fruit yield and qualities, as females lay eggs inside the fruits and subsequently young larvae feed on the pulp thus make them unmarketable. These flies are widespread over the entire world and richly predominant in the tropical and subtropical areas. About 4,500 species belonging to over 500 genera of fruit flies have been reported from different

parts of the world. From India 244 species arranged in 79 genera have been described (Agarwal and Sueyoshi, 2005). They can breed rapidly, disperse widely and successfully attack most fruit. Infested fruit are destroyed, while the larvae are a major quarantine issue for both domestic and international markets. Being the world's largest producer of subtropical and tropical fruits, India suffers a huge economic loss due to fruit flies in fruit crops especially like guava, mango, papaya, pear, peach, citrus, apricot, sapota, jujube etc. Besides, India's export potential of fruits and vegetables also remain largely unexploited as the fruits and vegetables infested by fruit flies are restricted for export.

Distribution of different fruit flies in the world

The distribution range of family Tephritidae are stretches to all world regions. *Anastrepha* spp. of fruit fly are found all over the South and Central America as well as the West Indies. These are dominating in the Argentina as well as their presence in the geographically attached to the USA. Further, *Bactrocera* spp. are found in tropical Asia, South Pacific regions and in Australia. In Africa, most species which cause damage to the fruit crops commercially belong to *Ceratitis* and *Dacus*, as well as some *Bactrocera* species. *Rhagoletis* spp have been located throughout the temperate regions of Europe. In fruit flies, each major pest genus has a characteristic pattern of host relations, most *Rhagoletis*, *Bactrocera* and *Dacus* spp. show a strong preference for attacking species of a single plant family, while some other like *Anastrepha*, *Bactrocera*. (*Bactrocera*) and *Ceratitis* spp. are polyphagous in nature, attacking plants belonging to different families (Qin *et al*., 2015)

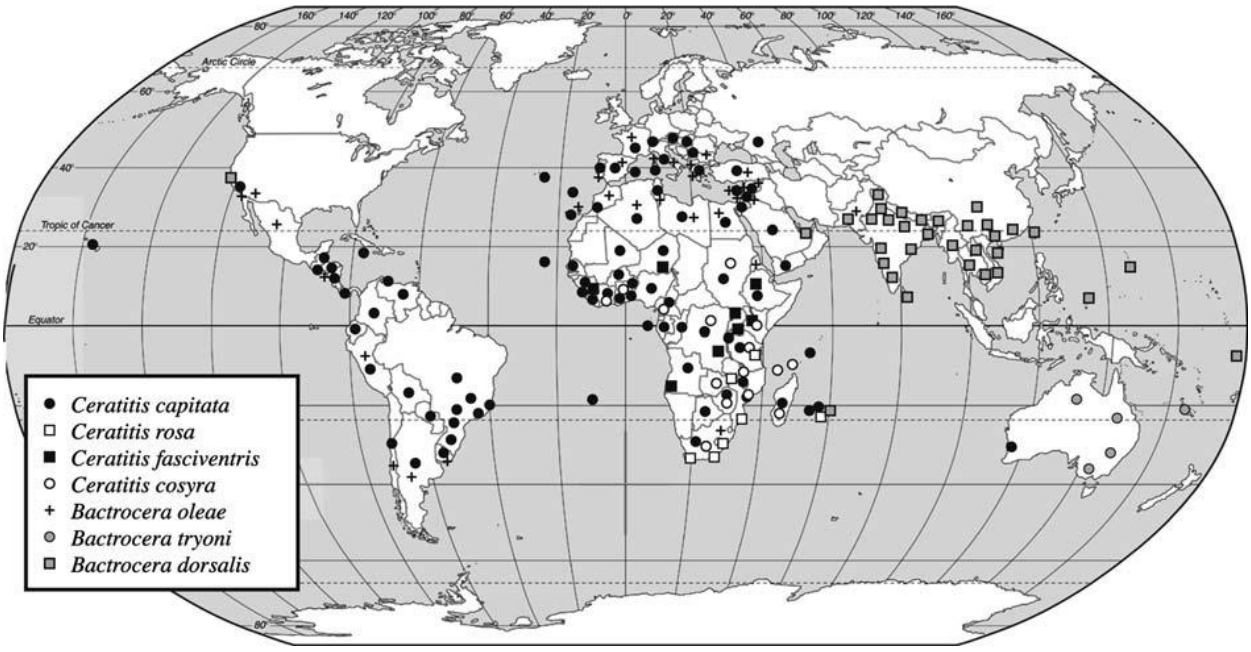

Figure 1: Distribution map of some of the key fruit fly species (Malacrida *et al*., 2007)

Crop affected and economically important fruit flies in India

Sl. No.	Common Name	Scientific Name
1	Mango fruit fly	*Bactrocera dorsalis* (Hendel)
2	Guava Fruit Fly	*Bactrocera correcta* (Bezzi)
3	Ber fruit fly	*Carpomya vesuviana* (Costa)
4	Olive fly	*Bactrocera oleae* (Ross)
5	Peach fruit fly	*Bactrocera zonata* (Saunders)
6	Chinese citrus fly	*Bactrocera* (*TetraDacus*) *minax* (Enderlein) *Bactrocera (ZeugoDacus) caudate* (Fabricius)
7	Papaya	*Bactrocera papaya*
8	Carambola fly	*Bactrocera carambolae* (Drew &Hancock)
9	Loquat	*Bactrocera dorsalis*

Life cycle of fruit fly

After emerging from puparia, adults of most species start feeding. Mature female mate and deposit eggs in growing hosts. The larvae utilize pulp of fleshy fruits of a wide variety of plant families, feed and develop in this resource but usually leave the seeds undamaged. Larvae feeding activity destroys and converts host tissues into a foul-smelling, semi-liquid mess. The infested hosts finally fall on the ground. The female fly can start egg laying within 8-30 days of its emergence from pupa. After final selection of the oviposition site, the protruding pointed ovipositor penetrates the host epidermis with its forward and backward movements to lay eggs. The entire ovipositor is inserted into the host and moved to construct a cavity for egg depositing. The number of eggs laid by a female varies and it can lay 300 to 1000 eggs depending upon the species. The eggs hatch within 24 hours to 3 days at 25°C temperature depending on the species. Fruit fly larvae are able to tunnels deeply into the fruit flesh for feeding once they hatch, spreading widely within infested fruit and rendering the whole fruit unpalatable. The larvae moult twice as they feed and grow. There are three larval instars. The mature larvae drop to the soil for pupation (several non-frugivorous species pupate within the host). Both larval and pupal duration varies considerably in different species and greatly influenced by nutritional status of the host and temperature. In unfavourable condition, adult may not emerge from the pupa but develops slowly within the pupa. Under favourable conditions their life cycle (from egg to adult) may complete within 2 weeks. Developmental periods may be extended considerably by cool weather. Adults occur throughout the year and begin mating after 8-12 days of emergence. Adult flies can survive for 1-4 months (up to 12 months in temperate environments) depending on the species, climate, and presence of hosts.

Nature of damage and symptoms

Generally, adult female fruit flies prefer to lay eggs in soft and tender fruit portions as well as soft tissues of vegetative parts of some plants by piercing them with the ovipositor. The

puncture leaks a watery fluid, which hardens into a brown resinous deposit and causes the puncture to become rather concave. After egg hatching, the maggots start boring into the fruit pulp tissue and make the feeding galleries in different directions inside the fruit. Consequently, fruit starts rotting or becomes distorted in shape. Young larvae abandon the necrotic tissue of fruit and move to healthy tissue, where they often introduce secondary microorganism and hasten fruit decomposition by invading of various pathogens. Often, significant damage can occur before any visible signs of infestation within a fruit are noticed. The earliest indicators of an infection are small discoloured patches on the fruit skin caused by the female fly's "sting" during oviposition. Fruit fly larvae are able to burrow deeply into the fruit flesh for feeding once they hatch, spreading widely within infested fruit and rendering the entire fruit unpalatable. Maggot infestation causes tissue disintegration and internal rotting in some fruit species, but this varies depending on the fruit attacked.

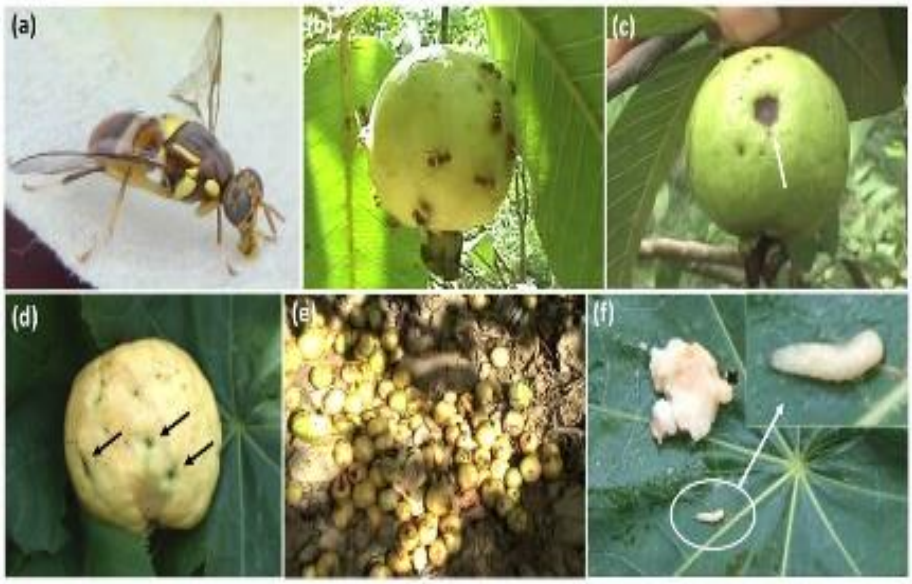

Figure 2: Nature of damage and symptoms

Management of fruit flies in major fruit crops

1. **Mango Fruit Fly**

Oriental fruit fly or mango fruit fly- *Bactrocera dorsalis* (Hendel) is a key pest of mango in India. There are eight species of genus *Bactrocera* which are considered as quarantine pest of mango. In India, the loss in fruit yield varies from 1 to 31% with a mean of 16% (Verghese *et al*., 2002) due to mango fruit fly. The female generally implants its eggs in the ripening fruit of the host plant. The larvae or maggots develop in the flesh of untreated fruit by making tunnels that allow secondary infections to occur when the larvae emerge out from fruit. The larvae pupate in the soil (5-10 cm) and flies emerge from April onwards, with a peak population from May to July, coinciding with fruit ripening.

Preventive measures

Cultural practices: Collect fallen infested rotten fruits below the tree and also remove fruits with ovipunctures and oozing clear sap from the trees if noticeable. Destroy these collected fruits by dumping in a pit (40-50 cm deep) and cover with soil to destroy all sources of possible breeding sites. Harvest fruit crops early before over ripening on tree. At mature green stage of fruit maturity, crops are not susceptible to fruit fly attack. Pick overripe fruits as these are excellent breeding sites for fruit flies. Plough the topsoil (5-10 cm deep) to expose the pupae to their predators, parasites, and direct sunlight. Practice crop and field sanitation.

Curative measures:

Pheromone traps: Methyl eugenol sex pheromone traps capture male flies. Set up methyl eugenol trap in the orchard @ 10/ha. Traps with pheromone + baits are used for monitoring and to reduce the population density of fruit flies infesting the fruits in the orchard @10/ha. Use of GF-120 a Spinosad based bait–insecticide mixture to attract and kill. The GF-120 is a naturally occurring mixture of two active ingredients of spinosad, the spinosyn A and spinosyn D, derived from the soil living actinomycete *Saccharopolyspora spinosa.* This compound has been described to be effective in the control of *Ceratitis capitata* (Wiedemann), *Bactrocera dorsalis* (Hendel), *Anastrepha ludens* (Loew), *Anastrepha fraterculus* Wiedemann and *Anastrepha obliqua* Macquart and also has low adverse effects on nontarget insect species.

Vapour heat treatment: vapour heat treatment (VHT) is a post-harvest treatment and performed to destroy the immature stages of fruit flies, if any present in the fruit materials. It is performed under a condition of high temperature and saturated water vapour with the goal to kill the insects without injuries to the fruits.

Hot-water treatments: post-harvest disinfestation of *Bactrocera dorsalis* (Hendel) in mango fruits using hot-water treatments is possible. In finding, Ndlela *et al*., (2017) reported that hot water treatment of mango hybrid "Apple" at 46.1 ^{0}C for 68 minutes leads to complete killing of all stages of fruit fly *Bactrocera dorsalis*.

Low-dose irradiation with modified atmosphere packaging: This method is effective for protecting mango fruits against the oriental fruit fly infestation. In a study conducted by Srimartpirom *et al.,* (2018) found that, mango fruits infested with *B. dorsalis* third instars maggot and wrapped with H34M bags and then irradiated at150 Gy (measured doses 121–187 Gy) revealed no survival (adult emergence) in 35,000-treated individuals, which satisfies the frequently used standard set for quarantine security of 99.99% mortality.

2. Guava Fruit Fly:

Guava is affected by different fruit flies such as *Ceratitis capitata, B. correcta, B. zonata* and other *Bectrocera* spp. In India, *B. correcta* is one of the important fruit fly of guava and can cause up to 80% damage (CABI, 2022). The population of fruit fly remain higher during June-September than in October-February. Adult fruit flies damage the fruit where they lay their eggs

by causing discoloration and blemishes. The maggots burrow into the fruit, developing inside and paving the way for secondary invaders (fungi or bacteria), which cause extensive rotting and fruit dropping.

Integrated Pest Management (IPM): Cover young fruits (about 2.5 cm in diameter) with clear plastic bags that have some holes in to allow drainage and prevent fruit burn. Use a trap containing protein baits and an attractant such as methyl eugenol. Destroy/bury all infested fruits in the soil. It is necessary to use pesticides in severe cases. Spray with fenvalerate (e.g., Fenfen) or cypermethrin (e.g., Ripcord or Cymbush) @ 1.0 ml/L water, 2-3 times at 15 days interval in case of severe infestation.

Early warning system: Since the sex ratio of fruit fly is 1:1, the emerged males can easily be attracted and killed with modified methyl eugenol (ME), in an orange-coloured attractant trap. The traps can be placed at a rate of 12/hectare on orchard borders to capture invading adults.

A new and more effective male lure for guava fruit fly *Bactrocera correcta*: β-caryophyllene (CAR), a compound present in the pheromone glands of wild *B. correcta* males, is of ecological significance to the species for mating. *Bactrocera correcta* males react to CAR at a younger age and more intensely compared to ME. Also, CAR is more effective and selective than ME for trapping *B. correcta* in the field. CAR feeding increased mating success of *B. correcta* males was the same as that for ME-fed. (Wee *et al.*, 2018).

3. Ber Fruit Fly:

The ber fruit fly (Carpomyia vesuviana) is a well-known monophagous pest of ber in India, Pakistan, and the Middle East countries. The fly infests most of *Ziziphus sp.* grown in the world and cause damage internally. Infestation starts with the onset of fruit setting. In severe cases yield losses upto 80% or even upto 100% damage (Vadivelu K., 2014). Adult females lay eggs singly by inserting their ovipositor into the growing young fruit. The larvae on hatching after 2 to 5 days, start feeding on the fruit pulps and make galleries inside it. Higher fruit fly incidence was found when the maximum temperature ranged from 17.0 to 25.0ºC and the minimum from 2.3 to 4.8ºC with ideal relative humidity range of 62.0 to 85.5%.

IPM approach for ber fruit fly management:

Prophylactic measures: Field sanitation, collection of infested fruits from orchard, destruction of wild bushes, and deep summer ploughing to expose the overwintering pupa to hot summer will help break the reproduction cycle and reduce the population load.

Host plant resistance: Growing of resistant cultivar like Tikidi, Mundia, Banarasi, Sanaur1, Safeda selection, Illaicihi, Mirchia, ZG-3. In a study ber cultivars Tikadi, Katha and Illaichi were found as resistant to *C. vesuviana* and these could be used in the future breeding program as resistant sources against this fruit fly. Certain biophysical characters (e.g., pericarp thickness, pulp: stone ratio and pulp texture) and biochemical traits (e.g., tannins, phenols and flavonoid content) of ber fruit were associated to resistance of ber against *C. vesuviana* and; hence, could

be used as marker traits in plant breeding programs to choose resistant cultivars (Haldhar *et al.*, 2018)

Biological control: The wasp parasitoid *Fopus carpomyia* attack the larval stage of fruit fly and its ovipositor is very suitable to parasitize the hidden fruit fly larvae in fruits. The rate of parasitization was reported around 21% to 26.7% with this parasitoid (Farrar *et al.*,2004). Use of neem powder and tobacco extract significantly decrease the infestation and they are potential candidates for organic ber cultivation.

Chemical control: Two application of 0.2% dichlorovos at pea stage and 15 days after give better control from this pest. Phosphamidon dimethoate, fenthion, and deltamethrin are also effective. The extract of azadiractin 1% and *Ocimum sanctum* 1% effective upto 10 days after spray.

4. Peach Fruit Fly:

The peach fruit fly, *Bactrocera zonata* (Saunders), is one of the most dangerous species of Tephritidae. It is one of the three most destructive flies in India, inflicting crop losses of 25 to 100% in peach, guava, apricot, and figs. It is a polyphagous species attacking more than 40 species of fruit crops, while it is considered as a serious pest of guava, peach and mango; secondary hosts include citrus, apricot and fig. The peach fruit fly is known in India and South-East Asia as a important pest of tropical and subtropical fruits.

IPM approach for peach fruit fly management

Sanitary measures: Infested host fruits should be picked, or those that fall to the ground should be collected and buried deep in the soil.

Male Annihilation: Methyl eugenol is considered as an effective attractant to the males of *B. zonata*. It can be mixed with insecticide and protein bait and can be used in traps for attraction and killing. Attracting efficiency of the paraphermone, TML(Trimedlure) and ME (Methyl eugenol) for attracting both of *C. capitata* and *B. zonata* males are improved when coating by using some polymers like St Acylate 8% and PVA 0.5%. (Metwally *et al.*, 2017)

Biological control: *Biosteres vandenvoschi* and *Biosteres longicaudatus* as parasitoids of immature stages of *B. zonata* whereas *Opius sp.* is as a good parasitoid of *B. zonata* pupae.

Plant quarantine: Prevention of *B. zonata* from establishing in fly-free regions may be achieved by strictly implementing quarantine regulations.

Physical control: Wrapping or bagging individual fruit to prevent oviposition by females is also effective but it required man power.

Chemical control: Use spinosad as bait spray.

Postharvest treatment: This may include fumigation, heat treatment (hot vapour or hot water), cold treatments, irradiation according to the requirement and availability of treatment.

Recent advances in fruit flies management

Organic Insecticide for trap: Essential oil derived from distillation of basil and tea tree leaves contain methyl eugenol (C12H24O2) which is acting as attractant for fruit flies. By placing methyl eugenol in the trap, fruit flies will be trapped. This technique is considered as environmentally friendly and easy to use, therefore can be applied in organic farming practice.

Toxic and hormetic-like effects of ingredients of citrus essential oils on adult Mediterranean fruit flies (*Ceratitis capitata*): Citrus essential oils (EOs) limonene, linalool and α-pinene have toxic properties against adult Mediterranean fruit flies. Sublethal doses of limonene (LD20) were found to enhanced the lifespan of adult Mediterranean fruit flies when they were deprived of protein. The toxicity induced by several citrus EOs compounds through contact and absorbance by adult Mediterranean fruit flies could provide useful insights towards the development of novel control tools like encapsulated EO compounds in food baits or insecticides (Stella *et al*., 2017).

Novel insecticides and bait stations: According to Fleischer *et al*., (2017) a promising group of organic insecticides are the avermectins, particularly the abamectin mixture are effective for control of *Anastrepha* fruit flies in mango orchards. These compounds are obtained from the soil living microorganism *Streptomyces avermitilis* as well as *Saccharopolyspora spinosa*. Contrary to the synthetic and some botanical insecticides, abamectin exhibits low residual effect and safer to beneficial insects. Abamectin has been assessed against different fruit fly species with different levels of success.

Implications of molecular techniques: Parasitoid detection and correct identification are a crucial step in the development and implementation of fruit fly bio control strategies employing parasitoid augmentive release. Molecular techniques also offer a considerable advantage over conventional morphological methods of fruit fly and parasitoid discrimination as well as within-host parasitoid identification, which presently relies on dissection of immature parasitoids from the host, or lengthy and labour-intensive rearing methods. In recent years, DNA-based methods have been used to identify natural enemies of pest species where morphological distinction is problematic. DNA barcoding involves the PCR amplification and sequencing of a key genetic marker of a given species and is one of the most commonly used molecular techniques employed in the study and management of arthropod pests and their parasitoids. The technique relies on the availability of a larger database of sequence orthologs for relationship, and when identifying an unknown sample, it requires prior knowledge of the relevant sequence of the species in question.

Implementing comprehensive molecular diagnostic techniques improved the success of fruit fly biological control programs by increasing understanding of host and parasitoid population genetics and improving parasitoid species matching to their preferred host. Molecular approaches are being used or can be used at many stages of the fruit fly and parasitoid lifecycles. Despite clear benefits in the use of these tools, molecular methods are not yet widely used for monitoring

the success of augmentative tephritid control programs. Such molecular tools are however becoming increasingly valuable in clarifying relationships between species, strains and populations of both fruit flies and their parasitoids, which are critical steps in planning successful releases. Certainly, these recent advances are likely to increase the emphasis on augmentative methods for fruit fly control in the future.

Loop-mediated isothermal amplification (LAMP): The LAMP assay for *C. capitata* at different stages of development; together with simple DNA extraction procedures and SYBR-green dye, it is possible to specifically identify *C. capitata* flies within 1 hour time period. LAMP assays have not yet been developed for fruit fly parasitoids, but would be a tremendously valuable tool in evaluating augmentative control programs by permitting rapid detection of parasitism in the field.

Restriction site associated DNA: Another new technology is Restriction site Associated DNA (RAD) frequently referred to as RADtag or RADseq. Adult Drosophila melanogaster genotypes have been successfully determined using this technique. This technology has the potential to be applied to diversity of biological questions from genotyping and biological diversity studies in both fruit flies and parasitoids (Jenkins *et al.,* 2012).

Biocontrol for fruit flies management

"Biocontrol is defined as the use of living organisms (called natural enemies) to suppress the population density or influence of a specific pest organism, making it less abundant or less damaging than it would otherwise be". Biological control includes the control of invertebrate pests using predators, parasitoids and pathogens. Recent research has looked into approaches that conserve natural-enemy communities while also reducing pest outbreaks, revealing that different agroecosystem components can influence natural-enemy populations. Major component of conservation biological control is to reduce the mortality of biological control agents from pesticide use also shifting from broad-spectrum insecticides to insect growth regulators. Habitat management is a valuable component of conservation biological control where, manipulation of farmland vegetation can exercise direct suppressive effects on pests and encourage natural enemies. Natural enemies are supported with shelter, nectar, alternative prey/hosts, and pollen (Gurr *et al*., 2017). Introduction of parasitoids to infested fields has given excellent results in management of fruit flies (e.g., in Hawaii). However, parasitoids seem to have little impact on populations of most fruit flies, with 0-30% levels of parasitism typical. In Thailand, parasitation rates of *B. dorsalis* by the wasps *Diachasmimorpha longicaudata* and *Fopius arisanus* were only 2%-9% in rose apple orchards. Furthermore, the residues of synthetic pesticides present in the environment may hamper this approach, it might be possible that biological control was more effective under a zero-spray approach. Other findings on the biology of one of the most promising parasitoids, *D. areolatus*, demonstrated average parasitism rates of *A. fraterculus* of 54% could be attained, with a range of 41.6% to 68.6%. Here development of the parasitoid from

larva to adult took 25 days, with an average longevity period of 16 days for males and parasitize *A. fraterculus.* (Nunes *et.al*., 2012).

List of parasitiods and their fruit fly hosts (Flavio *et al*., 2013)

Species	Family of parasitoid	Host/s
Aganaspis nordlanderi Wharton	Figitidae	*A. strita Neosilba* sp., *A. bahiensis, A. coronilli*
Aganaspis pelleranoi (Bréthes)	Figitidae	*A. amita, A. bahiensis, A. atrigona, A. fraterculus, A. serpentina, Ceratitis capitata, N. pendula, Neosilba* sp., *N. perezi, C. capitata*
Asobara Anastrephae (Muessebeck)	Braconidae	*Anastrepha* sp., *A. Bahiensis, A. Zenildae, A. obliqua*
Coptera haywardi Loiácono	Diapriidae	*A. fraterculus, A. sororcula*
Dicerataspis flavipes (Kieffer)	Figitidae	*A. amita*
Doryctobracon areolatus (Szépligeti)	Braconidae	*A. amita, A. bahiensis, A. bistrigata, A. fraterculus, A. leptozona, A. pelleranoi, A. obliqua, A. pulchra, A. pseudoparallela, A. serpentina, A. sororcula, A. striata, A. zenildae, R. pastranai, C. capitata, Neosilba* sp.
Doryctobracon brasiliensis (Szépligeti)	Braconidae	*A. amita, A. fraterculus, A. sororcula, A. serpentina, A. pelleranoi, O. Anastrephae, R. pastranai*
Doryctobracon fluminensis Lima	Braconidae	*A. fraterculus, A. paralela, A. montei, A. pseudoparallela, A. pickeli, Hexachaeta eximia*
Microcrasis lonchaeae (Lima)	Braconidae	*Neosilba pendula, Rhagoletotrypeta pastranai*
Opius bellus Gahan	Braconidae	*A. fraterculus, A. pickeli, A. montei, A. atrigona, A. obliqua, A. serpentina, C. capitata, Rhagoletis ferrugínea, T. Anastrephae, R. pastranai*
Opius bucki Lima	Braconidae	*Tomoplagia rudolphi*
Opius itatiayensis Lima	Braconidae	*Tomoplagia* sp.
Opius tomoplagiae Lima	Braconidae	*Tomoplagia rudolphi*
Opius sp.	Braconidae	*Anastrepha* sp, *A. atrigona, A. distincta, A. leptozona, A. obliqua*

Odontosema Anastrephae Borgmeier	Figitidae	*A. fraterculus*
Trichopria Anastrephae Lima	Diapriidae	*A. fraterculus*, *A. serpentina*
Tropideucoila weldi Lima	Figitidae	*Neosilba pendula*
Trybliographa sp.	Figitidae	*Neosilba* spp, *Anastrepha* spp.

Conclusion:

There is need of new and safer control strategies for management of fruit flies to avoid negative environmental impact of synthetic insecticides. Abamectin is a potential alternative to the use of Malathion and GF-120 for fruit fly control. Advantages of abamectin includes its low toxicity to mammals and birds and its rapid degradation in the environment (Fleischer *et al*., 2017). To facilitate access to export markets, post-harvest management measures such as hot-water treatment are required to ensure quarantine security. Hot water treatment of mango hybrid 'Apple' at 46.1°C for 68 minutes leads to complete killing of all stages of fruit fly (B. dorsalis). Combination treatment of low-dose irradiation and MAP (H34M-film) against third-instar larvae of B. dorsalis in 'Nam Dok Mai' mango showed 100% mortility. B-caryophyllene (CAR) is a highly effective and selective male lure as compare to methyl eugenol (ME) against guava fruit fly. (Wee *et al*., 2018). Use of essential oils obtained from basil and tea tree leaves containing methyl eugenol, neem powder and tobacco extract significantly reduce the infestation and they are potential candidates for organic cultivation as these are environment friendly. The wasp parasitoid, Fopus carpomyia was found at larval stage of ber fruit fly and very suitable to parasitize the hidden host in fruits. Citrus essential oils limonene, linalool and α-pinene inferred high toxicity on adult mediterranean flies (Stella *et al*., 2017). Molecular techniques also offer a considerable advantage over traditional morphological methods of fruit fly and parasitoid detection and differentiation as well as within-host parasitoid identification. EPNs Heterorhabditis strains with H. taysearae isolates Azohoue 2 and Hessa1 being highly pathogenic to B. dorsalis (Godjo *et al*., 2017). A low-dose of 116 Gy gamma radiation phytosanitary treatment against the oriental fruit fly, B. dorsalis (Hendel) in guava sufficient for disinfection (Zhao *et al*., 2016).

Summary points

- IPM is effective tool for controlling fruit fly infestation in fruit crops.
- The use of abamectin and bait stations offer several advantages including reduced insecticide use as well as reduced environmental impacts in the control of fruit flies.

- Development of effective lure which attract the male at younger age before commencement of sexual activity should be done.
- Studies on the bioclimatic requirements of biocontrol agent as well as post-release monitoring and assessment of parasitoid efficacy are still needed.
- Studies should be done on the special characteristics of fruit crops that can be used within fruit fly system approaches to improve management.
- Application of molecular techniques for augmentative release of biocontrol agent should be considered.

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THE STUDY OF TRANSPORT OF POLLUTANTS IN UNSATURATED POROUS MEDIA FOR ONE-DIMENSIONAL FLOW

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Abstract:

Contaminants containing different chemicals will pass through different hydro geologic zones as they migrate through the soil to the water table. The water table is the upper surface of the groundwater system. The pore space between soil particles above the water table are occupied by both air and water. Flow in this unsaturated zone is taken to be vertically downward, as liquid contaminants or solutions of contaminants and precipitation move under the force of gravity. The upper most region of the soil, the unsaturated zone, is the site of important process leading to pollutant attenuation. In responding to the growing concern over deteriorating groundwater quality, groundwater flow models are rapidly coming to play a crucial role in the development of protection and rehabilitation strategies. These models provide forecasts of the future state of the groundwater aquifer systems. The objective of the present work is to demonstrate how mass transport, flow of pollutants and other technologies can be applied to define the behaviour of pollutants in the unsaturated and saturated soil zones. The present study is concerned with the development of analytical models for unsaturated and saturated flow behaviour in soils.

Introduction:

The increasing demand for water for domestic, industrial and agricultural purposes is placing greater emphasis on the development of ground water resources. The exploitation of ground water resources at some parts of the country induces degradation of groundwater quality as well as the discharge of untreated effluents which add contaminants to the groundwater system. In recent years considerable interest and attention have been directed to dispersion phenomenon in flow through porous media.

The solutions of one, two and three-dimensional deterministic advection-dispersion equation have been investigated in numerous publications before and are still actively studied. Wexler [1992] and it's cited references there have documented many previously derived analytical solutions with different initial and boundary conditions. Eungyu park and Hongbin Zhan [2001] have developed an analytical solutions of contaminant transport from one, two, three-dimensional finite sources in a finite-thickness aquifer using Green's function method..

For simulating most field problems, the mathematical benefits of obtaining an exact

analytical solution are probably out weighted by errors introduced by simplifying approximations of the complex field environment that are required to apply the analytical approach (De Smedt and Wirenga, [1978a], Foussereau *et al.* [2000a], Yates *et al.* [1992, 2000].

Since exact analytical solutions are difficult to obtain, numerical solutions are commonly resorted.

Not many analytical solutions are available for two and three-dimensional problems even through the numerical solutions exist. In spite of difficulties in obtaining solution for two and three-dimensional cases, in the present study, we have developed a mathematical model for one-dimensional flow assuming linear retardation, a zero order sink/source term, a first-order production/decay term, and using first and third type boundary conditions at the inlet. The governing partial differential equation is solved in a straightforward manner for general inlet and initial solute distributions by applying a Laplace transforms with respect to z and t; Fourier transforms with respect to x and y for a cartesian coordinate system. The solute concentration in the real space and time domain is obtained by solving the algebraic equation and applying appropriate inverse integral transforms. The general solutions for the first and third-type conditions are used to derive expression for the concentration distribution.

Mathematical formulation and model

We consider one-dimensional unsteady flow through the semi-infinite unsaturated porous media in the x-z plane in the presence of a toxic material. The uniform flow is in the z-direction. The medium is assumed to be isotropic and homogeneous so that all physical quantities are assumed to be constant. Initially the concentration of strength C_0 exists at the surface. The velocity of the groundwater is assumed to be constant. With these assumptions the basic equation governing the flow is

$$\frac{\partial C}{\partial t} = \frac{\partial}{\partial z}\left(D\frac{\partial C}{\partial z}\right) - \omega\frac{\partial C}{\partial z} - \frac{\rho}{\theta}\frac{\partial S}{\partial t} \qquad (1)$$

where C is the constituent concentration in the soil solution, t is the time, S is the adsorbed constituent concentration, D is the hydrodynamic dispersion coefficient, z is the depth, ω is the average pore-water velocity, θ is the soil water content fraction and ρ is the bulk density of soil.

The first term on the right hand side of equation (1) represents the change in concentration due to hydrodynamic dispersion while the second term gives the effect of advective transport and the last term represents source/sink term i.e., chemical reaction or radioactive decay. The physical system assumes constant application of a Leachate constituent of concentration C_0 to the soil surface or large sources of wastes in a landfill that release a given constituent to the soil water system at a concentration.The third term on the right hand side of equation (1) represents adsorption.An equilibrium adsorption state will be assumed with a linear relationship between solution and adsorbed phases and this can be expressed as

$$S = K_d C \tag{2}$$

where K_d is the partition or distribution coefficient. The distribution coefficient is expressed as the ratio of solute concentration on the adsorbent to solute aqueous concentration at equilibrium. Differentiating equation (2) with respect to time and substituting it into (1) and rearranging, we get

$$R\frac{\partial C}{\partial t} = D\frac{\partial^2 C}{\partial z^2} - \omega\frac{\partial C}{\partial z} \tag{3}$$

Where $R = \left(1 + \rho/\theta\ K_d\right)$ is called the coefficient of retardation. When there is no adsorption (K_d = 0) the retardation factor R reduces to unity. Then the advection-dispersion equation (3) can be written as

$$\frac{\partial C}{\partial t} = D\frac{\partial^2 C}{\partial z^2} - \omega\frac{\partial C}{\partial z} \tag{4}$$

Equation (4) with its auxiliary conditions is an appropriate mathematical model of the physical problem. The problem is solved when an unique C(z,t) is found that satisfies equation (4) and its auxiliary conditions. There are several well-known analytical and numerical methods for solving the mathematical model. However, an alternative formulation of the problem is possible with the aid of the calculus of variations. An extremum problem replaces the given differential equation. A functional is found such that the extremum function also satisfies the given differential equation and its auxiliary conditions. A necessary condition that an extremum function exists is that the function satisfies the Euler equation. In practice the natural boundary conditions of the problem are only approximately satisfied with no loss in the validity of the solution.

Initially saturated flow of fluid of concentration C=0, takes place in the medium. At t = 0, the concentration of the plane source is instantaneously changed to C = C_0. Then the initial and boundary conditions for a semi-infinite column t are

$$C(z,0) = 0 : z \geq 0, C(0,t) = C_0 : t \geq 0, C(\infty,t) = 0 : t \geq 0 \tag{5}$$

The physical meaning of the boundary conditions corresponds to a situation where a soluble constituent in leachate is continually supplied to the soil surface which do not contain the material initially. The chemical process represents irreversible adsorption precipitation and/or changes in the chemical state of the constituent being described.

Equation (5) is a concentration type initial and boundary condition. However, use of a different boundary condition, such as a flux-type boundary condition should have little effect on the final results. For uniform soils, value of hydrodynamic dispersion coefficient D and average

velocity ω may be estimated by matching values of the relative concentration measured at specific depths as a function of time. For layered soil, values for D and ω may be estimated by matching observed concentration versus time distributions at specific soil depths with those obtained for a numerical model which allow for depth dependent values of D, θ and ω.To reduce equation (4) to a more familiar form, we take

$$C(z,t) = \Gamma(z,t)\exp\left[\frac{\omega z}{2D} - \frac{\omega^2 t}{4D}\right] \tag{6}$$

Using equation (6), equation (4) reduces to Fick's law of diffusion equation

$$\frac{\partial \Gamma}{\partial t} = D\frac{\partial^2 \Gamma}{\partial z^2} \tag{7}$$

The above initial and boundary conditions (5) transform to

$$\Gamma(0,t) = C_0 \exp\left(\frac{\omega^2 t}{4D}\right) : t \geq 0, \Gamma(z,0) = 0 : z \geq 0, \Gamma(\infty,t) = 0 : t \geq 0 \tag{8}$$

The solution of equation (7) can be obtained by using Duhamel's theorem.If C=F(x,y,z,t) is the solution of differential equation for semi-infinite media in which the initial concentration is zero and its surface is maintained at concentration unity, then the solution of the problem in which the surface is maintained at temperature $\varphi(t)$ is

$$C = \int_0^t \varphi(\tau)\frac{\partial}{\partial t} F(x,y,z,t-\tau)\,d\tau \tag{9}$$

This theorem is used principally for heat conduction problem, but the above has been specified to fit this specific case of interest.

Let us consider the problem in which the initial concentration is zero and the boundary is maintained at concentration unity. The boundary conditions are

$$\Gamma(z,0) = 0 \ , z \geq 0; \Gamma(0,t) = 1, t \geq 0; \Gamma(\infty,t) = 0, t \geq 0 \tag{10}$$

This problem can be solved by the application of the Laplace transform

$$L\{\Gamma(z,t)\} = \bar{\Gamma}(z,p) = \int_0^\infty e^{-pt}\,\Gamma(z,t)\,dt \tag{11}$$

where p is a number whose real part is positive and large enough to make the integral (4) convergent.

By applying Laplace transformation (11) to equation (7), the partial differential equation (7) is reduced to the ordinary differential equation below. The equation for $\bar{\Gamma}$ derived in this way we shall always refer to as the 'subsidiary equation'. If there is one more space variable, for example, if the general differential equation

$$\nabla^2 \bar{\Gamma} - \frac{1}{D}\frac{\partial \bar{\Gamma}}{\partial t} = 0 \tag{12}$$

has to be solved in some region with initial and boundary conditions then the subsidiary equation will be

$$\frac{d^2 \bar{\Gamma}}{dz^2} = \frac{p}{D}\bar{\Gamma} \tag{13}$$

whose solution can be written as $\bar{\Gamma} = Ae^{-qz} + Be^{+qz}$ where $q = \sqrt{\frac{p}{D}}$

The boundary condition as $z \to \infty$ requires that B=0 and boundary conditions at z=0 requires that A=1/p, thus the particular solution of the Laplace transform equation is

$$\bar{\Gamma} = \frac{1}{p}e^{-qz} \tag{14}$$

We determine Γ from $\bar{\Gamma}$ by the use of the Inversion theorem for the Laplace transformation. This states that

$$\Gamma(t) = \frac{1}{2\pi i}\int_{\gamma - i\infty}^{\gamma + i\infty} e^{kt}\Gamma(k)dk \tag{15}$$

Where γ is to be large that all the singularities of $\bar{\Gamma}$ (k) lie to the left of the line ($\gamma - i\infty, \gamma + i\infty$). k is written in place of p in equation (13) to emphasise the fact that in equation (15) we are considering the behaviour of $\bar{\Gamma}$ regarded as a function of a complex variable, while in the previous discussion p need not have been complex at all. Equation (14) can be written in the form of complementary Error Function (erfc). The error function to the probability integral is defined as

$$erf(z) = \frac{2}{\sqrt{\pi}}\int_0^z e^{-\eta^2} d\eta \tag{16}$$

This integral arises in the solution of certain partial differential equations of applied mathematics and occupies an important position in the probability theory. The complementary error function erfc(z) is defined as

$$erfc(z) = 1 - erf(z) = \frac{2}{\sqrt{\pi}}\int_z^\infty e^{-\eta^2} d\eta \tag{17}$$

then the equation (15) can be written in the form of complimentary error function,then the above result will be

$$\Gamma = 1 - erf\left(\frac{z}{2\sqrt{Dt}}\right) = \frac{2}{\sqrt{\pi}}\int_{z/2\sqrt{Dt}}^\infty e^{-\eta^2} d\eta \tag{18}$$

By using Duhamel's theorem, the solution of the problem with initial concentration zero and the time dependent surface condition at z=0 is

$$\Gamma = \int_0^t \phi(\tau)\frac{\partial}{\partial t}F(z,t-\tau)d\tau \tag{19}$$

where

$$\Gamma(z,t-\tau) = \frac{2}{\sqrt{\pi}}\int_{z/2\sqrt{D(t-\tau)}}^{\infty} e^{-\eta^2}d\eta \tag{20}$$

Since $e^{-\eta^2}$ is a continuous function, it is possible to differentiate under the integral, which gives

$$\frac{2}{\sqrt{\pi}}\frac{\partial}{\partial t}\int_{\frac{z}{2\sqrt{D(t-\tau)}}}^{\infty} e^{-\eta^2}d\eta = \frac{z}{2\sqrt{\pi D}(t-\tau)^{3/2}}\exp\left[\frac{-z^2}{4D(t-\tau)}\right] \tag{21}$$

The solution to the problem is

$$\Gamma = \frac{z}{2\sqrt{\pi D}}\int_0^t \varphi(t)\exp\left[\frac{-z^2}{4D(t-\tau)}\right]\frac{d\tau}{(t-\tau)^{3/2}} \tag{22}$$

By putting

$$\mu = \frac{z}{2\sqrt{D(t-\tau)}} \tag{23}$$

Equation (21) can be written as

$$\Gamma = \frac{2}{\sqrt{\pi}}\int_{\frac{z}{2\sqrt{Dt}}}^{\infty} \varphi\left(t-\frac{z^2}{4D\mu^2}\right)e^{-\mu^2}d\mu \tag{24}$$

By taking boundary condition as, $\phi(t) = C_0\exp\left(\frac{\omega^2 t}{4D}\right)$ the particular solution of the problem can be written as

$$\Gamma = \frac{2C_0}{\sqrt{\pi}}\exp\left[\frac{\omega^2 t}{4D}\right]\int_{z/2\sqrt{Dt}}^{\infty}\exp\left[-\mu^2-\frac{\varepsilon^2}{\mu^2}\right]d\mu \tag{25}$$

Then the above equation can be written by changing the integral limits as

$$\Gamma(z,t) = \frac{2C_0}{\sqrt{\pi}}\exp\left[\frac{w^2 t}{4D}\right]\left\{\int_0^{\infty}\exp\left[-\mu^2-\frac{\varepsilon^2}{\mu^2}\right]d\mu - \int_0^{\alpha}\exp\left[-\mu^2-\frac{\varepsilon^2}{\mu^2}\right]d\mu\right\} \tag{26}$$

where $\varepsilon = \sqrt{\left(\frac{w^2}{4D}\right)} \frac{z}{2\sqrt{D}}$ and $\alpha = \frac{z}{2\sqrt{Dt}}$

The integration of the first term of the equation (25) gives

$$\int_0^\infty \exp\left[-\mu^2 - \frac{\varepsilon^2}{\mu^2}\right] d\mu = \frac{\sqrt{\pi}}{2} e^{-2\varepsilon} \tag{27}$$

Noting that

$$-\mu^2 - \frac{\varepsilon^2}{\mu^2} = -\left(\mu + \frac{\varepsilon}{\mu}\right)^2 + 2\varepsilon = -\left(\mu - \frac{\varepsilon}{\mu}\right)^2 - 2\varepsilon \tag{28}$$

the second integral of equation can be written as

$$I = \int_0^\alpha \exp\left[-\mu^2 - \frac{\varepsilon^2}{\mu^2}\right] d\mu = \frac{1}{2}\left\{e^{2\varepsilon} \int_0^\alpha \exp\left[-\left(\mu + \frac{\varepsilon}{\mu}\right)^2\right] d\mu + e^{-2\varepsilon} \int_0^\alpha \exp\left[-\left(\mu - \frac{\varepsilon}{\mu}\right)^2\right] d\mu\right\} \tag{29}$$

Since the method of reducing to a tabulated function is the same for both the integrals on the right side of equation (27) only first term is considered. Let $\alpha = \frac{\varepsilon}{\mu}$ adding and subtracting we get

$$e^{2\varepsilon} \int_{\varepsilon/\alpha}^\infty \exp\left[-\left(\frac{\varepsilon}{a} + a\right)^2\right] da \tag{30}$$

The integral can be expressed as

$$I_1 = e^{2\varepsilon} \int_0^\alpha \exp\left[-\left(\mu + \frac{\varepsilon}{\mu}\right)^2\right] d\mu = -e^{2\varepsilon} \int_{\frac{\varepsilon}{\alpha}}^\alpha \left(1 - \frac{\varepsilon}{a^2}\right) \exp\left[-\left(\frac{\varepsilon}{a} + a\right)^2\right] da +$$

$$e^{2\varepsilon} \int_{\varepsilon/\alpha}^\infty \exp\left[-\left(\frac{\varepsilon}{a} + a\right)^2\right] da \tag{31}$$

Further, let $\beta = \left(\frac{\varepsilon}{a} + a\right)$ in the first term of the above equation, then

$$I_1 = -e^{2\varepsilon} \int_{\alpha + \frac{\varepsilon}{\alpha}}^\infty e^{-\beta^2} d\beta + e^{2\varepsilon} \int_{\frac{\varepsilon}{2}}^\infty \exp\left[-\left(\frac{\varepsilon}{a} + a\right)^2\right] da \tag{32}$$

Similarly, the second integral of equation (27) reduces to

$$I_2 = -e^{2\varepsilon}\int_{\frac{\varepsilon}{\alpha}}^{\alpha}\exp\left[-\left(\frac{\varepsilon}{a}-a\right)^2\right]da - e^{2\varepsilon}\int_{\frac{\varepsilon}{\alpha}}^{\alpha}\exp\left[-\left(\frac{\varepsilon}{a}-a\right)^2\right]da \tag{33}$$

Again substituting $-\beta = \left(\frac{\varepsilon}{a}-a\right)$ in to the first term, then the above equation reduces to

$$I_2 = e^{2\varepsilon}\int_{\frac{\varepsilon}{\alpha}-\alpha}^{\infty} e^{-\beta^2}d\beta - e^{2\varepsilon}\int_{\frac{\varepsilon}{\alpha}}^{\alpha}\exp\left[-\left(\frac{\varepsilon}{a}-a\right)^2\right]da \tag{34}$$

Noting that

$$\int_{\frac{\varepsilon}{\alpha}}^{\alpha}\exp\left[-\left(\frac{\varepsilon}{a}+a\right)^2+2\varepsilon\right]da = \int_{\frac{\varepsilon}{\alpha}}^{\alpha}\exp\left[-\left(\frac{\varepsilon}{a}-a\right)^2-2\varepsilon\right]da \tag{35}$$

Substituting this in to equation (27) gives

$$I = e^{-2\varepsilon}\int_{\frac{\varepsilon}{\alpha}-\alpha}^{\infty} e^{-\beta^2}d\beta - e^{2\varepsilon}\int_{\frac{\varepsilon}{2}+\alpha}^{\infty} e^{-\beta^2}d\beta \tag{36}$$

Equation (26) can be expressed as

$$\Gamma(z,t) = \frac{2C_0}{\sqrt{\pi}}\exp\left[\frac{w^2t}{4D}\right]\left\{\frac{\sqrt{\pi}}{2}e^{-2\varepsilon} - \frac{1}{2}\left[e^{-2\varepsilon}\int_{\frac{\varepsilon}{\alpha}-\alpha}^{\infty} e^{-\beta^2}d\beta - e^{2\varepsilon}\int_{\frac{\varepsilon}{\alpha}+\alpha}^{\infty} e^{-\beta^2}d\beta\right]\right\} \tag{37}$$

However, by definition

$$e^{2\varepsilon}\int_{\alpha+\frac{\varepsilon}{\alpha}}^{\infty} e^{-\beta^2}d\beta = \frac{\sqrt{\pi}}{2}e^{2\varepsilon}\left[1+erf\left(\alpha+\frac{\varepsilon}{\alpha}\right)\right] = \frac{\sqrt{\pi}}{2}e^{2\varepsilon}erfc\left(\alpha+\frac{\varepsilon}{\alpha}\right) \tag{38}$$

$$e^{2\varepsilon}\int_{\frac{\varepsilon}{\alpha}-\alpha}^{\infty} e^{-\beta^2}d\beta = \frac{\sqrt{\pi}}{2}e^{-2\varepsilon}\left[1+erf\left(\alpha-\frac{\varepsilon}{\alpha}\right)\right] = \frac{\sqrt{\pi}}{2}e^{-2\varepsilon}erfc\left(\alpha-\frac{\varepsilon}{\alpha}\right) \tag{39}$$

Writing equation (37) in terms of error function, we get

$$\Gamma(z,t) = \frac{C_0}{2}\exp\left(\frac{\omega^2t}{4D}\right)\left[e^{2\varepsilon}erfc\left(\alpha+\frac{\varepsilon}{\alpha}\right)+e^{-2\varepsilon}erfc\left(\alpha-\frac{\varepsilon}{\alpha}\right)\right] \tag{40}$$

Substituting the value of $\Gamma(z,t)$ is equation then the solution reduces to

$$\frac{C}{C_0} = \frac{1}{2}\exp\left(\frac{\omega z}{2D}\right)\left[e^{2\varepsilon}erfc\left(\alpha+\frac{\varepsilon}{\alpha}\right)+e^{-2\varepsilon}erfc\left(\alpha-\frac{\varepsilon}{\alpha}\right)\right] \tag{41}$$

Resubstituting the value of ε and α gives

$$\frac{C}{C_0}=\frac{1}{2}\exp\left(\frac{\omega z}{2D}\right)\left\{\exp\left[\frac{\sqrt{\omega^2+4D}}{2D}z\right]erfc\left(\frac{z+\sqrt{\omega^2+4D}}{2\sqrt{Dt}}t\right)+\right.$$

$$\left.\exp\left[-\frac{\sqrt{\omega^2+4D}}{2D}z\right]erfc\left(\frac{z-\sqrt{\omega^2+4D}}{2\sqrt{Dt}}t\right)\right\} \quad (42)$$

When the boundaries are symmetrical the solution of the problem is given by the first term of the equation. The second term in the equation is this due to the asymmetric boundary imposed in a general problem. However, it should be noted that if a point a great distance away from the source is considered, then it is possible to approximate the boundary conditions by $C(-\infty,t)=C_0$, which leads to a symmetrical solution.

Mathematical models have been developed for predicting the possible concentration of a given dissolved substance in steady unidirectional seepage flows through semi-infinite, homogeneous, and isotropic porous media subject to source concentrations that very exponentially with time

Results and Discussion:

The water eventually enters the groundwater storage basin (aquifer) - a source for potable water. During the passage of water through the soil, the pollutants are mixed, dispersed and diffused through the flowing flux and led to an intense effort to develop more accurate and economical models for predicting solute transport and fate, often from solute sources that exist in the unsaturated soil zone.

The mixing takes place in the soil medium by two processes, viz., molecular diffusion and dispersion. Molecular diffusion is a physical process, which depends upon the kinetic properties of the fluid particles and cause mixing at the contact front between the two fluids. Dispersion, however, is defined as mechanical mixing process caused by the tortuous path followed by the fluid flowing in the geometrically complex interconnections of the flow channels and by the variations in equations solute transport are solved analytically and numerically. An analytical solution for one-dimensional model is obtained using Laplace transformation techniques.

To estimate the magnitude of the hazard posed by some of these chemicals, it is important to investigate the processes that control their movement from the soil surface through the root zone down to the groundwater table. At present, major thrust on the transport of contaminant and research is directed towards the definition and qualification of the process governing the behaviour of pollutants in sub surface environment, coupled with the development of mathematical models that integrate process descriptions with the pollutant properties and site characteristics.

Conclusion:

We conclude that the solute transport in semi-infinite homogeneous porous media is modelled analytically for one-dimensional flow assuming linear retardation, a zero order sink/source term, a first-order production/decay term, and using first and third-type boundary conditions at the inlet. The governing partial differential equation is solved in a straightforward manner for general inlet solute distributions by applying Laplace transform with respect to z and t. From the equation (42), with an increase in $\frac{C}{C_0}$, most of the contaminants get absorbed by the solid surface and thereby retarding the movements of the contaminants as evident from the graphs. Most of the contaminants are attenuated in the unsaturated zone itself and thus the threat for groundwater being contaminated is minimized.

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WATER POLLUTION AND HUMAN HEALTH

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Abstract:

For life water is the most essential resource. But due to growing industrialization, agricultural practice and lack of knowledge about water pollution among people contribute immensely to the pollution of water and about 80% of world population facing with scarcity of water. The shortage of fresh water resources is a global problem because of pollution in water and unhygienic human activity and ignorance by industries and government authorities. There are various sources for water pollution such as industrial and domestic discharge; radioactive waste, population growth, fertilizers and pesticides etc. These sources have negative impacts on human health. Different viral, bacterial and parasitic disease spreading through contaminated water. Thus it is necessary to examine the water quality on regular basis and wastes should not be disposed in water without treating them to avoid destructive effect of pollution on human health and other organisms.

Keywords: Water pollution, wastewater treatment, infectious diseases, chemicals.

Introduction:

It is clear to us that, environmental factors play a significant role to well-being and health of human populations' [1]. Now a day's environment pollution becoming a world's wide-reaching problem and has potential to influence greatly the health of the human population [2]. In densely settled urban-industrial areas of the developed countries, pollution reaches its most serious phase. Water is considered as most vital resource among all natural resources for life. Water pollution is one of the serious environmental problems which occur when unwanted materials or pollutants enter into the water body and causes changes to the quality of the water [3] and make is harmful to human health and surrounding environments [4]. Because of rapid urbanization, industrialization and lack of knowledge about importance of water among people, approximately 80% of the population of world facing with water scarcity and waterborne disease [5]. Though earth is covered with mostly water, but only about 2% water is fresh water and rest is water present in sea and oceans. And from the 2% of the fresh water only 0.036% is reachable for use. Moreover, because of huge amount of pollution in fresh water resources by industries and human activities, the resources of fresh water are gradually decreasing [6].

Pollutants emerging from industrial and domestic wastes, chemical fertilizers, pesticides, chemical compounds like heavy metals, dye, personal care products, pharmaceuticals product,

radioactive waste, marine dumping and atmospheric deposition may directly or indirectly enter into the water body and affects aquatic environment as well as human health. Some pathogenic microbes from hospitals, research laboratory, untreated sewage, meat and food processing industries also enter the water system and directly affect human health and ecosystem [7]. Infectious diseases like, typhoid fever and cholera [8] and other diseases like vomiting, diarrhea, gastroenteritis, skin and kidney related problem are spreading through water pollution [9]. Direct damage of plants and animal nutrition affects the human health. Pollutants in water killing the crustaceans, fishes, mollusks, marine birds, sea weeds and other organisms that serves as human food. The polluted water affects the quality and health of the soils and vegetations [10].

The severity of water pollution cannot be controlled without any strict regulation by government and other environmental organization. Strict law policy must be imposed to industries and people for proper management of discharge and wastes. Water contamination through untreated industrial discharge is a major problem worldwide. In India also lack of sanitation awareness and mishandling of practices, the resources of water is not property utilized.

To overcome such problem, government and other environment concerned organization have to take strict laws about security and regulation of water and develop sustainable treatment technology of wastewater to overcome the problem of water pollution for mankind and biodiversity [11].

Sources of water pollution

There are various sources, through which water can be polluted, and major sources of them are:-industrialization, urbanization, domestic sewage, population growth, pesticides and fertilizers, heavy metals, plastics and polythene bags and weak management system.

The pollution of water is generally induced by activities of humans. The growth of human population, industrial and agricultural practices is the major causes of pollution. Sewage is the waterborne waster of the society and it is very unhealthy when discharged untreated into the water. Reports showed that about 70-80% cause of water pollution is domestic sewage. A huge amount of untreated domestic sewage is discharged into the water of river including, solid waste, toxicants, bacterial contaminants and plastic litters and these discharged materials causes pollution of water [12]. The result of dumping sewages into river is an immediate drop in the amount of dissolved oxygen as decomposers especially bacteria get stimulated by the organic matters and breaks down suspended materials in the sewage. The dissolved oxygen (O_2) is use up by the decomposers and there is declined in the level of Biological Oxygen Demand (BOD). Changes experienced by the flora and fauna of the rivers and due to lower oxygen demand the death rate increases by suffocation [13].

About 20% of the water pollution caused by industrial wastes and is so hazardous [14]. Toxic industrial materials cause pollution of both ground and surface water bodies. Waste

materials from industries like textile, sugar, pesticides, pulp and paper and electroplating are cause of pollution. The major problem is that the industrial effluents discharged into river without proper treatment [12]. Hot water discharged from the industries of cooling engine is another source of water pollution. The metabolic rate of aquatic organisms due to increase in temperature of the water and this cause increase oxygen demand. Copper salts and zinc sulphate are non-biodegradable chemicals produced by the industries of dye, which causes hazardous effects in ecosystem when discharged into the water. These materials enter into the water and decreased the quality of the water [15].

Pesticides and insecticides are generally used to kill pest and other microorganisms like bacteria and germs. But excessive use of pesticides, fertilizers and herbicides drained into the near water bodies and rivers through rainfall, excessive irrigation and caused serious danger to the life [16]. Like fertilizers, detergents are also very toxic to life of marine water. Chemicals from distaffs have been found to be carcinogen to animals when enters into the water bodies.

Heavy metals enters into the water through various activities like agriculture, industrial discharge and mining and; animals and humans exposed to toxic effect of heavy metals' through consumption of the contaminated water directly [17]. Although some heavy metals like, iron, copper, cobalt, zinc etc are essential in small quantity in our body for various processes but metals like mercury, arsenic, cadmium and lead causes great threat to health [18].

Increasing population plays a great role in creating water pollution. Most of the liquid or solid waste of day to day life is discharged into river waters. Waste of personal care products, dyes, petroleum and its waste, endocrine disruptive chemicals (EDCs) plant and animal pharmaceuticals acts as pollutants of water which causes great effect on humankind [19]. The pharmaceuticals are used all over the world and they polluted water through disposal of household and hospital wastes and enter rivers through drainage water and sewage [20]. Dyes are water soluble compounds and presence of dyes in water not only affects humans but also aquatic animals and plants. Human exposed to the toxicity of dye through consumption of water that are bioaccumulated with dye, fish and vegetables [21]. So removal of dyes from wastewater before discharged in to water is essential as dyes are carcinogenic and mutagenic compounds [18]. Water is also contaminated with harmful bacteria from excreta of human and other animals. Government is not capable to supply essential sanitation to citizen because of growing number of population. Increasing use of plastic and polythene bags and their wastes are major pollutants. Most of the people throw away wastes by putting it into plastics. And this growing plastic wastes are great threat to human as well as biodiversity of aquatic life. Large populations of people defecate open and in urban areas, about 77% people are using flush latrine and 8% pit latrines. In urban areas, unhygienic conditions, overcrowding and unsafe drinking water are major health issues. Thus urbanization can cause many infectious diseases [22]. Apart from these, other

natural factors like volcanic eruptions, floods, storm etc also affect quality of water. Some major sources of water pollution are shown in Fig. 1.

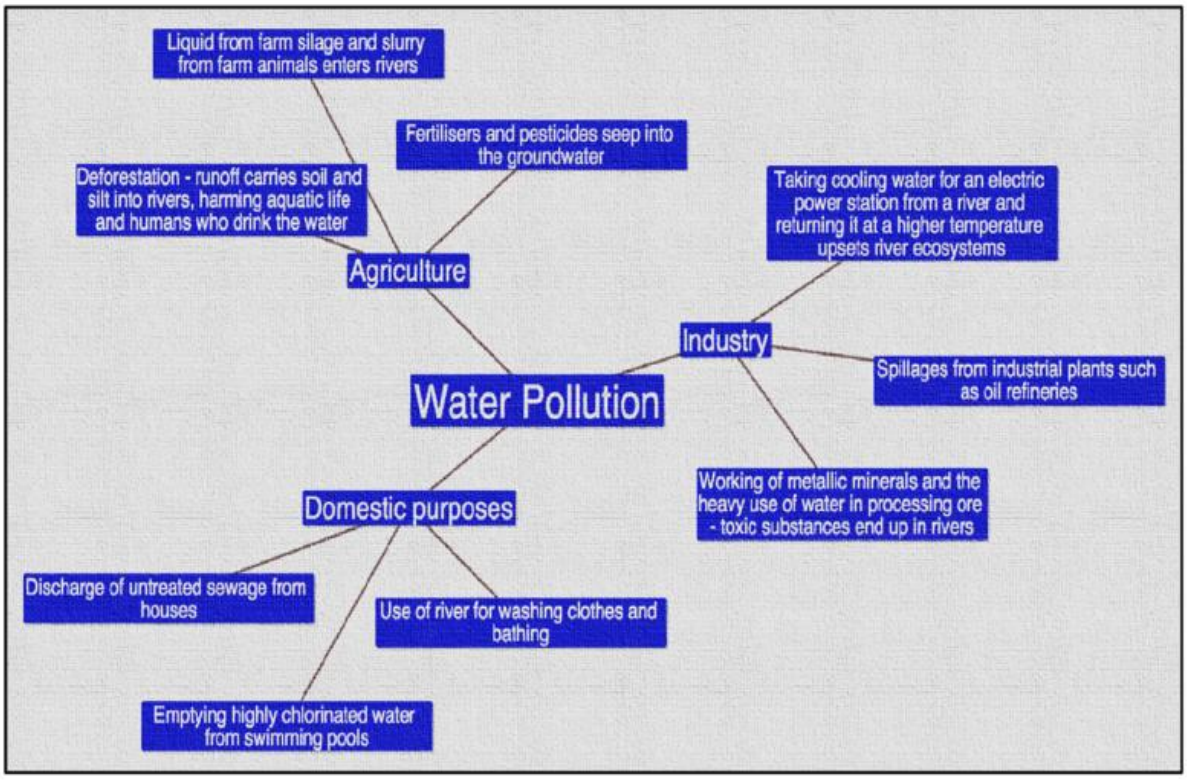

Figure 1: Different sources of water pollution [37]

Effect on human health

Water pollution greatly associated with human health problems. Due to pollution, various waterborne microorganisms spread diseases among humans known as pathogens. Some of the pathogen found worldwide while some confined to a particular area. Various water borne diseases are infectious and spread from man to man [23]. The extreme condition of flood and rainfall creates different diseases. About 10% of the world population consumes vegetables and food grains that are grown in water that are contaminated. Fecal pollution of water sources of many infectious diseases that result in infection of fecal-oral route [24]. There are danger of many health issues that are connected with polluted water includes various diseases like, diarrhea, respiratory disease, neurological disorder, cancer, and cardiovascular disease. For blue baby syndrome and cancer, nitrogenous chemicals are responsible [25]. In rural areas the risk of cancer is higher due to lack of less facility to process water and use of untreated water for consumption. Thus poor people are at greater risk of health issues because of lack of proper sanitation, water supply and sanitation [26]. For pregnant women, contaminated water has very negative effects on the fetal health [27].

The use of polluted water for agriculture destroys the production of crop and infects the crop which is hazardous for human health. The effects of heavy metals are also toxic to human health which includes severe headache, skin and eye irritation; vomiting; dizziness to organ dysfunction; stomach ache; diarrhea and hematemesis [28]. Consumption of water containing arsenic can stimulate liver, bladder and lung cancer; candmium can result in lung and kidney damage. Exposure to lead cause memory loss, brain damage and hampering of learning [29] and mercury can cause renal dysfunction. Water contaminated with water can also leads to hair loss and liver cirrhosis [30]. Other chemicals like, endocrine disruptive chemicals (EDCs) creates abnormal endocrine activities in body which increase the risk of cancer and in aquatic animals causes reduction of eggs and sperm cells production through disruption of endocrine system [31].

Parasitic disease

Amebiasis is an intestinal disease caused by a parasite *Entamoeba histolytica*, a single-celled protozoan, usually enters the human body when a person ingests cysts through water contaminated with fecal matter and affects stomach lining. The life cycle of this parasite consists of cyst and non-cyst form and infection of the disease occurs when cyst form is swallowed and causes symptoms like chills, fever and water diarrhea [32].

Cryptosporidiosis is an infection caused by *Cryptosporidium parvum*, which found in stool. This parasite enters into the body after eating food or drinking water that is contaminated with stool. It can also get transmitted from person to person. This parasitic infection causes symptoms like, diarrhea, watery and loose bowls, fever, upset stomach and stomach cramps [33]. *Cryptosporidium* is resistant to disinfectants and thus affects immune system and cause infection. According to WHO, about 2.2 million deaths results from 4 billion cases of diarrhea [34].

Another parasitic disease Giardiasis is caused by *Giardia lamblia*, a microscopic parasite. It is resistant to disinfectant and temperature of winter. People exhibit giardiasis shows symptoms like excess gas, bloating, watery diarrhea, upset stomach and stomach cramps, while some people exhibits no symptoms [33].

Bacterial diseases

The main causative sources of diarrhea are fecal contaminated water and untreated drinking water. Approximately 4% to 15% of diarrhea cases worldwide caused by bacteria called *Campylobacter jejuni*. Symptoms pf diarheea are abdominal pain, fever, nausea and headache. Preventive measures of this disease are use of antibiotics and hygienic practice.

Cholera is another water contaminated disease caused by bacteria called *Vibrio cholerae*. Symptoms of cholera are nausea, vomiting, watery diarrhea and leads to dehydration and sometimes kidney failure. Use of anti-microbial treatment prevents the disease

Shigella bacteria cause a bacterial disease called Shigellosis. The bacteria cause damages to the intestinal lining of the digestive tract. This bacterium makes their route to human through

contaminated water and results in intestinal inflammation and sometimes death also. The other symptoms of the disease are abdominal pain, nausea, vomiting and watery diarrhea. It can be treated by taking anti-bacterial medicine [35].

Viral diseases

Viruses are also contaminated through water and cause various diseases. Hepatitis is a viral disease caused by virus from contaminated water and it mainly infects liver. Symptoms are loss of appetite, jaundice, fatigue, discomfort and high fever. It sometime cause death, if persists for long time. One can rid of the disease by adopting good hygiene practice and vaccines are also available for this disease [36].

A disease called Gastroenteritis is caused by viruses such as, adenoviruses, rotaviruses, norwalk viruses and calciviruses. The symptoms include headache, vomiting and fever. This infection can be dangerous among disabled person, young children and infants [33].

Another disease poliomyelitis is caused by poliomyelitis virus. Symptoms of polimylitis are fever, sore throat, nausea, diarrhea, constipation and sometimes paralysis. Vaccines are available for this disease.

Inflammatory disease Encephalitis is spread through bite of infected mosquitoes. The mosquito that spread the disease is Culex. They lay their eggs in contaminated water. People infected with encephalitis show symptoms like high fever, headache, muscle stiffness, convulsion, and in serious cases paralysis and coma results, however most people do not show any symptoms, only act as carrier [33].

Conclusion:

In this century, water pollution is a global issue and the whole mankind is facing with the worst result of water pollution. Effective approaches with sustainable, economical and technological measures need to be taken to overcome the problem of water pollution. Toxic compound, chemicals, hazardous heavy metals should not be allowed to enter food chain. Agricultural area should be protected so that, compound having bioaccumulation property could not spread into the area. To prevent water sources from contamination and pollution, the identification of anthropogenic and geogenic sources must be necessary and different approaches should be taken to prevent contamination. Efforts on developing sustainable and cost-effective system for waste water treatment have to be taken to provide proper sanitation and to fulfill water demands. For proper sanitation facility, household-centered sanitation system needs to be developed. There should be proper water disposal system for industries and wastes should be treated before discharged in to river or other water bodies. Most importantly, awareness and educational programs should be organized among students and people create awareness about the water pollution, and practice of good hygiene to control the problem.

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SUSTAINABLE DEVELOPMENT: RESEARCH STUDIES

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Abstract:

This article focused on the existing research which is based on sustainable development. Next is the different researcher point of view is mentioned related to sustainable development. Then after that it show the different goal of the SDG. This article find that every country has made some progress to achieve sustainable development. However also they face the difficulty while achieving that sustainable development goal. These difficulties have social, political, structural, institutional and economical. Also, at the end the different suggestions are given to attain SDG 17 goals.

Introduction:

The purpose of this article is to analyze the sustainable development. In this the aim is to analyzing the existing research that identifies the progress made and investigation output in many countries in sustainable development. There is developing concern in sustainable development and sustainability in the academics and policy literature. These two approaches have dominated the national development policy area for over two decades. In the policy area, recent events such has climate change, the method to reduce fossil fuel emission, to reduce poverty, stop water wastage, zero hunger, improve education system and the transition to natural resources have built up the push towards sustainable development and sustainability. In academics the experimenter has undertaken analysis to identify the factor that promote or delay the achievement of sustainable development objective in the hope that the resulting analyze output can inform policy decision goal at achieving the sustainable development goal.

Sustainable development has a very wide meaning depending on the feature being considered. Sustainable development has achieved much consideration from policy makers and academics for four important reasons.

1. Sustainable development is believed to be the end goal of united nation plan for the planet and many gave their consent to attain the sustainable development.
2. Sustainable development encourages to have a safe planet for every generation.
3. Sustainable development is study to be an all-embracing development goal because the objective of all other development aim is to maintain the level of development that is safe.
4. Sustainable development is predicted to carry lasting socio-economic benefits to all poor people and the environment.

Prior studies have researched many themes in the sustainable development and sustainability literature such as the encouragement of sustainable development and sustainability, advancing sustainable development through building infrastructure and alteration, the individual approaches to sustainable development, each region sustainable development practice, economic inclusion for sustainable development, and sustainable development through environmental responsibility and economic growth. While this subject address very important issue in the literature, there are very few analyses that present an outline of the progress made and issues affecting sustainable development and sustainability in different countries. But there is a necessity to look the advances made in the sustainable development and sustainability composition and the problem yet to be mark, alongside some suggested areas for future research into sustainable development and sustainability practices. This article fully analyzes the existing research in sustainable development. Also present the analyze of existing research on sustainable development into many countries. It also searches some country research in sustainable development and sustainability. This article pays to the composition in this way like,

a) It pays to the composition that check the main role of sustainable development and sustainability for better development outcomes.

b) This analyzes the contribution of the ongoing debate regarding the sustainable development on the earth. Then the next part will be the theoretical frame work and definition of sustainable development and sustainability. After that it discuss the global research on sustainable development and sustainability. Thereafter some countries research on sustainable development. Next it discusses some implementation of sustainable development in India. Also, it shows some research areas for future research. And at the end it presents the conclusion.

Definitions of sustainable development

United nation (1987) - Sustainable development is the development which meet the need of the human without compromising the need of the future generation.

Willers (1994) - defines sustainable development as a focused, long term and comprehensive process that affect the life at all level, fulfill the material, social need and interest of all the people, reduce the thing which damage and affect human life, save resources for future generation, maintaining the natural heritage and culture, it does not the country. If we see in the academic composition, sustainable development is defined as the process of improving the human life while alive within the environment.

Pearce, Atkinson and Duboug (1994) - define sustainable development in terms of per capita consumption path that is constant and raging. It also clears the misunderstanding that people have in there that sustainable development and sustainability both the word have same meaning.

Greenland (1997) - sustainability is a philosophy, approach or practice that guide the use of today resources in efficient manner to ensure that resources are available and sufficient to meet the today needs and the needs of future generation.

Grant (2010) - sustainability is the responsibility to make decision regarding the uses of resources which is present in the earth. Now that the meaning of sustainable development and sustainability is cleared. But still thinking that why we have to maintain sustainable development. So, the answer is if sustainable development is not maintained then in future. Future generation will not get any resources to live they're on earth.

Different goals of sustainable development

1. No Poverty

This is the first goal of SDG and its motive is to end poverty by 2030. It also aims to ensure social protection for the poor and vulnerable, increase access to basic services and support people harmed by climate related problems.

2. Zero Hunger

The united nation second sustainable development goal is zero hunger. So its main aim is to end world hunger by 2030.

3. Good health and Wellbeing

Sustainable development goal 3 is Good Health and Wellbeing. It is one of the 17 sustainable development goal established by the united nation in 2015. Its work is to ensure healthy lives and promote well being for all at all ages.

4. Quality education

This goal is established by united nation in September 2015. Its main agenda is to ensure inclusive and quality education for all.

5. Gender equality

It is 5th of the 17 sustainable development goal established by united nation in 2015. Its main aim is to achieve gender equality and empower all women and girls.

6. Clean water and sanitation

It is one of the 17 sustainable development whose function is to ensure availability and sustainable management of water and sanitation for all.

7. Affordable and clean energy

Its aim is to ensure access to affordable, reliable, sustainable and modern energy for all.

8. Decent work and economic growth

Sustainable development goal 8 is about decent work and economic growth. Its agenda is to promote sustainable economic growth and decent work for all.

9. Industry, Innovation and Infrastructure

Sustainable goal 9 is for building resilient and sustainable infrastructure. This goal more focus on to promote inclusive and sustainable industrialization.

10. Reduced inequalities

In this the SDG main goal is to reduce inequalities within and among countries.

11. Sustainable cities and communities

Sustainable development goal eleven titled sustainable cities and communities is one of main sustainable goal established by united nation general assembly. The mission of SDG11 is to make cities inclusive safe and resilient.

12. Responsible consumption and production

In this the main aim of this goal is to ensure sustainable consumption and production pattern.

13. Climate action

This goal main mission is to take urgent action to combat climate change and its impact.

14. Life below water

The main aim of this goal is to conserve and sustainably us the ocean, seas and marine resources for sustainable development.

15. Life on earth

This goal aim at securing sustainable livelihood that will be enjoyed for generation to come.

16. Peace, justice and strong institutions

The main agenda of this goal is to provide justice for all and build effective accountable and inclusive institution at all level.

17. Partnerships for goals

This goal aim is to built strong partnership for sustainable development.

Research studies related to sustainable development

Asian studies on sustainable development

1. Trupp and Dolezal (1997) - According to this researcher to attain sustainable development the Asian countries face many difficulties. So that they can maintain sustainable development in their region. In Asia the scientist savage examines the sustainable development very deeply like according to him the concept of sustainable development in south east Asia based on four themes- population growth, ecological system and the nature of development. He stresses the need of maintaining the sustainable development in their region. Also, Asian government should focus on sustainable development the region will play an important role in sustainable development in the future. He then argues that long term solution to sustainable development in south Asia will lie in changing living style, habits and goals. Also, they find that the marginalization of poor people in south Asia and the weak institution between agencies charged with disaster responsible for sustainable development.

To attain sustainable development most of the things which Asia did is given below –

a) Promoted poverty reduction- In 2012 the people of Asia living in very poor condition. So, they helped poor people to improve their condition.
b) Increasing resilience to disaster – The ENEA region is unsafe to weather condition. In 2015 a total of 22 million people in this region was affected by natural disaster. It is important to strengthen the capacity of the region.
c) Driving Ecological innovation for growth – Increased the rate of scientific and technological achievement contribute to shifting economic growth into resource efficient.
d) Integrating population ageing into national development priorities – The challenge of population ageing has already begun to affect ENEA countries.

2. Seneviratne et al (2014) – according to him the ever-increasing need of human for material, humanity energy and transportation requirement have caused the green house gas to create the hottest decade in earth history.

3. Cuthill (2010) – the amplified global temperature expanded the ocean and melt ice sheets exacerbating sea level rise and coastal region population increase cyclone intensity and other natural hazards.

4. Shaker (2015) – with urbanization enriches socioeconomic well-being. It degrades the life supporting biogeochemical system

5. Alberti (2008), Carpenter (2009) – According to his research urbanization directly affect the earth environmental service and indirectly disturb biogeochemical system far distance from urban resources.

Conclusion – According to the researchers the population growth, natural disaster and globalization are the main issue because of which the Asia face difficulty to attain SDG goal.

African studies on sustainable development

1. Tiba and Belaid (2021) - Africa is famous for whatever the challenges they faced. So that their country can achieve sustainable development. They find that the challenges they faced are high population growth, poor infrastructure, and inadequate employment opportunity and low climate change adaptive capacity. To attain sustainable development, they started with local level. Few areas which require much attention to attain sustainable development include- reducing the use of fuel wood, protect knowledge and local language, strengthen democracy and should improve agriculture. Also investigate about renewable energy. They use equation model and find a positive relation between renewable energy and sustainable development. And the result is high level of renewable energy have a positive impact on the economic system, environmental and social dimension of sustainable development.
2. Ojale (2006) - He investigates that whether the central government spending on education and health affect the level of sustainable development in Africa. The result it has positive effect on sustainable development.

3. Pizzey (1986) – During his research he observed that Africa government has launch the several strategies like Ghana poverty and national policy were designed.
4. Holmen (2001) – According to his research in Tanzania the Africa government started the national development vision and national strategy for solid waste management was designed.
5. Adam (2006) – The idea of sustainable development dates back more than 30 years ago and it was coined by the world conservation union.

Conclusion:

To achieve sustainable development Africa government started several strategies. And this strategy is also successful. But somewhere they are lacking to achieve fully SDG goal. Because of their economic problem

In order to achieve sustainable development Africa government launched several plans was formed like a) Ghana for instance, the Ghana poverty reduction. To reduce government builded efficient social service system.

b) Environment, sanitation and health – for SD to be attained progress is made to halving the proportion of Africa population without sustainable access to clean drinking water.

c) Agriculture is very important to attain sustainable development. So programmed like comprehensive Africa agriculture development is introduced.

d) Improved the condition of the Africa tribal people.

Middle East studies on sustainable development

Many researchers found that the somewhere middle east region is success to maintain sustainable development. Middle East countries such as United Arab Emirates and Qatar became the more environmentally friendly. The government in these Middle East countries have started sustainable development initiatives like green building code and regulation to promote environmentally friendly construction. So that they can achieve sustainable development.

1. Soderholm (2020) – explained that the green economy is an alternative vision for growth and development for generating economic development and improvement in people lives. And this significant of green economy is to promote sustainable technologies.

2. Mahmood nonurban Hossam (2021) – studied that the green economy as a tool for sustainable development n developing countries. According to his study this green economy is sustainable development.

3. Al tai (2021) – confirmed that the green economy has received the attention of the researchers. And according to his investigation the green economy also focused on reducing poverty and improving the standard of poor people.

4. Musa (2018) – addressed the role of the green economy. Its was found from this study that green economy plays an important role in achieving sustainable development.

5. Nafisi (2018) – according to the study green economy saved the life of the humans from environmental risk associated with polluting business.

Some of the Things which Middle East Asia does is given below

a) To attain sustainable development, they spread awareness to people to minimize the resource consumption.
b) Motivated people to use renewable and recyclable resources.
c) Created the nontoxic environment for Middle East Asia people.
d) Protected the natural environment.

Conclusion:

Middle East Asia to achieve sustainable development fully. They focused on green economy. But they didn't give much attention to education area. Then may their country will be sustainable country.

Some implementation of the sustainable development in the India – the concept of sustainable development was first introduced by Stockholm conference in the 1972.

To maintain sustainable development the government of India made some principle for sustainable development like – inter-general equity this principle state that right development must be fulfilled so that equality meet developmental and environmental need to future generation. The main aim of this principle is that human should not unnecessarily used the resources without their need. Moving on to next principle this principle state that state should made the precautionary approaches. So that they can protect the environment.

Area for research work – this region located many chances for further research. The suggested region for future research has limited region. This region is mainly the politically economy of sustainable development, that how the sustainable development can help to solve the local problems. There is a need of research on the politics of sustainable development. And according to the studies of Riordan and Voisey they found that there is other political feature of sustainable development that had not been discovered yet. Like existing work on sustainable development and sustainability have not been investigated. That how a government and politician can hide the efforts to achieve sustainable development. If the central government in India introduce and enforce the new policies. Then that may help to show the stoppage of harmful economic activities whose holders are financially powerful. In India there is the problem of economy for sustainable development. This problem is because the politician does not give much attention to maintain sustainable development in India. They only wasted the money. Because according to them human should use the resources without thinking about the future generation. The money which they get from central government to maintain environment that they used for their election purpose. So, this is the reason why India is still to maintain sustainable development in some level. Now that it is clear that political system also has the effect on sustainable development.

Some researchers also show the link between the sustainable development and work of the government. This research is discovered by Cuthill in 2002 which state that sustainable development can be best implemented through the collaborative method. There are other researchers like Ruthanne they say that even though local government is trying the best to maintain sustainable development in their region. But their region is still lacking in maintaining sustainable development also, the policy maker still rejected the sustainable developmental goal. Because they are thinking that the maintaining sustainable development level will not be going to help world problem. They are thinking that this will not help poor countries in their upliftment process. So, I just want to say that future research should find a way in which they can help the poor people and also improve their economy wellbeing.

Conclusion:

So, this article had analyzed the existing research on sustainable development. Also clarify the meaning of sustainable development and sustainability. In this I discussed the different countries approaches to attain sustainable development. And what all the problem they faced. So that their country can achieve sustainable development goal. Also, I point out the future research areas in order to improve the sustainable development. Next, I present the implementation of sustainable development in India. At the end I just want to say that till I discussed the existing research which is based on sustainable development. All country tried their best to achieve sustainable development.

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A CASE STUDY ON MUNICIPAL SOLID WASTE MANAGEMENT IN CHIKKAMAGALURU CITY, KARNATAKA

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Abstract:

Solid Waste management involves the collection, transportation, processing, recycling or disposal and monitoring of waste materials. The present study was under taken to study the existing system of storage, collection and transportation of solid waste in Chikkmagaluru town. The primary data acquired related to SWM was collected through site visits and interfacing with people. The secondary data has been obtained from Municipal Corporation and other reliable sources. The total solid waste collected per day was 54 tons among which 35 tons was domestic waste and 11 tons from commercial establishment, 4 tons from sweeping and 1 ton from slaughter waste and 3 tons from drain silt. It is necessary to educate people and convince them to adopt practices for reduce, reuse and recycle. Municipal Corporation and government should pay importance to dispose waste economically.

Keywords: Solid waste, Municipal Corporation, domestic waste, recycle, Chikkamagaluru.

Introduction:

Solid Waste management involves the collection, transportation, processing, recycling or disposal and monitoring of waste materials. It relates to refused materials produced by human activity, and is generally undertaken to reduce their effect on health, environment or aesthetics. Waste management is also carried out to recover resources from it. It involves the use of solid, liquid, gaseous or radioactive substances with different methods and fields of expertise for each (Bacinschi *et al.*, 2010). The primary source of municipal solid waste includes waste generated in domestic, institutional, commercial activities, garden and municipal services. The domestic wastes are high in quantities and vary with time and season. It is generally comprised of organic and inorganic constituents. Now days the quantity of organic waste is decreasing and the quantity of metals, paper and plastics are increasing, indicating that there is growing preference for consumption of packaged food in recent years in modern society. The problem of municipal solid waste management in major cities has acquired alarming dimensions in India especially during the last decade. Municipal solid waste management (MSWM) is one of the major environmental challenges in most of the cities of developing countries like India. Improper management of municipal solid waste (MSW) causes hazards to inhabitants and environment. The waste quantity is increasing at an alarming rate in India due to rapid urbanization and high

population growth. The growth rate of population for India in last decade was 17.6% (Census of India, 2011). Urban waste generation rate in India is lower compared to other developing countries and approximately one-third to half that of developed countries (Asnani, 2006). A World Bank publication reports that the waste generation rate in urban areas of India will be approximately 0.7 kg/person/day by 2025, which is roughly four to six times higher than it was in 1999 (World Bank, 1999). The economic growth in the area in the recent past has led to a large increase in urban population, driving dramatic urban expansion, land use change and increase in generation of solid wastes (Mahini and Gholamalifard, 2006). The total waste generation increases in proportion to the rise in population and urbanization, and issues related to disposal have become demanding as more land is needed for the ultimate disposal of these solid wastes (Khan *et al.,* 2016). The present study was under taken to enlist the causes of solid waste generation and possibilities of associated problems. The study was mainly concentrated to investigate the present status of Municipal Solid Waste Management (MSWM) generated in Chikkamagaluru city.

Materials and Method:

Study area:

The present study was under taken in Chikkamagaluru city. Chikkmagaluru is one of the important hill stations located in the western part of Karnataka and situated in the backdrop of the Bababudangiri Hills of the Western Ghats. The chikkamagaluru town is very well known for coffee. The town is situated at an altitude of 1021m above the mean sea level and is located on 130 36’ North altitudes and 750 45’ Eastern longitudes. The minimum and maximum temperature observed in the city is 14^{o} C and 32^{o} C respectively with an annual rainfall of 920mm. The administrative limits of Chikkmagaluru town Municipal Council encompass an area of 27.00 sq. Km., which is divided into 35 wards, with population of 1,18,496 (2011 Census). Coffee curing, Trading centre for agro, forest and plantation products are growth potentials of the city.

Figure 1: Map showing Karnataka and Chikkamagaluru district

Data collection

The primary data acquired related to SWM was collected through site visits and interfacing with people. The secondary data has been obtained from Municipal Corporation and other reliable sources. Interviews which involved people such as waste management facility operators and municipal corporation officers were conducted in order to collect information and knowledge about the current solid waste management situation in Chikkamagaluru. The interviews gave an important insight into the solid waste management in the Chikkamagaluru town.

Observation and Discussion:

The main objective of collection and transportation is to clear the waste from the city and to dispose it off at the disposal site. It is the responsibility of the local body to ensure the city to be clean. As in the case of many cities of Karnataka, Chikkmagaluru city municipal council has adopted open transportation of the waste from the temporary storage to the disposal site. Waste collected from various wards and open collection points were loaded to the collection vehicle. Solid waste stored in the secondary containers and the open areas along the route was transported to the disposal yard every day from the prime residential areas, commercial streets and markets. But in some wards waste was transported to the disposal yard only in alternate days. Chikkamagaluru city is divided into 35 municipal wards for the effective waste collection by the municipal corporation. (Table-1) Chikkmagaluru had population of 1,137,961(2011).

Table 1: Total Municipal wards, Population and number of Houses in chikkamagaluru Town

Sl. No	Ward Name	Population	No. of Houses
1	Ward no-1	3.6k	1126
2	Ward no-2	3.5k	1790
3	Ward no-3	3.4k	463
4	Ward no-4	3.5k	776
5	Ward no-5	3.4k	894
6	Ward no-6	3.2k	804
7	Ward no-7	3.3k	771
8	Ward no -8	3.3k	255
9	Ward no-9	3.1k	471
10	Ward no-10	3.0k	852
11	Ward no-11	3.3k	1431
12	Ward no-12	3.3k	778
13	Ward no-13	3.5k	480

14	Ward no-14	3.3k	384
15	Ward no-15	2.8k	827
16	Ward no-16	3.4k	1200
17	Ward no-17	2.9k	645
18	Ward no-18	3.6k	348
19	Ward no-19	3.5k	338
20	Ward no-20	3.5k	420
21	Ward no-21	3.3k	1500
22	Ward no-22	3.4k	600
23	Ward no-23	3.2k	1494
24	Ward no-24	3.4k	799
25	Ward no-25	3.3k	263
26	Ward no-26	3.4k	603
27	Ward no-27	3.5k	565
28	Ward no-28	3.4k	540
29	Ward no-29	3.2k	732
30	Ward no-30	3.0k	540
31	Ward no-31	3.5k	2937
32	Ward no-32	3.3k	1650
33	Ward no-33	3,5k	840
34	Ward no-34	3’3k	960
35	Ward no-35	3.6k	1991

The activities associated with the Management of municipal solid waste from the point of generation to final disposal can be grouped into following four functional elements.

1. Waste generation
2. Collection and transportation
3. Segregation & Processing
4. Disposal

1. Waste Generation

Generation of solid waste is the stage at which materials become valueless to the owner and since they have no use for them and require them no longer, they wish to get rid of them. The generation of MSW in Chikkamagaluru town was very high comparing to rural areas. The Chikkamagaluru town alone generates about 54 tons of MSW per day. In the city of Chikkamagaluru 0.35 kg/capita/day was being generated, which were slightly lower than the average amount for the whole country, 0.37 kg/capita/day. Households were required to separate

waste into two streams, Organic or Biodegradable waste, Dry waste (such as plastic, paper, metal and wood). The solid waste generated in Chikkmagaluru for a year is about 20000 tons. The total quantity of solid waste collected per day is about 54 tons of which 37 tons were wet waste and 17 tons were dry waste.

2. Collection and transport of solid waste

Waste collection is the process of transfer of solid waste from point of use and disposal to the point of treatment or landfill. It is the largest cost element in municipal solid waste management system. Collection of solid waste includes door to door collection. Collection on regular pre-informed timing and scheduling by using musical bell of the vehicles. Community bins are removed in Chickmaglur city to maintain high degree of hygiene and to control diseases spreading from open community bins. Chikkamagaluru is divided into 35 wards and there are 168 workers involved in municipal solid waste managemen. The total solid waste collected per day was 54 tons among which 35 tons was domestic waste and 11 tons from commercial establishment, 4 tons from sweeping and 1 ton from slaughter waste and 3 tons from drain silt (Table 2).

Table 2: Different types of waste generated in Chikkamagaluru city

Type of Waste	Amount of Waste in Tons	Percentage of Waste Generated
Household Waste	35	65 %
Commercial Waste	11	20 %
Sweeping Waste	04	8 %
Slaughter Waste	01	2 %
Drain waste	03	5%

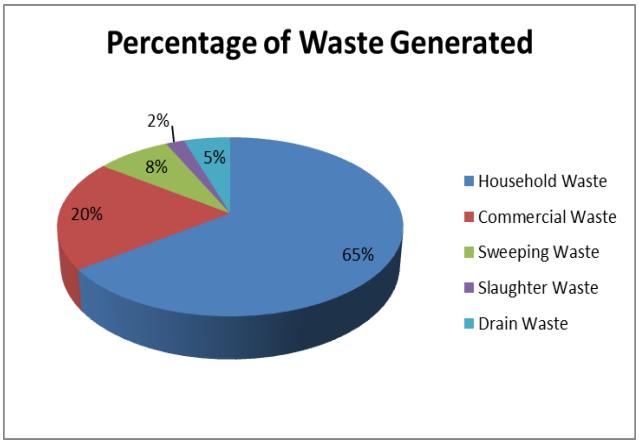

Figure 2 : Composition and classification (by material) of MSW generated by the chikkamagaluru city

Solid waste was collected through door-to-door collection. In all wards ‘door to door’ collection system was in practice. Small trucks were used to collect solid waste from each house. The collected waste from Auto tippers were conveyed and emptied to the segregation site near Dantaramakki tank. Most of the population of the city does not store the waste at source and instead disposes the waste into the garbage bins, roads, open spaces, drainage pipes, etc. Isolation of recyclable waste is not properly practiced. Most of the recyclable material is also disposed of with domestic and trade waste. Therefore, recyclable waste was generally found mixed with rubbish on the streets, into the garbage bins and at the dumping zones from where part of this waste was picked up by the street sweepers. Street sweeping was also one of the processes of primary collection of waste.

Figure 3: Door to door collection of solid waste

Transportation:

Transportation is the stage when solid is transported to the final disposal site. There are various modes of transport which may be adopted and the chosen method depends upon local availability and the volume of waste to be transported. The domestic waste and commercial waste were collected daily with the vehicles like Auto tippers, truck and tractor. Collected Waste was dumped in to the segregation site near Dantaramakki tank.

Figure 4: Transportation of solid waste to the disposal site

3. Segregation and processing of solid waste

Separating different types of waste components is an important step in solid waste management. In Chikkmagaluru town Solid waste was segregated near Dantaramakki tank. Every day nearly 8-9 workers separate the collected solid waste into bio degradable and non- degradable waste. After segregation of solid waste in to wet waste and dry waste, solid waste was transported with truck and tractors to the disposal site located in Indavara.

Figure 5: segregation of solid waste in to wet waste and dry waste

The disposal site is located about 6kms west of Chikkmagaluru town. The site is bounded by Indavara Village towards southeast, Hukunda village towards south and Narganahalli towards north. It lies near the road which connects Chikkmagaluru town and Joladalu.

Processing

The wet waste dumped in the disposal site was used for vermicomposting. The biodegradable waste or the wet waste was finely chopped using chopper machine. Three qualities of waste particles were obtained on processing in chopper machine. Finely chopped particles which were ready to be used for vermicomposting, the little chopped particles which were again processed in chopper machine and the third is the non-biodegradable waste particles which were disposed in a landfill. The finely chopped waste particles were transferred to vermi bed which consists of earthworms and allowed for processing for about a month. Later the vermicompost was sold to the farmers; a ton of vermicompost sold for Rs. 32, 000 by the Chikkmagaluru Municipal authority. Plastic waste was collected separately and bailed by using Bailing machine. Later the bed plastic was transported to cement factory which is located at Wadi of Gulbarga district.

Figure 6: Vermicomposting of biodegradable waste

4. Disposal of solid waste:

The final stage of solid waste management is safe disposal where associated risks are minimised. Globally, most waste is currently dumped or disposed of in some form of a landfill. This land filling is simple, cheap and effective

The dry waste was taken care by NGO workers. The useful dry wastes were taken by NGO workers and rag pickers from disposal site and are recycled. Non-biodegradable waste was disposed daily to the landfill site in Indavara.

Impact on workers

The information on health impacts was collected by personal interview. data details are beyond the scope of this paper. Solid waste workers are exposed to significant levels of physical, chemical and biological toxins. The general impacts are summarized in following lines.

Workers, who are associated with the process solid waste management at different level, are vulnerable as far as health hazards are concerned due to constant and long-time direct contact with solid waste, workers get health problems like accidental injuries like individual cuts sometimes injuries caused by infected sharp metal waste. further eye and skin infections due to exposure of infected dust are also reported in workers. Apart from these health problems, workers also face problems like asthma. T.B and some respiratory health effects. Sweepers are suffering from backache due to regular sweeping for a considerable distance per day. Those workers who are loading garbage into trucks are facing high problems.

Impact on environment

The disposal is dumped in landfills and open giving rise to contamination. The landfill site is not well maintained, which create the threat of ground water contamination due to leachate percolation. Open dumped garbage serves as breeding ground for disease vectors such as flies, mosquitoes, cockroaches and rats. An inefficient municipal solid waste management system may

create serious negative impacts like infectious diseases, land and water pollution, obstruction of drains and loss of biodiversity.

Conclusion:

This study explored the importance of SWM for sustainable development with the concern of new development process. It is clear that improper waste management practices have a significant impact on the natural environment and sustainable development in the study area. Waste management is the major issue that needs government attention. The practice used to generate waste is dangerous not only for workers but they could be disastrous for future generations. It is found that with increase in global population and the raising demand for food and other essentials there has been a rise in the amount of waste been generated daily by each household. Waste that is not properly managed, especially excreta and other liquid and solid waste from household and the community, are a serious health hazard and lead to the spread of infection diseases. It is necessary to educate people and convince them to adopt practices for reduce, reuse and recycle. Municipal Corporation and government should pay importance to dispose waste economically.

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MICROBIAL WORKHORSES

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Microorganisms are small, living organisms, which are invisible to our naked eye. Which can see under microscope. Hence, they are also known as microorganisms. Some microorganisms are harmful and disease-causing pathogens, while others are useful microbes, which are more beneficial and harmless to humans. Microorganisms benefit us in a number of ways. This chapter revealed their uses in following categories.

1) Commercial 2) Medicinal
3) Agricultural and 4) Environmental.

1. Commercial uses of microorganisms:

Production of dairy products: Bacteria are the key players here. Which helps in making different forms of dairy products from milk like curd, buttermilk, butter, cheese etc.

Curd: A bacterium called Lactobacillus, present in the curd added to the milk, converts the lactose sugar present in milk to lactic acid. Usually, curd is added to warm milk, which turns into curd overnight. Here a protein called casein present in milk coagulates to form curd.

Cheese: The production of cheese and paneer also involves the use of bacteria like *Lactobacillus* and *Streptococcus.*

Making alcoholic beverages: Production of alcoholic beverages like beer and wine involves fermentation of sugar present in barley and grapes, etc., by a yeast *Saccharomyces cerevisiae*. Fermentation by yeast produces alcohol and carbon dioxide.

Making bread: Yeast Saccharomyces cerevisiae converts sugar to alcohol and carbon dioxide. As more and more carbon dioxide is produced, the dough rises in volume. This makes the bread porous and spongy.

Making vinegar, coffee, and tobacco: Bacteria are used in the production of vinegar (acetic acid), coffee, and tobacco.

Making toothpaste: Shells of diatoms are used in toothpaste to give it a gritty texture that helps in cleaning teeth. Xanthan gum, obtained from the bacteria Xanthomonas campestris, is also used in making toothpaste.

Fuel: Biofuel can be obtained from extracted microalgae oil, biomethane by anaerobic digestion of Microalgae biomass, ethanol by fermentation of carbohydrate.

Biodiesel: Microalgae are a potential source of oil content for biodiesel production. They also contain a higher amount of lipids that serve as raw material for biodiesel production.

Butanol and ethanol: Microalgae contain a large amount of cellulose, starch, mannitol, agar and laminarin that are fermented to alcohol (ethanol and butanol). This microalga includes *Chlorella, Chlamydomonas, Scenedesmus, and Spiruli*.

Enzymes: Many microbes are used in the derivation of enzymes such as lipase, lactase, protease, peptidase to name a few.

Vitamins: Fungi are responsible for manufacturing vitamin B_{12}.An essential vitamin that people need for proper digestion.

2. Medicinal uses of microorganisms:

Making antibiotics: Certain bacteria and fungi are used in the production of medicines called antibiotics that destroy certain disease-causing microbes. Penicillin, streptomycin, and tetracycline are examples of antibiotics.

Making vaccines: Vaccines are prepared from live or heat killed microorganisms. Vaccines help in preventing diseases caused by microbes (e.g., polio, cholera, typhoid, smallpox, and hepatitis). When a disease-causing microbe enters our body, our body produces substances called antibodies. These antibodies fight and destroy the disease-causing microbe and remain in the body to fight future infections by the same microbe.

Making food supplements: Microbes like Chlorella which is algae are rich in proteins and other nutrients and are used as food supplements.

In human body: Bacteria like *Lactobacillus acidophilus* live in human intestines, where they help to digest food and destroy disease-causing microbes.

3. Agricultural uses of microorganisms

Nitrogen fixation: Blue-green algae and bacteria like Rhizobium help in atmospheric nitrogen fixation and increasing soil fertility.

Decomposition of toxic compounds: Microorganisms help in decomposing toxic compounds in agricultural soil preventing toxic accumulation in the soil. Thus, it helps in increasing the fertility of the soil.

Decomposition of organic matter: Actinomycetes (*Nocardia)* and Molds (*Mucor and Aspergillus*) increase the fertility of the soil by decomposing its organic matter.

Production of plant growth promoting traits: Soil bacteria support plant growth by producing several PGP traits like IAA, gibberellins production, Phosphate solubilization.

Insecticides: Certain bacterial and fungal species are used as insecticides to keep certain insects and pests away from crops. A best-known soil bacterium *Bacillus thuringiensis* have the ability to control caterpillar pests of plants.

Mineral absorption: Fungi like Mycorrhiza help the plant absorb minerals and water from the soil and protect its roots from other fungi and nematodes.

Other soil bacteria help in nitrification, mineralization and sulphur oxidation, etc.

4. Environmental uses of microorganisms

In the environment, microorganisms have two vital roles-

Enhancement of soil fertility

Azotobacter, Rhizobium, Clostridium are few examples of Nitrogen-fixing bacteria which play a primary role in transforming atmospheric nitrogen into inorganic compounds which are then used by the plants. Without this process, the vast majority of the nitrogen present in the atmosphere becomes unusable.

Cleaning:

Microorganisms also act as cleaners. Plants and animals eventually die and their bodies are turned into nutrients which the environment can use. Bacteria help us clean water through sewage treatment. Bacteria degrade the organic matter in sewage removing the pollution from water. Microorganisms degrade toxic pollutants from the environment. For example, Acinetobacter can degrade a wide range of aromatic compounds. Heterotrophic microorganisms play an important role in decomposing organic matter and cycling of nutrients in aquatic systems. In the aquatic system, microbes are placed at the bottom of the food chain.

Nitrification and phosphorous removal are occurred by bacteria in the sewage system. In this system, *Nitrosomonas spp*. oxidize ammonium to nitrite and *Nitrobacter spp*. oxidize nitrite to nitrate. Denitrifying bacteria (*Pseudomonas*) reduce nitrate into nitrogen gas using the chemical energy in organic matter to reduce. Aerobic bacteria also ferment solid components of the sewage. Microbes like bacteria and fungi act on the bodies of dead plants and animals and convert them into simple substances. These substances are used by other plants and animals.

Microorganisms also play various important roles in aquaculture as they grow naturally in the aquatic environment. Microorganisms may improve the overall quality of water.

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Environment and Sustainability Volume IV

ISBN: 978-93-91768-94-2

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ISBN 978-93-91768-94-2
9 789391 768942