An Assessment of Climate Smart Approaches to Reduce Emission of Greenhouse Gasses

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ABSTRACT

Greenhouse gases (GHGs) are natural occurring gases in the atmosphere which interact with the sun to trap heat. This keeps the earth warmer and makes it a habitable planet to living organism. Example of these gases are carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and water vapor. Over the years there has been a spike in human activities as the human world advances and more technological breakthrough are being achieved, these result in emission of increasingly large amount of these gases to the atmosphere. These gases are increasingly trapped in the earth surface, this trapped gasses result in an effect that increase the earth climate and temperature, the heightening temperature result makes the environment unfavorable to human, plant and animal. A lot of strategies have been employed in reducing greenhouse effect such as afforestation, changing the energy source but as a result of developing increasing human activities, the effect are becoming less or minimal. Excessive evaporation of water, increase in rainfall, desertification of some environment and flooding of others, drought, erosion are some of the impact of GHGs to the environment. This also causes migration of animals to cooler region and evolution of some plants to adapt to the constant changing weather. This has impacted heavily on the ecosystem displacing balance of the biogeochemical circles.

Many researchers over the time have discovered the role of GHGs in earth atmosphere. This paper examined the methods in mitigating GHGs and its impact on the environment. Different method has been employed in mitigating greenhouse effect but due to the high concentration of CO2 most of these method are centralized in it reduction, capturing or introduction of new renewable energy that will not increase the concentration of GHGs in the atmosphere but most of these strategies are unable to be employed on a large scale. Another method is the use of living organism such as plant and microorganism. Plant generally use CO2 as energy source and are able to utilize it and reduce the concentration in the atmosphere, in this method plant is use to capture the CO2 in the atmosphere. Microorganisms has a wide range of adaptability to different environments, this is own to their capability to utilize different source of energy for growth and their ability to evolve in an extreme environment. Microorganism plays a key role in biogeochemical cycle, fostering plant development, degradation of organic matter, fixing atmospheric nitrogen and carbon, thereby reducing the emitted GHGs in the atmosphere. There is need for constant monitoring of the environment and developing suitable, low cost method in mitigating the GHGs emission in the atmosphere.

Keywords: Greenhouse Gases (GHGS), Temperature, Earth Atmosphere, Mitigation.

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INTRODUCTION

The dynamics of climatic conditions around the world have been shifting, thus it is critical to address this issue. To ensure that humans can live on earth in a healthy and sustainable fashion, it is necessary to identify contributing factors and strategies for reducing them. A change in climatic patterns that is predominantly brought on by greenhouse gas emissions is referred to as climate change. As a result of national and international organizations' worries, collaborations at various echelons of authority have been formed to help mitigate climate change.

Examples of greenhouse gases (GHGs) include carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and fluorinated gases, such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6) [1]. According to the Emission Gap Report 2022, emissions can be divided into five worldwide economic sectors: energy supply, industry, agriculture, forestry, and other land-use change, transportation, and direct energy consumption in buildings [5]. Natural sources of GHG emissions include forest fires, earthquakes, ocean currents, permafrost, wetlands, mud volcanoes, and volcanoes [2]. Agriculture is the main source of greenhouse gas emissions (GHG), contributing 10% to 20% of all anthropogenic GHG emissions, according to recent study [3].

The temperature rises as a result of GHG emissions heating the lower layers of the atmosphere. It consequently raises air temperatures above what is ideal, which inevitably results in climate change and global warming [4]. Changes in climate indicators, like as temperature, precipitation, seal-level rise, ocean acidification, and extreme weather events, have been documented, according to a recent report by the United Nations Climate Change Secretariat [6]. Among the documented climate threats were landslides, heat waves, wildfires, hurricanes, severe storms, droughts, floods, and hurricanes [6]. It is accurate to argue that humans are altering the earth's climate because of the influence of human activity on climatic activities.

Due to the seriousness of climate change challenges, regulations and strategies to reduce emissions causing these changes have been developed. The majority of mitigation strategies fall into three general categories: carbon capture and storage, utilization, and decarbonization methods that lower carbon dioxide emissions. One strategy to reduce emissions is to switch to renewable energy. The most important thing in the energy sector is to remove barriers because costs are frequently no longer a concern. Legislation, incentives, the purchase of green electricity, the removal of administrative barriers, and direct investments can all be used to achieve this [5]. By encouraging businesses and organizations to employ renewable energy, the utilization of this resource can be improved.

Industries' GHG emissions are rising along with their expansion. Therefore, it is crucial that they switch to using renewable energy sources. Comprehensive decarbonization of industries must begin right now by utilizing electricity, green hydrogen, and carbon management for heat sources and feedstock, such as cement, iron, and steel, as well as chemicals and plastics [5]. Promoting technologies that are incompatible with comprehensive decarbonization in the transportation sector, such as biofuels that destroy forests and/or compete with food production and natural gas for road transportation, should be avoided [5].

To reduce emissions in the building sector, four significant adjustments must be made: reducing surplus floor area, reducing energy intensity, reducing the emissions intensity of energy use, and reducing embodied emissions from construction [5].

Food systems have a direct impact on the depletion of freshwater resources, the contamination of aquatic and terrestrial ecosystems by nitrogen and phosphorus runoff from fertilizer and manure applications, and other environmental problems [5]. Therefore, in order to achieve the Paris Agreement goal, it is crucial to reduce emissions from this industry. Additionally, this will increase food productivity, guarantee food availability, and raise the standard of food items.

Numerous mitigation techniques at various levels have been developed as a result of how severe the effects of climate change are. Since subnational governments implement mitigation measures, they must work with national governments, corporations, and individuals to implement them [5].

These mitigation actions are necessary to curb warming to less than 2°C, in preference to 1.5°C.

GREENHOUSE GASSES

The concentration of carbon dioxide and other greenhouse gases has increased due to human activity since around 1750. The amount of atmospheric carbon dioxide that was actually measured in 2021 [7] was more than 50% higher than pre-industrial levels. Natural sources of carbon dioxide are more than 20 times larger than human-caused sources. Agriculture, land uses, and other land uses make up around 13-21% of total anthropogenic greenhouse gas (GHG) emissions in the world between 2010 and 2019 [8].

2.1 Transportation

The majority of greenhouse gas emissions in 2021—28% of total emissions, or roughly 28% of total emissions—are produced by this sector. The continual burning of fossil fuels by automobiles, ships, aircraft, trucks, and trains is the main contributor to GHG emissions from transportation. The only fuel utilized for transportation is petroleum-based, and it has been found that diesel and gasoline account for more than 94% of all such fuel. [9].

2.2 Production of Electricity

The second largest contributor to greenhouse gas emissions in 2021, after the transportation industry, is the production of electricity, which accounts for around 28% of total emissions. Electricity is a secondary energy source since it is created by converting primary energy sources like coal, natural gas, nuclear energy, solar energy, and wind energy into electrical power. Other end-use industries, like industry, which accounts for 79% of the generation of these gases, burn petroleum and petroleum byproducts like coal and natural gas. [10].

2.3 Agriculture

Methane is the main gas emitted by enteric fermentation, which includes the digestion of animals like cattle and sheep, rice farming, manure management, burning of biomass, and the application of synthetic fertilizer from various soil management practices that can raise soil NO_2 levels. As they develop, plants take in CO_2 from their surroundings and store some of it as perennial above- and below-ground biomass. Depending on how the soil is managed and other environmental factors (such as the climate), decaying organic matter and trash in the environment can also retain some of the carbon released by these plants. [8].

2.4 Industry

Emissions from burning fossil fuels for energy and GHG from particular chemical processes that are frequently used to create goods from raw materials are produced by the industry.

2.5 Buildings

Waste management and non-building-specific emissions, such as the use of fossil fuels for heating, lighting, refrigeration, and cooling in households and businesses, are included in the GHG from buildings.

2.6 Effect of the GHGs in the Environment:

2.6.1 Carbon dioxide (CO2)

Carbon dioxide (CO2), which is generated primarily by human activity, is a substantial greenhouse gas. Carbon dioxide emissions accounted for 79% of all greenhouse gas emissions brought on by human processes and activities in the US in 2021. Despite the fact that there are numerous natural sources of CO2 emissions, since the industrial revolution, the atmosphere's CO2 concentration has increased as a result of human-related emissions. [11].

2.6.2 Methane (CH4)

Although methane has a much shorter atmospheric lifetime than carbon dioxide (CO2), it has a far stronger greenhouse effect; during a period of 100 years, CH4 has a 28-fold greater impact than CO2. [12]. Methane (CH4) accounted for 12% of all greenhouse gas emissions brought on by human activity in the United States in 2021. Agriculture, biomass burning, waste management, and energy use all contribute to CH4 emissions. CH4 is a better radiation absorber than CO2.

2.6.3 Nitrous Oxide (N2O)

Effective greenhouse gas is nitrous oxide. 6% of all GHG emissions in the United States in 2021 came from nitrous oxide produced by human activities, which may include waste water management, burning fossil fuels, agricultural processes, and heavy industrial processes. 40% of the world's N2O emissions are caused by human activity. [11]

2.6.4 Industrial Gases

Fluorinated gases are man-made substances that are released during industrial and manufacturing operations. The four main types are sulfur hexafluoride (SF6), hydrofluorocarbons (HFCs), nitrogen trifluoride (NF3), and perfluorocarbons (PFCs). Only 2% of the world's total man-made GHG emissions come from them, yet they trap a lot more heat despite having lower emissions than other GHGs.

2.6.5 Water Vapor

Water vapor, the most common GHG, differs from other GHGs in that its atmospheric concentrations are related to warming caused by other GHGs that have been released, rather than directly to human activity. As a result, as greenhouse gas concentrations rise and global temperatures rise, the total amount of water vapor in the atmosphere rises as well, increasing the warming effect [13].

THE DETRIMENTAL EFFECTS OF GREEN HOUSE GAS EMISSIONS ON WEATHER AND CLIMATE WITH RELEVANT INFORMATION OF CHANGES OVER THE YEARS

Those gases that trap heat in the atmosphere are called greenhouse gases. This heat trapping alters the Earth's radiative balance, or the ratio of energy absorbed from the sun to energy emitted by the planet, which impacts both local and worldwide temperatures and weather patterns. Fossil fuels (such as coal, oil, and gas) are by far the biggest causes of global climate change, contributing in excess of 75% of all greenhouse gas emissions and almost 90% of all carbon dioxide emissions. [15].

Because of greenhouse gas production, the heat from the sun is kept trapped on Earth. This leads to global warming and climate change. The rate of global warming is at its highest point ever right now. Warming temperatures are altering weather patterns, which also disturbs the natural order. This poses a serious threat to both people and all other kinds of life on Earth [18]. The greenhouse effect is a natural occurrence that has a considerable impact on the planet's climate. It produces the relatively warm and friendly environment near the earth's surface that has facilitated the development of humans and other life forms. It is only one of many physical, chemical, and biological processes that interact and collaborate to shape the earth's climate, which is the sum of weather data collected over a long period of time [16].

Climate change is the phrase used to describe long-term changes in temperature and weather patterns, and both anthropogenic and natural forces may be to blame. Climate change is the periodic altering of Earth's climate caused by changes in the atmosphere and by interactions between the atmosphere and other geologic, chemical, biological, and geographic elements in the Earth system [17]. Carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and halocarbons (a class of gases including fluorine, chlorine, and bromine) are among the greenhouse gases created by human activities. The concentrations of these gases increase over time as they accumulate in the atmosphere. The primary heat-trapping gas that has contributed to the majority of the recent global warming is carbon dioxide (CO2) [14].

The Greenhouse effect is essential in maintaining the planet's temperature because without it, the Earth's atmosphere would lose some of its heat to space. The greenhouse effect increases Earth's temperature by trapping heat in our atmosphere. The Earth's temperature is maintained higher as a result of this than it would be if the Sun were the only source of heat [16]. This increase in atmospheric GHG concentration leads to climate change and global warming. A gas's global warming potential (GWP), which is frequently used to describe a gas's contribution to global warming and climate change, enables comparison of the gas's global warming impact to that of a reference gas, typically carbon dioxide. The effects of greenhouse gas emissions are being felt on every continent, and they include warmer oceans, decreased snow and ice cover, fluctuating rainfall, and increasing sea levels [16].

Rising sea levels from the melting of glaciers and ice caps, which can result in coastal flooding and erosion, changes in precipitation patterns that can have an impact on agriculture, water supplies, and ecosystems, and changes in the timing of seasonal events, such as the timing of flowering, are just a few of the negative effects of higher levels of these gases in the atmosphere on weather and climate [17].

Greenhouse gas emissions can harm infrastructure, destroy property, displace people, and increase healthcare costs in addition to having a detrimental economic and social impact on weather and climate [17].

To diminish the harmful consequences of greenhouse gas emissions, it is essential to reduce our emissions by actions including switching to renewable energy sources, improving energy efficiency, and enacting laws to limit emissions from industry and transportation. [19].

Additionally, it is imperative to implement measures like building sea barriers, improving water management, and developing drought-resistant crops in order to adapt to the current changes. By taking action to cut greenhouse gas emissions and adapt to the changes currently underway, we can lessen the severity of climate change and protect the world for future generations.e.

DETRIMENTAL EFFECTS OF GREENHOUSE GASES ON AGRICULTURE

Climate change can make it harder for farmers to grow crops. When the temperatures get too hot, the crops grow too quickly and don't produce as much food. The heat also makes it harder for plants to get the water they need. More water evaporates from the ground and plant leaves as the temperature rises.This is called "evapotranspiration." Even though global warming might bring more rain, the evapotranspiration usually wins and there isn't enough water for the plants. But there is one good thing about climate change – the carbon emissions that cause it can help some crops grow better. These crops use a process called photosynthesis, and the extra carbon can make them grow more. However, this doesn't really help other types of crops as much [25].

Plants are really important for us to live. We eat plants or animals that eat plants, so they help us get our food. Plants also help keep the environment balanced and they absorb some of the bad stuff we put in the air. But because of climate change, the air is getting more carbon dioxide and it’s getting warmer. This is causing some problems for plants [22].

When greenhouse gases increase, it causes the amount of carbon dioxide to go up. This makes plants do photosynthesis and prevents them from opening their stomata. In the long term, this causes really big changes in the climate like floods, droughts, and heatwaves. These changes can make plants stressed and produce harmful substances called reactive oxygen species [23].

Human activity is changing the Earth’s climate by messing with the way energy moves around in the air [21]. This is mostly because of the gases we put into the air, not just the heat we make from using energy. When there’s more of a gas called CO2 in the air, plants react by doing more photosynthesis and closing up their little holes [23]. But too much of another gas called O3 can make it harder for plants to do photosynthesis and can stress them out. In the future, experts think that there will be even more CO2 in the air and it will get hotter on the Earth’s surface [24]. This could cause more weird weather like really hot days, not enough rain, or too much rain. These changes can be really hard for plants to handle and can make them produce less food or not grow as well [24].

Plants can change and adapt to different environments over a long time. But right now, the climate is changing and it’s affecting all kinds of ecosystems. Some species are trying to adapt to these changes by evolving [22].They might also move to different places where the climate is better for them. But sometimes, it’s hard for plants to move because their habitats are being broken up [26]. This is a big problem for their adaptation. Even though plants can’t move by themselves, their seeds can be carried to new places by humans and other things [20].

4.1 Rising Temperatures

Griffin discovered that the way plants make food and use nitrogen is affected by temperature. When it gets hotter, the enzymes that help plants make food become less efficient. One important enzyme called Rubisco can’t work as well and sometimes makes a mistake, using oxygen instead of carbon dioxide. This makes the plant less efficient at making food and wastes its resources. If it gets even hotter, Rubisco can stop working completely. But it turns out that plants can still use nitrogen even when it’s hot. This is good news because it means that plants might be able to make up for the problems with Rubisco when it gets hot [27].

Because of the heat, some plants are also moving to different places where it is cooler. They are moving north or to higher places. This can be a problem because there might not be enough space or resources for them in their new home. Some plants might not have anywhere else to go and they could be hurt by the changes, while others might benefit [27].

4.2 Extreme Weather

Climate change will make the weather more extreme. This means that there will be more storms with heavy rain, strong winds, and really hot days. It can also cause droughts, which is when there is not enough rain for a long time. These extreme weather events can hurt plants and make it harder for them to grow. They can also cause flooding and erosion, which is when the soil gets washed away. The hot weather and lack of rain can also make it harder for crops like corn to grow, and this could lead to smaller harvests [27].

ENVIRONMENTAL ENGINEERS APPROACH TO MITIGATING GREENHOUSE GASES (GHGS)

Environmental Engineers play a vital role in mitigating greenhouse gases (GHGs) and addressing climate changes. There three main greenhouse gases mitigation approaches are discussed below

First, traditional mitigation strategies use decarbonization tools like Utilizing carbon collection, storage, and use along with renewable energy to reduce CO2 emissions. These methods have been around for a while and are regarded as secure [29].

A new set of techniques and technologies that were just lately developed makes up a second way. Negative emissions technologies are those that can remove and store CO2 from the atmosphere. The literature provides a full discussion of a number of the most significant negative emissions technologies, such as direct air carbon capture and storage and bioenergy carbon capture and storage. [38].

The third strategy is predicated on the notion that solar and ionizing radiation control can alter the earth's radiation equilibrium. Temperature stabilization or reduction is the main objective of these techniques, which are also referred to as radiative forcing geoengineering technologies. Unlike negative emissions strategies, this is performed without influencing the atmospheric amounts of greenhouse gases. Injecting stratospheric aerosols, brightening the maritime sky, cirrus cloud thinning, space-based mirrors, surface-based brightening, and various radiation management techniques are among the main geoengineering techniques for radiative forcing that are discussed in the literature. All of these methods contain a great deal of uncertainty and danger when it comes to actual large-scale implementation because they are still in the theoretical or very early testing stages. Techniques for radiative forcing geoengineering are not currently covered by policy frameworks [38].

5.1 Carbon capture, storage and utilization

The literature has explored carbon capture and storage as a potential decarbonization strategy for the industrial and energy sectors. The technology entails capturing and storing CO2 gases from systems that burn coal, oil, or gas. The obtained CO2 is then transported and kept for a very long time in geological reserves. Utilizing fossil fuels while lowering pollution is the main objective. The three capture technologies oxyfuel combustion, post-combustion, and pre-combustion are covered in the literature. Each technology has a unique method for removing and capturing CO2. However, post-combustion collection methods are best suited for retrofit projects and offer a wide range of possible applications. Once CO2 has been effectively gathered, it is liquefied and sent to suitable storage locations through pipelines or ships. According to the literature, storage options include saline subterranean aquifers not used for potable water, coal beds, and depleted oil and gas fields [46]. Safety in respect to secured storage and the potential for leakage are two of the key downsides of capture carbon and storage. Ma et al. have looked into the potential negative environmental effects of onshore storage places that experience inadvertent leakage. The analysis concentrated on how leaking would affect agricultural land [40]. Also mentioned by [46] was the risk of leaking and its related detrimental effects. Public acceptance and the high deployment costs are two more problems with this technology [45, 46]. Another option after carbon capture is to use the CO2 captured in the production of chemicals, fuels, microalgae, concrete building materials, as well as in greater oil recovery [37].

5.2 Bioenergy carbon capture and storage

A method of removing and storing carbon dioxide from the atmosphere is through bioenergy carbon capture and storage. It functions by utilizing plants to absorb carbon dioxide while they are growing and then using those same plants to produce energy. The carbon dioxide that is emitted when the plants are burned for energy is caught and stored underground. This helps to reduce the amount of greenhouse gases in the air. The plants used for this can be special energy crops or leftover plant material from farms or forests. They can be used on their own or combined with other fuels in power plants [43].

The primary drawback of this technique is the considerable amount of biomass feedstocks required to effectively reduce emissions. Large-scale deployment of dedicated crops would result in a significant demand for resources, imposing a significant burden on the available resources for land, water, and fertilizer. The competition for the land, water, and nutrients required to grow food and animal feed is one issue with using biomass as fuel [43]. Another problem is that in some cold places, biomass can replace snow and make the ground darker, which can make climate change worse instead of better [31].

Bioenergy technologies are somewhat advanced, although carbon capture and storage technologies are still in their infancy. [41] go over the technical challenges of quickly scaling deployment. Furthermore, they doubt that this technology will be able to achieve its potential for abatement within the anticipated time frame. In terms of policy, it is stated that in order to effectively advance the technology, a solid framework and sufficient incentives must be in place [41].

5.3 Direct air carbon capture and storage

A promising synthetic CO2 removal method is emerging: direct air carbon capture and storage. The primary concept behind this technology is the direct removal of atmospheric CO2 through chemical bonding, followed by storage in geological reservoirs or use for other tasks like the production of chemicals or mineral carbonates. CO2 is taken out of the atmosphere by allowing ambient air to come into contact with compounds known as sorbents. In addition, The CO2 is then released from the revived sorbents for usage or storage by heating or soaking them. Basically, there are two ways that sorbent function: first, through absorption, Second, through adsorption, where the CO2 sticks to the sorbent and is often performed using liquid sorbents like potassium hydroxide or sodium hydroxide, while the CO2 sticks to the sorbent and is typically accomplished using solid materials like amines [39]. In order to regenerate the sorbent and release the CO2, thermal energy is needed in both processes; nevertheless, it is significant to highlight that the adsorption pathway uses less energy. [32]. The enormous cost involved with establishing direct air carbon capture and storage facilities is one of the key drawbacks mentioned in the literature [31]. Similar to carbon capture and storage and bioenergy carbon capture and storage, the main risk of this method is the integrity of the CO2 storage [43].

According to Gambhir et al.'s 2019 comparison of direct air carbon capture and storage to carbon capture and storage, the latter technology is more energy- and resource-intensive because it is much more difficult to capture CO2 from ambient air than it is to do so from highly concentrated flue gas streams. The energy required for direct air carbon capture to remove one ton of CO2 is three times higher than that required for conventional carbon capture [32]. However, direct air carbon capture and storage systems are more flexible and can be installed anywhere if low-carbon energy and adequate transportation and storage infrastructure are available. Many processes are currently being developed and are either in the laboratory-scale or pilot-scale phases in terms of technology readiness. As one of the major obstacles to deployment and scalability, technology developers are primarily focused on minimizing energy consumption [43].

5.4 Stratospheric aerosol injection

By intentionally injecting reflective aerosol particles in the stratosphere, the stratospheric aerosol injection technique seeks to replicate the cooling effect brought on by volcanic eruptions [38]. Based on modeling and data from prior volcanic eruptions, the maximum cooling that might be achieved using this strategy is predicted to fall between 2 and 5 W/m2 [38]. Smith et al. investigated the plans and costs for the technology's initial 15 years of operation, starting in 2033. They investigated a number of deployment techniques and came to the conclusion that an aircraft-based delivery system is the most efficient means of injecting aerosols into the stratosphere. However, even with improvements, the present models won't be sufficient, necessitating the development of a brand-new, specially crafted high-altitude aircraft. Smith et al. estimated initial costs for deployment to be in the range of $3.5 billion with average annual operating expenses of $2.25 billion (about $1500/t SO2 injected) in an effort to cut the anthropogenically induced radiative forcing rate in half [44]. The fundamental problem with this strategy is that there is a lack of trust in its harmful side effects and deployment repercussions, which have an adverse influence on the hydrological cycle and stratospheric ozone depletion in particular. Although this strategy will temporarily lower the temperature, it shouldn't be viewed as a long-term fix. Research and development for this tacticare currently in their very early phases [38].

MICROBIOLOGICAL APPROACH TO MITIGATE EMISSION OF GREENHOUSE GASSES

Microorganisms and biological components have a wide range of potential roles for mitigation by contributing forward response. In particular, they can be used to treat and reduce greenhouse gas emissions by recycling nutrients, which helps to lessen environmental risks brought on by both natural and anthropogenic activity [48].

Biogeochemical cycles and microorganisms are like two sides of the same coin. It happens on land, in the water, and in both open and closed environments. Both help to make and use greenhouse gases more efficiently. Microorganisms offer long- and short-term positive and negative feedback reactions to climate change and global warming [49]. Due to their ability to recycle and change vital components like carbon and nitrogen that make up cells, microbes play a significant role as either producers or consumers of these gases in the environment [50]. Regarding the recycling of nutrients, biological methods for reducing greenhouse gas emissions are quite beneficial. Due to their incredibly adaptable metabolism and ability to thrive in a variety of climatic situations, microbes in various ecosystems play a significant role in regulating and combating the detrimental effects of climate change. Gas uptake, storage, and release by microorganisms are simple processes [51]. Microbial communities and biogeochemical cycles work well as a strategy to combat climate change because they use greenhouse gases as a source of energy to grow their cells [49]. Microbial communities play a key role in the global carbon cycle by fixing atmospheric carbon, fostering plant development, and degrading or transforming organic matter in the environment. Most of the time, microbial activity causes methane (CH_4), a greenhouse gas, to enter the atmosphere. For the Earth’s climate to remain stable, methane-eating microbes are essential. Methane is a source of energy for bacterial metabolism [52]. A symbiotic relationship between Rhizobium bacteria allows the bacteria to fix atmospheric nitrogen to the root nodules of a legume plant while the plant supplies the bacteria with energy and nutrients. This process aids in the reduction of greenhouse gasses. Atmospheric nitrogen makes up about 78% of the earth’s atmosphere but is unusable by plants and animals.

Due to their inability to degrade, plastic materials made from petrochemicals have a significant negative impact on the environment [53]. Since their introduction in the 1950s, synthetic plastics have become one of the materials we use the most in our daily lives [53]. The plastics industry produces about 25 million tons of plastic annually [54] Demand for plastics is constantly increasing due to their relatively low cost, ease of manufacture, and flexibility [55], but their continued use has a negative impact on the environment [56].

Recycling plastics is possible but time-consuming and expensive, which is why it is rarely done [54]. Incineration of plastic trash produces harmful byproducts, including greenhouse gases. Biodegradation of plastic is necessary for the elimination of these and numerous other issues, such as the fact that carbon emissions during incineration contribute to global warming [55]. To provide the basic needs of the global population, businesses and researchers are looking for alternatives, such as biodegradable polymers [57].

When it comes to preventing the environment from being harmed by petroleum-based plastic products, biodegradable or biobased polymers have been determined to be the best options. In many different bacteria, including *Bacillus* spp., polyhydroxybutyrates (PHBs) are produced andeposited as cytoplasmic inclusions. Although biodegradable plastics have been on the market for a while, their expensive price has prevented them from displacing the conventional non-degradable polymers [58].

The goal of a study by [58] was to use sugarcane bagasse and Bacillus sp. to manufacture biodegradable plastic. The study’s findings supported the use of agro-residues, which are easily accessible and inexpensive, to make PHB.

CONCLUSIONS

The general conclusion on this study is the complexity nature of the environment makes it ecologically sustainable but the dependence of human society on its environment and our needs to provide a suitable or comfortable living environment has result in introduction of different technologies that makes the earth viable to depletion of its natural resources and returning them to the atmosphere as waste which result in the increase in the emission of GHGs. As more industries and human activities are on the increase, more emission rate are being recorded, this can be combated by introducing the use of renewable energy to home and industries. The alarming increase of GHGs in the atmosphere has result in focused of it reduction worldwide, several researches are constantly being carried out to find a method of reducing it concentration. Most of the current methods in use to reduce GHGs emission cannot be launched on a large scale to create a desired effect on the human environment due to several constraints. Microorganism have diverse ability and their low cost of growth requirement makes them one of the best suitable strategies in combating Greenhouse effect, microorganisms can also be genetically engineered to utilize the excess GHGs in the atmosphere as a source of energy for their growth requirements, thereby reducing its concentration. These method might require the constant monitoring of the engineered microorganisms to prevent an unfavorable mutations to the environment.

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