SMALL-SCALE TO LARGE-SCALE, NONGOVERNMENTALLY-MANDATED CARBON EMISSION AND SEQUESRATION INITIATIVES—A MARKET-BASED, WIN-WIN STRATEGY TO COMBAT CLIMATE WARMING

There Is Something That Each of Us Can Do to Slow Global Warming

Robert L. Wershaw

Printed in the United States of America by Great Western Printing Inc, Aurora CO

Preface

The impetus to write this short proposal grew out of my frustration with the inability or unwillingness of politicians to implement effective measures to deal with the impending catastrophic effects of global warming. In reality, it is unrealistic to expect politicians, who are generally overwhelmed with issues that must be dealt with immediately, be they wars, large-scale unemployment, food or fuel shortages, natural or man-made disasters, or upcoming elections, to effectively deal with more long-term issues It is therefore incumbent on concerned citizens to initiate the necessary measures to begin to mitigate the worst effects of global warming. With enough public concern and activity politicians will take notice and act. The only way to develop widespread public concern is to provide an easily understood basic description of how human activity causes global warming and how this warming affects us and our environment in general. I have attempted to do this in the first chapter of this booklet. In the second chapter I show how all of us can use the marketplace to drive change. In the third chapter I describe a few examples of ancient highly sustainable farming methods. In the fourth chapter I describe nongovernmental initiatives that can combat climate change. These can be brought about by individuals and companies voluntarily providing money to support innovators, wherever they may be, who have shown that they have workable projects to reduce carbon emissions or to sequester carbon. The carbon emissions of each one of the roughly 8 billion people who live on this planet directly impacts not only that person but every other person on Earth. Therefore, every person in the world can make a meaningful contribution to combatting global warming. In contradistinction to proponents of artificial intelligence (AI), I believe that united human intelligence (UHI) can more readily solve problems that threaten our very existence on the only planet we have. To that end I am establishing a website called NetZeroWarriorsUnited.org where anyone with an idea on how to reduce global warming can present his or her ideas to a broad audience for comments and implementation.

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Illustrations by Rob Alaya

ABSTRACT

Over 99% of the energy that reaches the surface and atmosphere of the Earth comes from the Sun in the form of electromagnet radiation mostly in the ultraviolet, visible, and infrared wavelengths. Part of this radiation is reflected from the surface of the Earth back out into space, however, much of it is absorbed by surface materials such as soil, rocks, water, plants and animals. This absorbed radiation energy is converted into heat energy. These materials in turn dissipate heat by emitting radiation; since these heated materials on the surface of the Earth are much cooler than the Sun, most of the radiation they emit is in the infrared region. Carbon dioxide (CO2) molecules in the atmosphere strongly absorb this infrared radiation and are heated by it. The more CO2 in atmosphere the warmer the atmosphere becomes. The concentration of CO2 in the atmosphere of the Earth has increased from about 280 parts per million (ppm) in 1750 to about 420 ppm in 2020; from 1960 to 2020 alone, it increased from 320 ppm to 420 ppm. Increasing temperatures and accompanying low relative humidities are causing a dramatic increase in the number and size of major fires that consume large areas of forests and grasslands throughout the World that in the past converted CO2 into oxygen, wood, and foods. Extreme heat waves are becoming more common throughout the World. These extreme events are having a devastating effect on human health in the places where they occur. Worldwide carbon emissions due to human activity continue to increase with no end in sight. To make matters worse, major forest fires and forest destruction have reduced the amount of carbon sequestered by trees. Highly mechanized, intensive industrial farming can also lead to loss of sequestered carbon in soils. In this report some examples of more sustainable forest management and agricultural practices that were successfully used by previous generations are described.

I propose that an initiative be undertaken to adapt some of these practices to modern requirements and to develop new sustainable practices that will begin to help us reduce carbon emissions to net zero. This initiative will be supported by individuals and companies voluntarily providing money to support innovators, wherever they may be, who can demonstrate that they have workable projects to reduce carbon emissions or to sequester carbon. Global governmental efforts up to this time have largely been ineffective in slowing global warming. The lack of effective world-wide governmental programs, however, should not deter informed energy consumers, both large and small, from using the marketplace to drive change. If consumers world-wide would favor products that are produced in a verifiable carbon-neural manner, producing companies will respond in the same way that companies have responded to the demand for organic foods, fair trade coffee and chocolate, the elimination of the trade in conflict rough diamonds, and many other consumer-driven concerns. The carbon emissions of each one of the roughly 8 billion people who live on this planet directly impacts not only that person but every other person on Earth. Therefore, every person in the world can make a meaningful contribution to combating global warming.

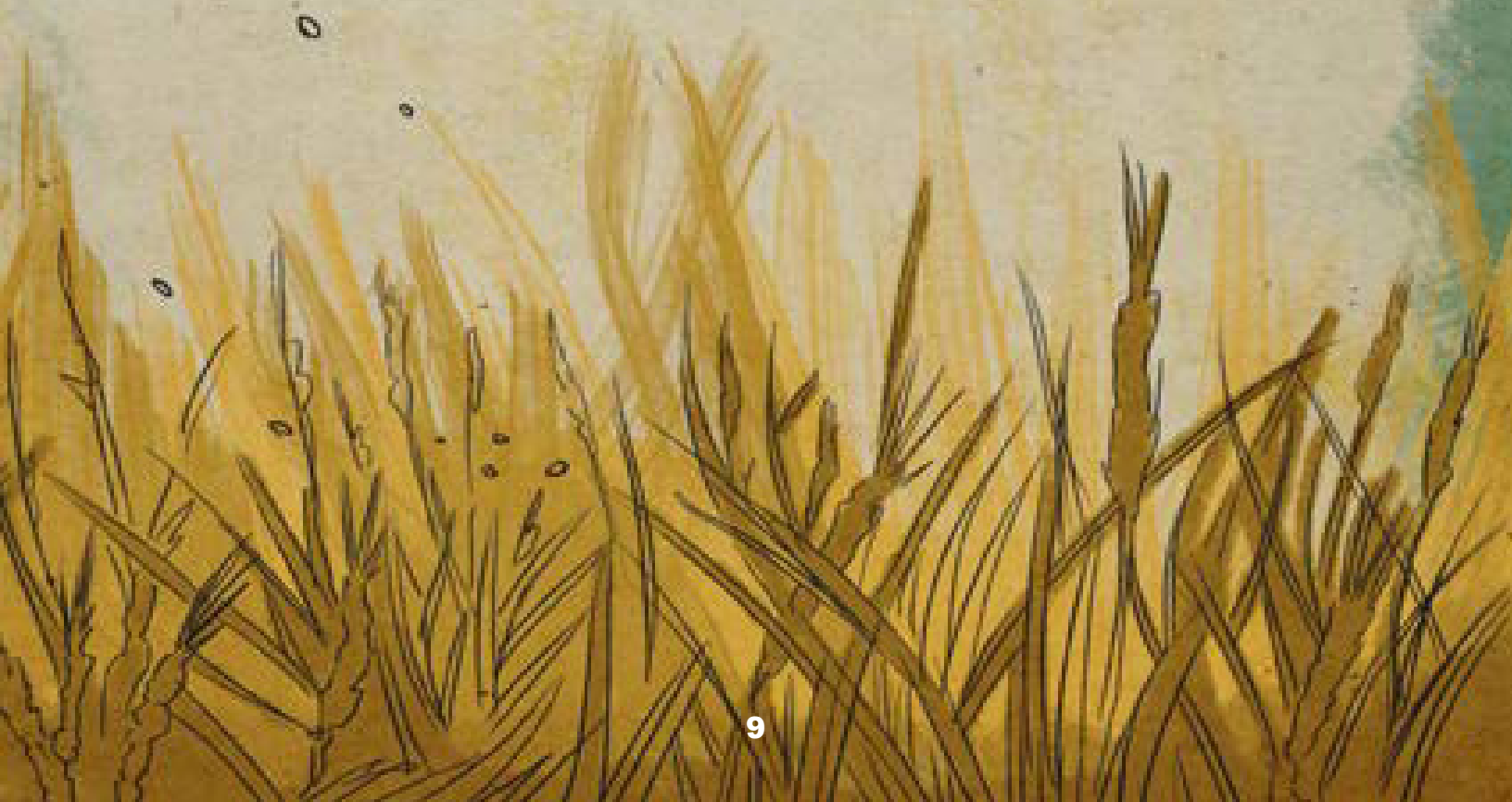
Basic Principals of Global Warming

The purpose of this chapter is to provide the lay reader with a basic understanding of the processes that are driving the warming of our planet. These processes are governed by the first and second laws of thermodynamics. That part of the physical world under study is called a system in thermodynamics. The first law of thermodynamics states that energy in a given system such as the Earth and its atmosphere is conserved, it cannot be created or destroyed. However, energy can move from one system to another. Energy in a system exists in various forms such as heat, work, internal energy, and electromagnetic radiation (such as light).

The second law of thermodynamics in its simplest form states that all of the heat transferred from a heat reservoir to a heat engine cannot be converted into work; some of the heat will be lost to a colder body. For example, all of the heat from the burning of fuel in an automobile engine cannot cannot be converted into work to move the automobile; that which is not converted must be transferred to the atmosphere by way of the radiator.

Similarly, all living beings are heat engines in which heat from the burning (oxidation) of food is converted into the work that allows them to live, grow, reproduce, and gather the food they need. Some of this energy, however, is not converted into work, but is lost through perspiration or other cooling mechanisms, as pointed out in Genesis chapter 3, verse 19:

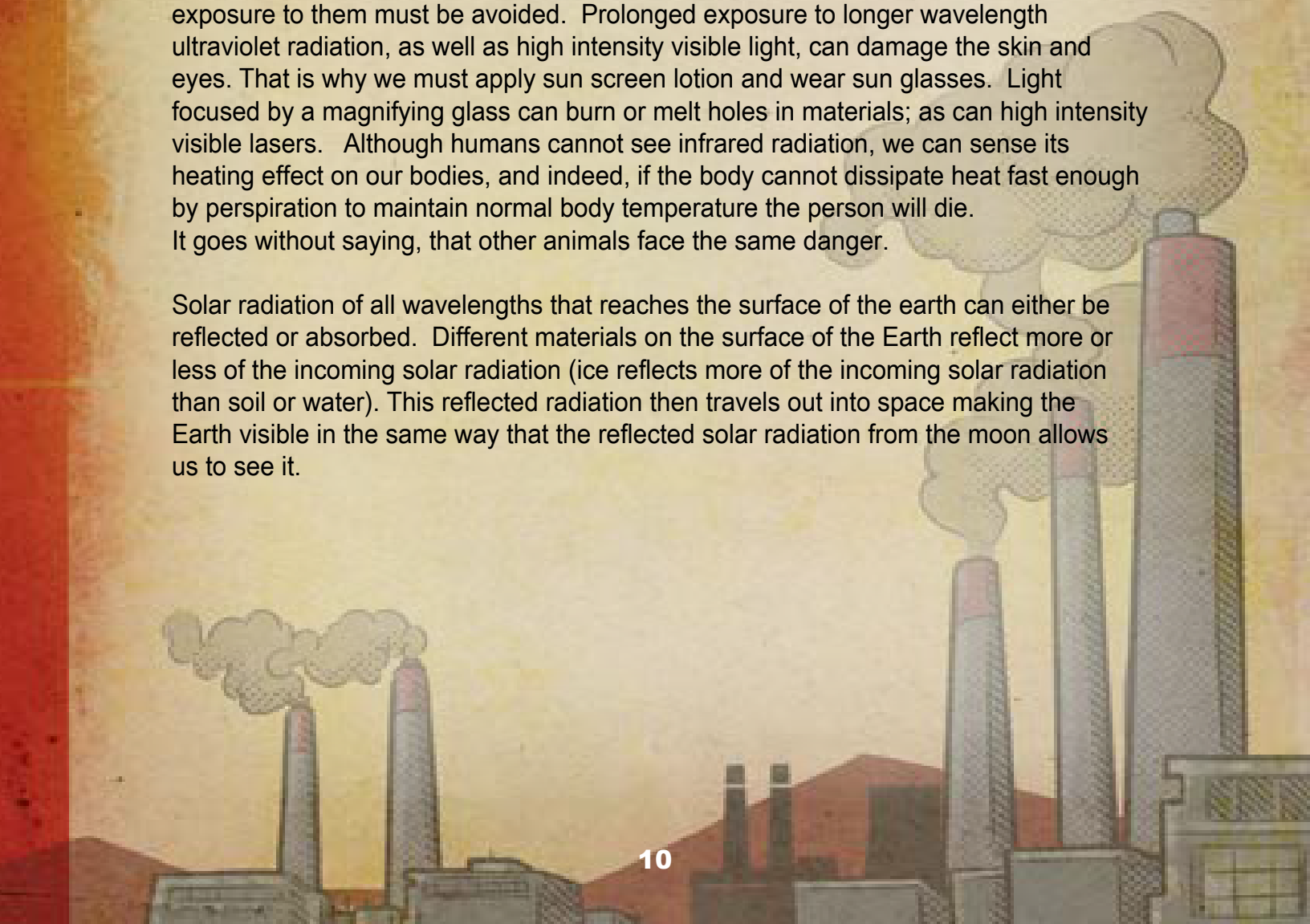
“By the sweat of your brow shall you eat bread…”.



Over 99% of the energy that is delivered to the surface and atmosphere of the Earth comes from the Sun with the rest coming from the interior of the Earth. The energy generated in the Sun comes from the nuclear fusion of hydrogen nuclei to form helium nuclei. This energy is transmitted to the Earth by electromagnetic radiation. Most of the solar radiation reaches the surface of the Earth in the ultraviolet, visible, and near infrared regions. The ultraviolet range of interest is from about 200 nanometers (billionths of a meter, abbreviated as nm) in wavelength to about 380 nm; the visible range is from 380 nm to about 700 nm; and the infrared range of interest is from about 700 nm to about 16,000 nm; the entire infrared range extends to about 1,000,000 nm (1 millimeter).

The color (wavelength) of the radiation emitted by a body is dependent on the temperature of the emitting body; the higher the temperature of the body the shorter the wave length of the emitted radiation. However, the energy that is contained in any of these three wavelength ranges, when at high enough intensity can be very damaging. Ultraviolet radiation shorter than about 200 nm does not penetrate the Earth's atmosphere. However, some artificial light sources do emit ultraviolet radiation of wave lengths less than 200 nm. These sources are very dangerous and exposure to them must be avoided. Prolonged exposure to longer wavelength ultraviolet radiation, as well as high intensity visible light, can damage the skin and eyes. That is why we must apply sun screen lotion and wear sun glasses. Light focused by a magnifying glass can burn or melt holes in materials; as can high intensity visible lasers. Although humans cannot see infrared radiation, we can sense its heating effect on our bodies, and indeed, if the body cannot dissipate heat fast enough by perspiration to maintain normal body temperature the person will die.
It goes without saying, that other animals face the same danger.

Solar radiation of all wavelengths that reaches the surface of the earth can either be reflected or absorbed. Different materials on the surface of the Earth reflect more or less of the incoming solar radiation (ice reflects more of the incoming solar radiation than soil or water). This reflected radiation then travels out into space making the Earth visible in the same way that the reflected solar radiation from the moon allows us to see it.



The radiation that is absorbed causes absorbing materials such as soil, pavement or water to become hotter. These materials in turn dissipate heat by emitting radiation; since these heated materials on the surface of the Earth are much cooler than the Sun, most of the radiation they emit is in the infrared region. Carbon dioxide strongly absorbs infrared radiation. The main absorption bands of CO_2 are in the region from about 4000 nm to 16000 nm, and those of H_2O in the region from about 1000 nm to 7000 nm. Methane (CH_4) also strongly absorbs in the region from 3000 nm to 8000 nm, however methane is rapidly oxidized to CO_2 in the atmosphere.

The infrared radiation absorbed by the CO_2, CH_4, and H_2O molecules causes these molecules to become warmer in the same way that water is heated in a microwave oven when it absorbs microwave radiation. The absorption of infrared radiation by these molecules causes them to vibrate; they become warmer. Water vapor and CO_2 however, bring about climate change in very different ways. Water exists as both a vapor and a liquid on the surface of the Earth, and the concentration of water vapor in the atmosphere varies with temperature. The higher the temperature, the higher the concentration of water vapor in the air (the equilibrium concentration which is generally referred to as partial pressure at that temperature). If the concentration exceeds the equilibrium concentration then the excess water will precipitate as rain. Carbon dioxide however, only exists as a gas on the surface of the Earth and therefore, as more CO_2 is added to the atmosphere from the burning of fossil fuels and other sources it remains in the atmosphere. The more CO_2 in the atmosphere the more infrared radiation (heat) will be absorbed. The heated CO_2 will in turn radiate infrared radiation in all directions; some of which will be radiated back to the Earth thereby warming it. This is called radiative forcing. Radiative forcing heats the atmosphere thereby increasing the equilibrium concentration of water vapor in the atmosphere causing more water to be removed from standing bodies of water and soil, as well as, plants and other living organisms. This additional water in the atmosphere then absorbs additional infrared radiation causing further atmospheric warming. Methane is similar to CO_2 in behavior in the atmosphere, however, it is rapidly oxidized to CO_2 and therefore, its concentration is much less than CO_2.

The concentration of CO2 in the atmosphere of the Earth has increased from about 280 parts per million (ppm) in 1750 to about 420 ppm in 2020; from 1960 to 2020 alone, it increased from 320 ppm to 420 ppm. In the 1960s the Total World emissions of CO2 were about 11 billion tons per year, while in the last decade it has increased to about 35 billion tons per year. It is estimated that at the present time only about half of the CO2 emitted into the atmosphere is removed by natural processes on Earth (https://airs.jpl.nasa.gov/resources/156/fast-carbon-cycle/). Unfortunately, at the present time there is little evidence that the major emitters of the World (China, the US, India, and Europe) are on a path to reduced emissions. In fact, their emissions are increasing while at the same time the five major forests of the World (the Eurasian boreal the North American boreal forest, the tropical rain forests of the Amazon River Basin and the Congo River Basin, and the island forest of New Guinea) are experiencing increased deforestation. The deforestation of both the major and smaller forests of the World have markedly decreased the terrestrial capacity to remove CO2 from the atmosphere. The situation in Southeastern Amazonia is even worse. In a recent detailed study of the Amazon Rainforest , (Gatti, L. V. and others, Nature v.595, pp.388-393, 2021) the authors stated: "We find that total carbon emissions are greater in eastern Amazonia than in the western part, mostly as a result of spatial differences in carbon monoxide-derived fire emissions to the atmosphere. Southeastern Amazonia, in particular, acts as a net carbon source (total carbon flux minus fire emissions) to the atmosphere. Over the past 40 years, eastern Amazonia has been subjected to more deforestation, warming and moisture stress than the western part…". This finding is very disturbing because it shows that forests that in the past were able to remove large amounts of CO2 from the atmosphere can become, through deforestation and conversion to agriculture, net contributors of CO2 to the atmosphere.

Increasing temperatures and accompanying low relative humidities are causing a dramatic increase in the nuimber and size of major fires that consume large areas of forests and grasslands throughout the World. In 2023, Canada experienced the most destructive fire season on record. Over 16.5 million hectares (40.8 million acres, 63.7 thousand square miles) of forest land had burned by September 5, 2023. This is more than double the previous record set in1989 (https://natural-resources.canada.ca/simply-science/canadas-record-breaking-wildfires-2023-fiery-wake-call/253303). Europe, Australia and Africa have also experienced catastrophic increases in wildfires in recent years.

The destructiveness of the increased frequency of wildfires due to global warming at times may be amplified by local conditions. For example, the major wildfires in Canada and Australia are often in unpopulated or sparcely populated, remote areas that are ignited by lightning. To make matters worse, especially in Canada, the burning areas may be very difficult to access. The lack of ready accessibility allows the fires to rapidly spread over very large areas before efforts can be made to contain them. Wildfires have become much more destructive in the United States because the US Forest Service, in general, has pursued a policy of total fire suppression which has prevented the spread of low intensity fires that would normally burn dry fallen trees, branches, and underbrush on a more or less regular basis. However, because of this policy, fuel has been allowed to accumulate on forest floors resulting in much more intense and destructive fires. To make matters worse more homes are being built in forested and other wooded areas and in grasslands that are prone to periotic droughts without proper consideration of the dangers involved. For example, the 2021 Marshall fire caused massive property damage and loss of life in a densely populated urban area. A warming climate has only exacerbated the problem.

The ocean absorbs about 25 % of the CO_2 emitted by the burning of fossil fuels. When CO_2 is absorbed by water, carbonic acid is formed which makes the ocean more acidic. Studies by scientists at the Woods Hole Oceanographic Institution have shown that roughly over the last 250 years the acidity (hydrogen ion concentration) of the ocean has increased by about 26%. There is evidence that this increased acidity could inhibit shell formation in some shell-building organisms such as some coral and conch species. The shells of these animals and many other types of shell fish are composed of calcium carbonate which is soluble in acidic solutions. Ocean warming has been found to harm coral which is important in the propagation of many fish species, providing habitat and food for the fish.

The National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA) have been measuring the amount of solar warming of the oceans of the World since 1955. These measurements show that the oceans which cover more than 70% of the surface of the Earth have absorbed about 90% of the additional heat energy caused by increases in CO_2 concentrations in the atmosphere. Since about 1990 the NASA data show that the rate of increase of the heat content in the oceans is greater than it was prior to 1990. In the NASA Ocean Warming article (climate.nasa.gov) it states that "The effects of ocean warming include sea level rise due to thermal expansion, coral bleaching, accelerated melting Earth'smajor ice sheets, intensified hurricanes…and changes in ocean health and biochemistry."

Oceanic warming brought by climate warming is a major cause of the record-breaking flooding and coral bleaching that are being experienced in much of the world. Average ocean temperatures are higher now than they have been since reliable measurements began in 1880. These higher temperatures mean that more water is in the air above the oceans. This addition moisture results in heavy rain falls when the moist air rises over land. Extremely heavy rain storms are becoming much more common than they were in the past. Extreme rain events caused devastating floods in 2022 and 2024 in Pakistan, massive flooding in southeastern United States, southeastern China, central Europe, and Spain in 2024, and unprecedented flooding in southern Brazil that affected more than two million people.

Extreme heat waves are becoming more common throughout the World. These extreme events are having a devastating effect on human health in the places where they occur. In a recent article in the New England Journal of Medicine (NEJM, v. 3, no. 7, July 2022) the authors stated that: "Extreme heat events (EHEs), such as those in the western United States, India, Pakistan, Central Europe, and other locations in recent years, are one of the deadliest consequences of climate change. EHEs cause excess morbidity and mortality directly from heat illness, aggravation of comorbid conditions, and exacerbation of the damaging health effects of social factors as well indirectly from corollary events such as wildfires and air poas pollution." Unfortunately with the current lack of coordinated action on the part of the international community to curb CO2 emissions matters can only get much worse. Poor people without access to air conditioning, livestock, and wildlife will suffer the most. Increased demands for electricity during periods of extreme temperatures could easily result in large-scale power outages, so that even those with air conditioning would be at risk to the adverse health effects of extreme temperatures.

Actions That All of Us Can Take to Reduce Global Warming

The 2016 Paris Climate Accord, and the UN Intergovernmental Panel on Climate Change 2018 Report point out that in order to avoid possibly catastrophic climate changes, global emissions of carbon must be reduced to net-zero by 2050. We are already witnessing increased frequencies of powerful, highly destructive late-season tropical cyclones, extreme heatwaves, and disruptive changes in rainfall and flooding patterns. Increased concentration of carbon dioxide in the atmosphere and the concomitant increased concentration of dissolved carbon dioxide in the oceans, lakes, and rivers of the World leads to increased acidification (lowering of pH) of these bodies of water. Lower pH's have a deleterious effect on many aquatic organisms that have evolved when the pH of their environments was higher than it is now; for example, lower pH's reduce the ability of some shell fish to produce their shells. These changes are only expected to get worse in the coming years. The UN Intergovernmental Panel on Climate Change 2018 Report outlines the deteriorations in food supplies, health, and habitat that increased mean temperatures are causing.

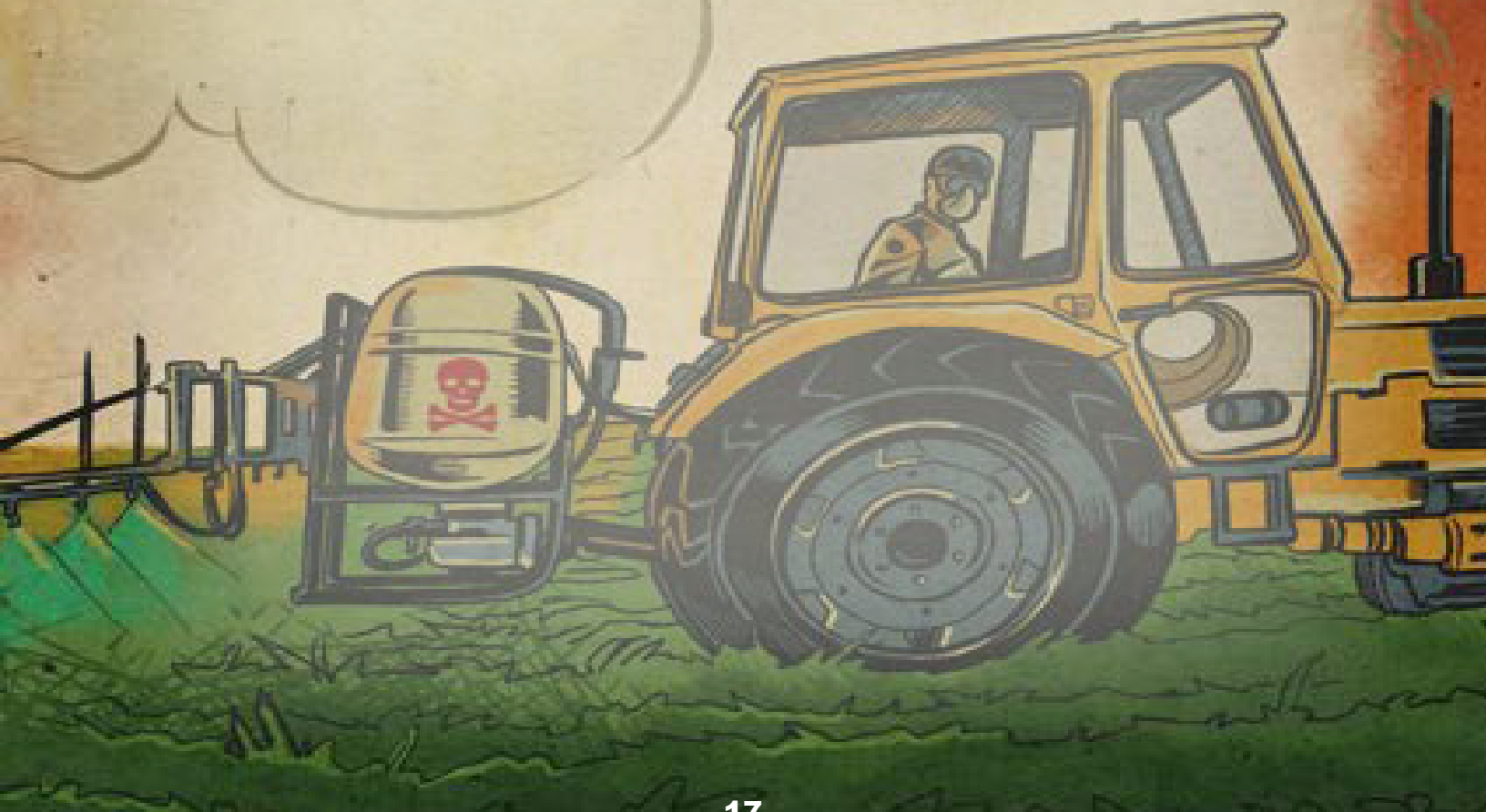
In order to achieve reductions of global emissions of carbon to net-zero by 2050, various government-imposed carbon pricing (taxing) and emissions trading systems (ETS's) have been proposed. ETS's are more commonly called Cap and Trade mandates. Cap and Trade mandates are in the very early stages of implementation; full implementation of these programs is still very much a work in progress. Effective carbon caps will require a world-wide acceptance of drastic limitations on the use of fossil fuels for power generation; unfortunately, China, which emits more carbon dioxide than any other country in the world, is still building many new coal-fired power plants, as is India, the third largest carbon emitter. The United States, the second largest emitter, is currently phasing out coal-fired power plants in favor of wind and solar power. Both market forces and governmental incentives are driving the changes in the United States. However, it seems unlikely that the governments by themselves will be able to achieve net-zero by 2050. Even in the United States, where President Biden has set appropriate goals to achieve carbon neutrality, he has urged petroleum producers to increase production in order to reduce the rising cost of gasoline.
To make matters worse, consumers in much of the world have been misled into thinking electric vehicles are part of the solution to global warming, whereas, in reality, in most parts of the world, they are fossil-fuel burning vehicles that waste heat from combustion of the fuel that could be used to warm the cars in the winter. For example, in the United States consumers have been incentivized with tax rebates to purchase electric vehicles. Electric vehicles by themselves will only make sense when power grids are decarbonized. However, the owners of electric cars can accelerate decarbonization of the grid in their areas by installing solar panels on their homes and using that power to charge their cars. In this way they become independent of the wild fluctuations in the price of gasoline, and their solar panels also will supply electricity for their homes thereby decreasing the need to burn fossil fuel to produce that electricity. For those without solar panels hybrid vehicles are a much more fuel efficient option.

The lack of effective world-wide governmental programs, however, should not deter informed energy consumers, both large and small, from using the marketplace to drive change. In the same way that electric car owners can by themselves decrease their dependence on fossil fuels, so too can consumers of other products achieve similar results.

If consumers world-wide would favor products that are produced in a verifiable carbon-neural manner, producing companies will respond. It is important that company claims of carbon neutrality be verified by an independent agency to avoid so-called “green washing”. Many companies have already informed consumers of their intention to reach carbon neutrality by a certain date. For example, Apple has committed to reach carbon neutrality by 2030. Google has claimed to have already achieved carbon neutrality in part by planting trees. Wind farms and solar energy projects have attracted much of the money that is being spent to achieve carbon neutrality. Small scale, less formal possibilities exist that could provide significant contributions to the achieving of carbon neutrality while at the while at the same time providing additional income and improved nutrition to large numbers of people. For example, informal programs could be developed through organizations such as The Nature Conservancy, the National Wildlife Federation, and the Sierra Club to allow individuals to offset their carbon emissions by financially supporting carbon sequestration or carbon emission mitigation programs. Individuals could also independently support such programs. In addition to ETS payments, individuals and companies could provide capital for entrepreneurs in poor countries to develop sustainable industries that would provide jobs for their increasing populations.

The proposals included here would allow farmers in poor countries to increase their incomes while at the same time providing carbon capture and emission reduction if given relatively modest amounts of financial aid. This would be especially important in some African countries where it is not unusual for 40% or more of the working population to be engaged in subsistence agriculture. It is not unreasonable to expect that the possibility of increased income might also help to reduce mass migration from poor countries to wealthier ones. These proposals, however, need not be limited to farmers in poor countries; farmers in richer countries could also benefit.

The achievement of net-zero carbon emissions within any reasonable time frame will require both drastic reductions in carbon emissions and carbon capture. Carbon capture is required because not all energy uses can be readily converted to renewable sources. For example, the energy density of lithium batteries is far too low to power commercial airplanes. Perhaps in the future a plentiful supply of sustainably-produced liquid biofuels or hydrogen produced by solar-powered electrolysis of water that can be subsituted for jet fuel will become available, but at the present time such a supply does not exist, and it is unlikely to become available any time soon. There is no shortage of complex engineering carbon capture schemes that are in various stages of development; however, none of them have yet achieved widespread use. Some of these schemes will, undoubtably, be successfully applied when sufficient capital is available to implement them. However, there are many simple methods of carbon sequestration in soils and plants that have been used successfully for thousands of years to improve agricultural yields. I shall propose in this report a system to encourage the use by farmers of simple, well-established methods that can sustainably increase agricultural yields and at the same time sequester significant quantities of carbon in soils. Sustainable has been defined in USDA Special References Series no. SBR 99-02 as follows: “The goal of achieving a sustainable planet, one that will accommodate the basic needs of its present inhabitants while preserving the resources that will enable future generations to flourish…”. Highly mechanized monoculture farming methods have replaced the sustainable farming practices of the past. Many of these practices are more profitable in the short run, but are damaging in the long run.



The monoculture methods generally require deep plowing and large inputs of chemical fertilizers and pesticides. Over-fertilization often leads to eutrophication (proliferation of plant growth with an accompanying loss of oxygen supply to aquatic animals) in bodies of water that receive runoff from over-fertilized fields. Extensive soil erosion is often the result of intensive farming practices. The extensive, indiscriminate use of pesticides often has a devastating effect on insect populations. Insects are an important component of the food web, providing food for fish, birds, and many species of land animals. They are also vital in the pollination of fruits, vegetables, and nuts, and in the natural control of weeds, agricultural pests and some disease vectors.

Examples of Traditional Sustainable Farming Methods

I am going to list a few examples of highly sustainable farming methods developed by ancient agriculturists that could substantially reduce the carbon footprint of present day agriculture and can lead to carbon sequestration in soils. Scattered throughout the Amazon basin and other regions in South America are relatively small patches of very fertile farming land called Terra Preta del Indio (black Indian soils) that were created over time by native farmers prior to the coming of European settlers to the Americas. The soils of these patches of land are character-ized by the presence of relatively high concentrations of charcoal that was produced by the incomplete combustion of plant tissue (biochar). In this regard, they are similar to the very fertile black (Chernozem) soils of Ukraine, Central Russia, Northeastern China, and the Central United States among other places. The charcoal in these soils accumulated over millennia as a result of the natural burning of prairie vegetation. The Terra Preta soils are generally surrounded by highly leached tropical soils of low fertility.

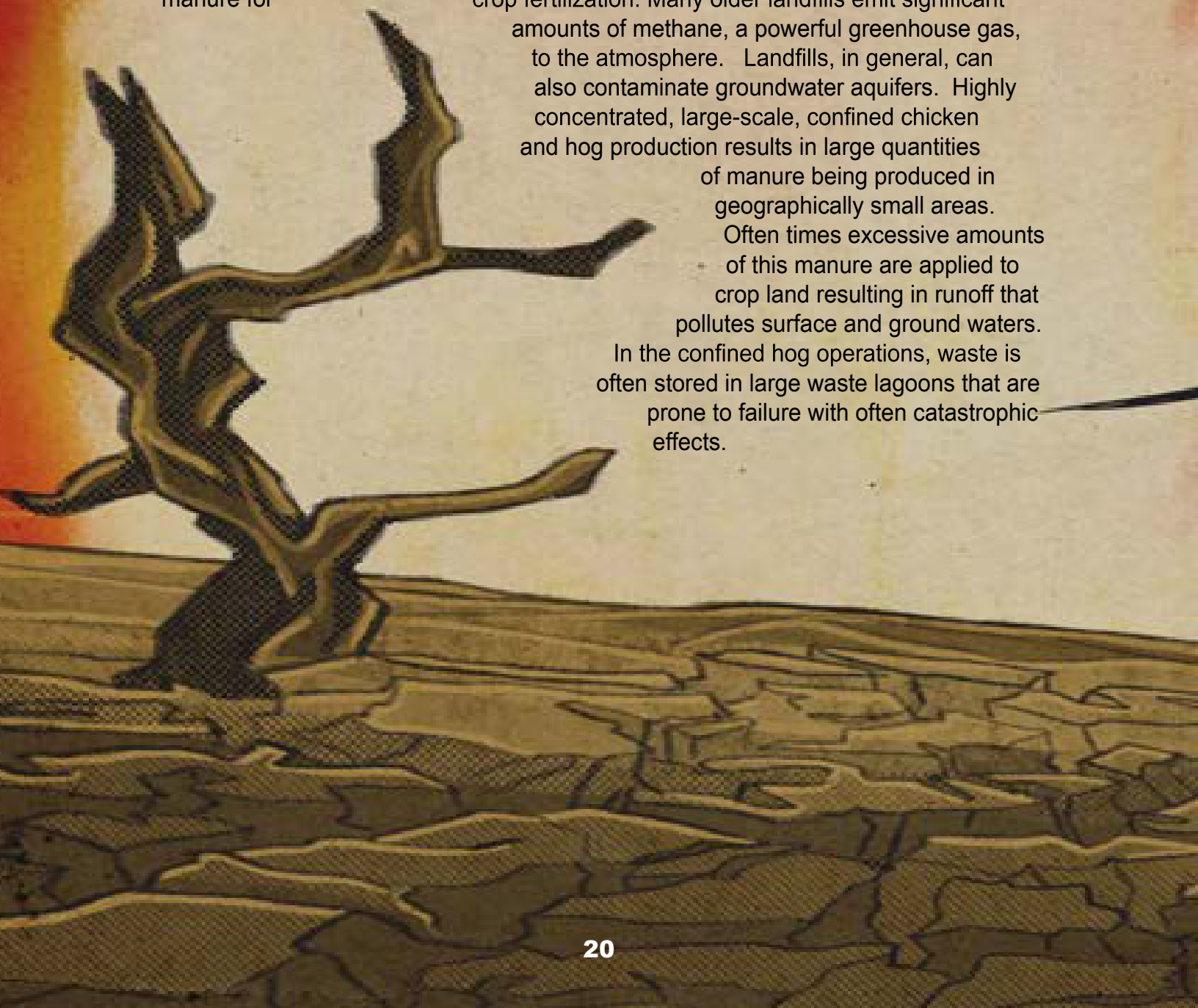
Charcoal greatly enhances the fertility of soils by improving the water-holding capacity and the retention of nutrients in the soils. When charcoal is produced from vegetation it is called biochar. Biochar can be produced by the incomplete combustion of waste wood and dead trees such as those that have been killed by disease, insect infestations such as those that have been killed by bark beetles, or extreme drought. These dead or dying trees now pose a major fire hazard in many parts of the western United States. The incidence of forest fires has increased dramatically in recent years mainly as a result of climate change. Tens of billions of dollars a year of damage are caused by forest fires. The Camp Fire in California in 2018, alone, caused between 8.7-10.7 billion dollars in damage, and 85 people died in the fire.

One possible solution for reduction of fire hazard is to harvest the dead trees. Unfortunately, most of these trees are not suitable for lumber; however, they could be converted into biochar that could be used to improve soil fertility and sequester carbon in the soil. Accumulated fuel on forest floors could also be converted into biochar. Thinning of healthy trees could also improve overall forest health by reducing competition for limited soil moisture. The production of charcoal from wood however, must be carefully regulated to prevent the destruction of heathy forests. Haiti provides an extreme example of this destruction where the production of charcoal for cooking fuel has led to massive deforestation and the accompanying episodic flooding and soil erosion from denuded hillsides during heavy rain events. In places like Haiti, the population should be encouraged to convert to cooking with simple unleaded gasoline stoves or better yet the simple bioethanol stoves (https://unf ccc.int/climate-action/momentum-for-change/activity-database/ethanol-gel-fueled-stoves-for-urban-poor) now being used by some of the urban poor in Kenya. Bioethanol can be readily produced from food waste or from locally produced sugar. Cash incentives should also be provided to plant trees to reduce soil erosion and loss of top soil, and to remove carbon from the atmosphere.

Waste agricultural products could also be used to make charcoal. In the Philippines some provinces have restricted charcoal production to the use of waste material such as coconut shells. Most of this charcoal is used now for fuel, but there is no reason that some of it could not be used for soil improvement. Farmers who only have access to small amounts of coconut shells or other waste products could easily produce charcoal with simple earth kilns that have been used for thousands of years.

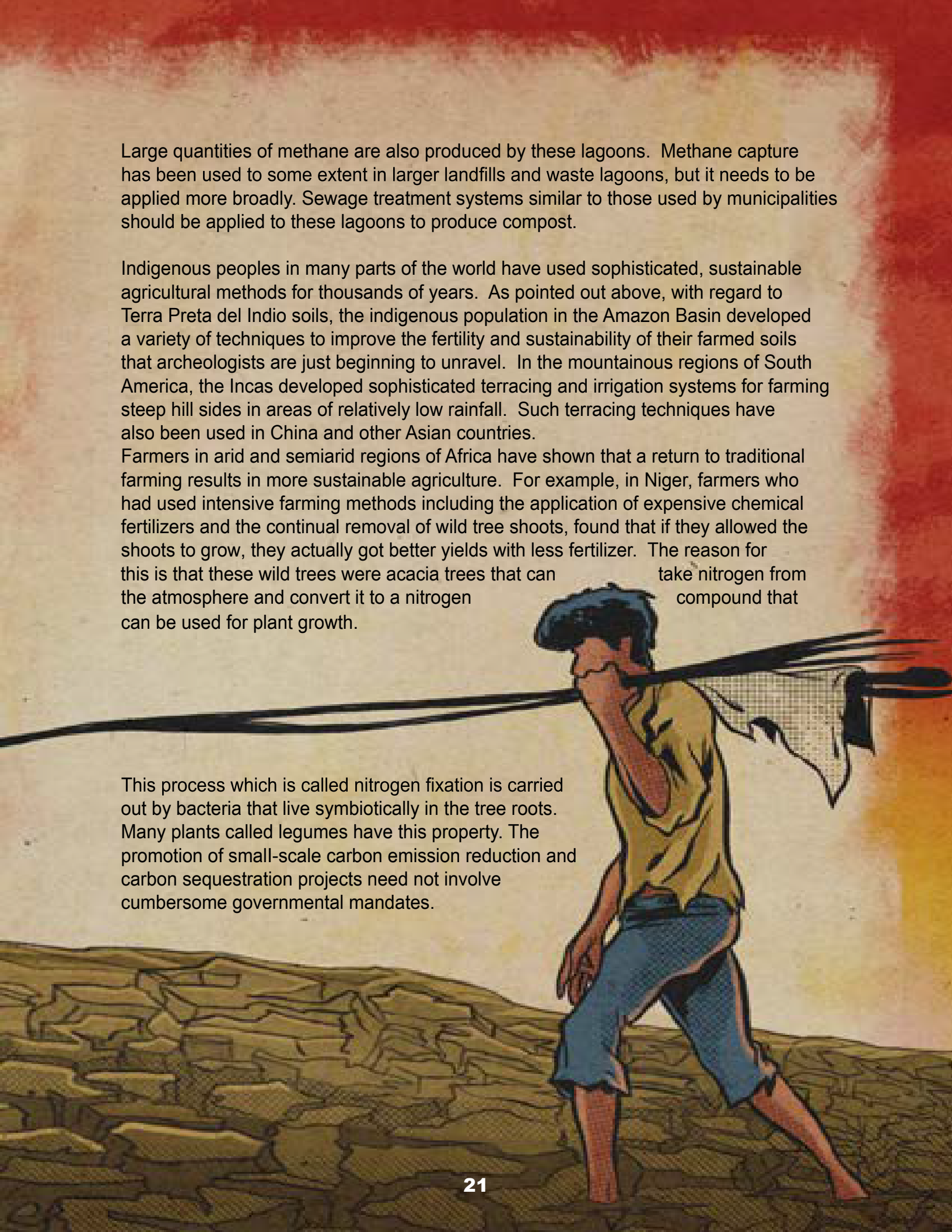
The recycling of plant and animal wastes by composting also results in increases in organic carbon content of soils, resulting in a net storage of carbon in soils. Composting is a low-tech solution that has been practiced since time immemorial. Composting ing, crop rotation, growing of nitrogen-fixing cover crops, and other techniques that have been used for centuries have been incorporated in the so-called organic farming movement to limit or eliminate the use of synthetic fertilizers and pesticides. Organic farming is becoming more common as consumers demand for more sustainably grown food increases.

Many other possibilities exist for low tech carbon storage or at least reduction in carbon release to the atmosphere by the reuse of building materials, eliminating as much as possible landfilling of waste, more efficient use of pig and chicken manure for crop fertilization. Many older landfills emit significant amounts of methane, a powerful greenhouse gas, to the atmosphere. Landfills, in general, can also contaminate groundwater aquifers. Highly concentrated, large-scale, confined chicken and hog production results in large quantities of manure being produced in geographically small areas. Often times excessive amounts of this manure are applied to crop land resulting in runoff that pollutes surface and ground waters. In the confined hog operations, waste is often stored in large waste lagoons that are prone to failure with often catastrophic effects.



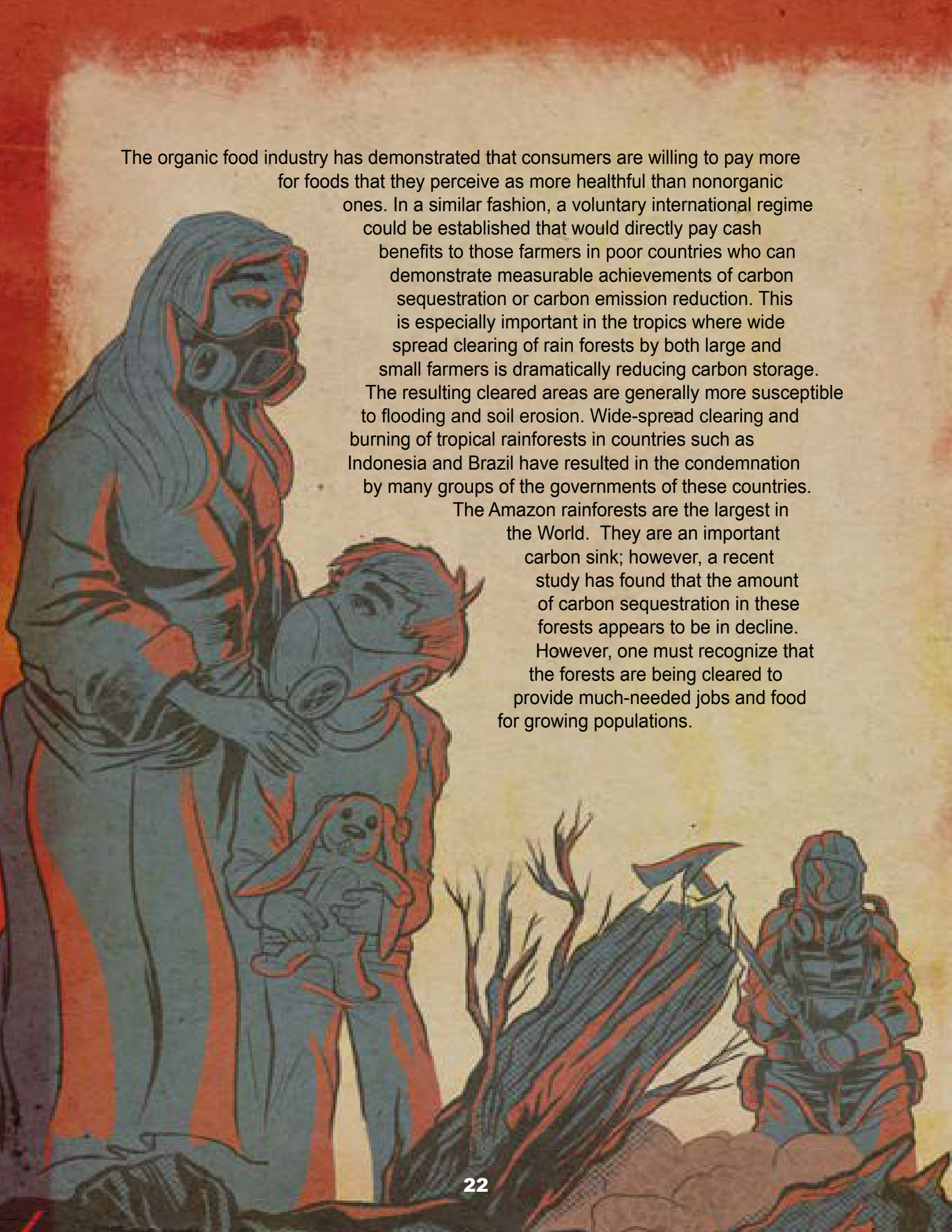
Large quantities of methane are also produced by these lagoons. Methane capture has been used to some extent in larger landfills and waste lagoons, but it needs to be applied more broadly. Sewage treatment systems similar to those used by municipalities should be applied to these lagoons to produce compost.

Indigenous peoples in many parts of the world have used sophisticated, sustainable agricultural methods for thousands of years. As pointed out above, with regard to Terra Preta del Indio soils, the indigenous population in the Amazon Basin developed a variety of techniques to improve the fertility and sustainability of their farmed soils that archeologists are just beginning to unravel. In the mountainous regions of South America, the Incas developed sophisticated terracing and irrigation systems for farming steep hill sides in areas of relatively low rainfall. Such terracing techniques have also been used in China and other Asian countries.
Farmers in arid and semiarid regions of Africa have shown that a return to traditional farming results in more sustainable agriculture. For example, in Niger, farmers who had used intensive farming methods including the application of expensive chemical fertilizers and the continual removal of wild tree shoots, found that if they allowed the shoots to grow, they actually got better yields with less fertilizer. The reason for this is that these wild trees were acacia trees that can take nitrogen from the atmosphere and convert it to a nitrogen compound that can be used for plant growth.



This process which is called nitrogen fixation is carried out by bacteria that live symbiotically in the tree roots. Many plants called legumes have this property. The promotion of small-scale carbon emission reduction and carbon sequestration projects need not involve cumbersome governmental mandates.

The organic food industry has demonstrated that consumers are willing to pay more for foods that they perceive as more healthful than nonorganic ones. In a similar fashion, a voluntary international regime could be established that would directly pay cash benefits to those farmers in poor countries who can demonstrate measurable achievements of carbon sequestration or carbon emission reduction. This is especially important in the tropics where wide spread clearing of rain forests by both large and small farmers is dramatically reducing carbon storage. The resulting cleared areas are generally more susceptible to flooding and soil erosion. Wide-spread clearing and burning of tropical rainforests in countries such as Indonesia and Brazil have resulted in the condemnation by many groups of the governments of these countries. The Amazon rainforests are the largest in the World. They are an important carbon sink; however, a recent study has found that the amount of carbon sequestration in these forests appears to be in decline. However, one must recognize that the forests are being cleared to provide much-needed jobs and food for growing populations.



A similar situation took place in the United States in the nineteenth century with the clearing of vast stretches of tall grass prairie land for agricultural use. Unfortunately, the slash and burn methods that generally are used in tropical rainforests are environmentally unsustainable and add huge amounts of carbon dioxide to the atmosphere. In Indonesia the burning of forests is mainly used to clear the land for the planting of palm oil trees. This burning not only burns the forest trees, but also the peat underlying the forest floor, thus adding additional large amounts of carbon dioxide to the atmosphere. In Brazil, in addition to burning rain forests for cattle ranching and other agricultural endeavors, various mining operations have also led to forest clearing in the Amazon Basin. In order to reduce and ultimately completely eliminate these large emissions which adversely affect all of us, the consumers of the World must be prepared to pay premium prices for products that provide employment opportunities for growing populations and that can be produced sustainably in the tropics.

Some of the leaders of tropical rainforest countries have attempted to reverse deforestation. For example, President Félix Tshisekedi of the Democratic Republic of the Congo (DRC) has been instrumental in efforts to preserve the rain forest of the DRC which is the second largest in the World. President Tshisekedi has initiated a community-based forest management program to develop sustainable logging practices that provide jobs for the people living there. He has also sought support from several governments with mixed success. Unfortunately, logging is still destroying large areas of the rainforest to produce wood for furniture construction, and charcoal production. In addition, forest land is being cleared for agricultural uses.

Charcoal is used in many parts of the world for cooking. Charcoal production is a very inefficient process in which much of the heat content of the source wood is lost. The use of simple, unleaded gasoline stoves would be one way to reduce the deforestation due to charcoal production. These stoves could easily be produced in the country providing much needed jobs. The Kenyan bioethanol stoves would even be a better solution.

The DRC is a relatively poor country (GDP per person of $1100) that is rich in undeveloped or underdeveloped resources. The Congo River system has the potential to produce large amounts of hydroelectric power. The present population of the country is estimated to be about 108,000,000 (CIA Factbook) that is increasing rapidly. The DRC and other countries that are trying to preserve or increase forest cover deserve support from the rest of the World in their efforts that will benefit all of us.

Recently, however, the government of President Tshisekedi has decided to open parts of the Congo rainforest to oil and gas exploration in order to provide jobs for the rapidly increasing population of the DRC. Governments in the rich countries of the World have similarly increased oil and gas exploration and production so that their citizens will not have to pay so much to fill the tanks of their SUVs, RVs, and gas-guzzling sports cars. It is therefore, more imperative than ever for all of us to realize that without immediate action to drastically reduce our consumption of hydrocarbons that the worldwide results of climate change will be truly catastrophic.

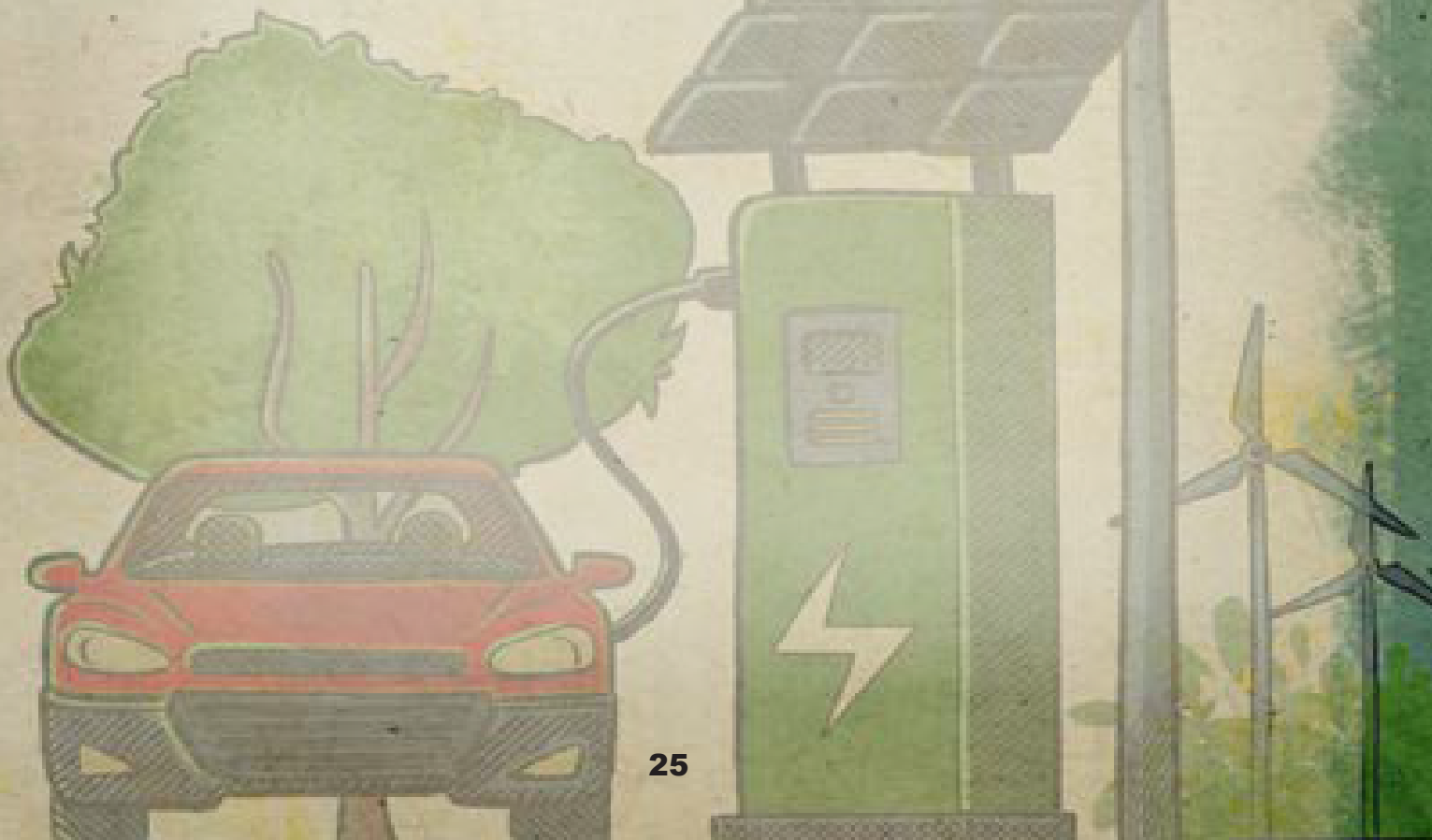
Nongovernmental Initiatives to Combat Climate Change

The payments of cash benefits should attract innovators who can demonstrate net carbon storage and reforestation. Urban gardening on small patches of land in both rich and poor countries could lead to a meaningful improvement in the nutrition of poor people while at the same time remove carbon from the atmosphere. I am certain that if significant cash incentives are offered directly to those on the ground doing the necessary hard work that there will be no shortage of takers. In order to allow poor innovators to implement their proposals, it will probably be necessary to provide cash advances to them (crowd funding or in some cases venture capital). Companies both large and small that participate in providing funds for such efforts could indicate their participation in the advertising of their goods and services in the same way that companies advertise that the raw materials in their coffee and chocolate products have been obtained using so-called fair-trade practices or that their food products are organic.

Consumers are willing to pay premium prices for organic and fair-trade products. In a similar fashion, companies could advertise what steps they have taken to reduce their carbon emissions. For example, Apple and Google have programs in place that will make all of their products “carbon neutral” by 2030; that is to say, they have promised to offset their carbon emissions by sequestering an equal amount of carbon. In order to prevent so-called “green washing”, companies must explain in detail how they are achieving carbon neutrality.

Those us who are aware of the dire consequences of not drastically reducing Worldwide carbon emissions must make every effort to convince our friends and neighbors that their efforts can make a real difference in reducing global warming. Their individual efforts to reduce their own carbon emissions and to demand that the products they buy are produced by companies that are actively reducing their carbon emissions can set an example for others to follow. By actively encouraging large numbers of people to participate in carbon reduction and sequestration projects, awareness of the detrimental effects of climate change will become better understood, and climate change skepticism will hopefully be reduced. As pointed out above, companies and individuals ultimately must be willing to pay to offset their carbon emissions to the atmosphere.

Large-scale projects such as Africa’s Great Green Wall could be financed by petroleum companies that are reaping record profits from the high price of gasoline at the pump. The major petroleum companies realize the carbon emission must be reduced to avoid catastrophic increases in global temperatures.



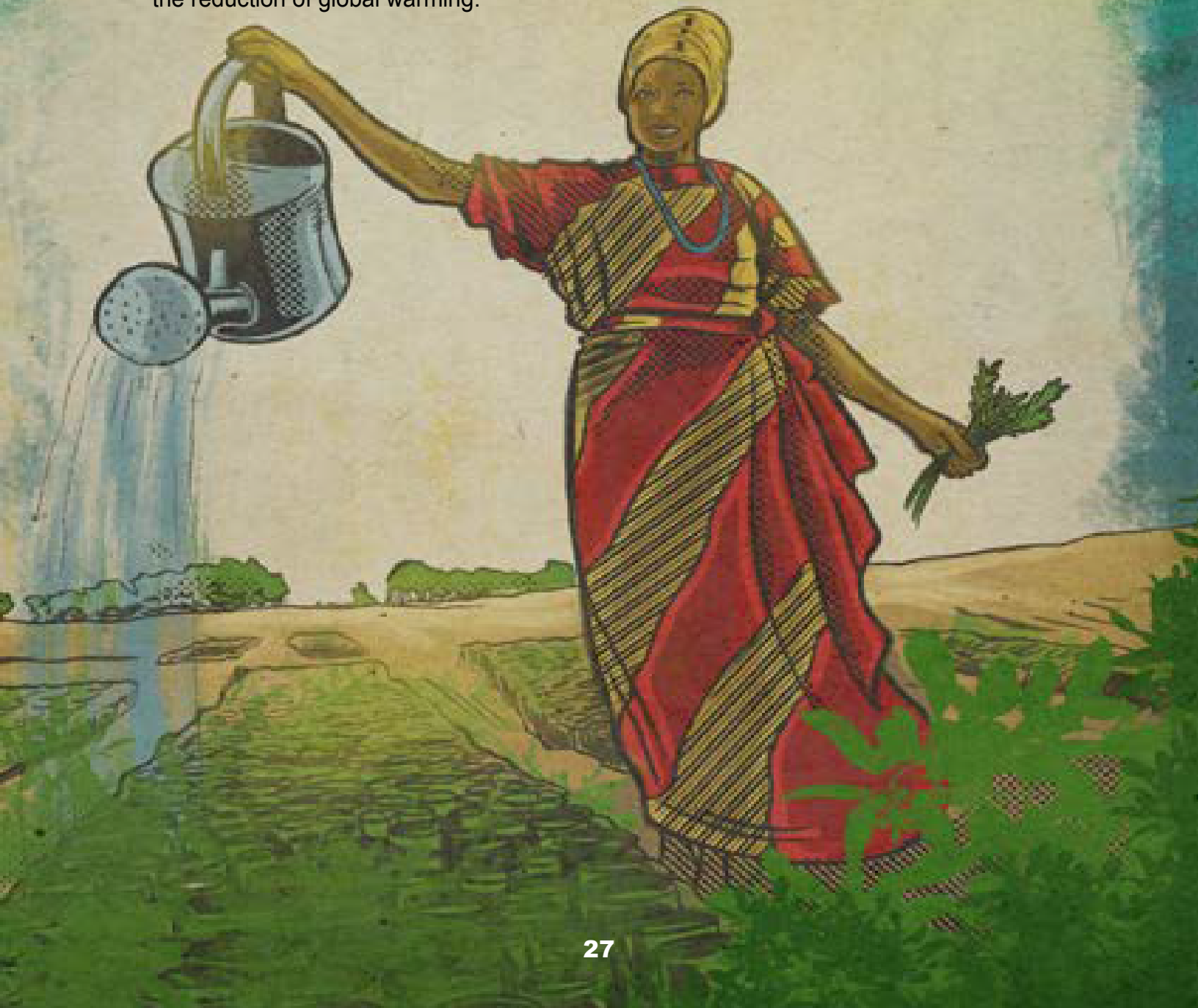
For example, Joe Blommaert, the recently retired head of ExxonMobile Low Carbon Solutions has pointed out that his team "… is working to commercialize and deploy technologies to help cut global emissions and address the impact of climate change" (https://energyfactor.exxonmobil.com/insights/voices/low-carbon-solutions-joe-blommaert/#.Ynru9hIs-FM.link). One of the objectives of his team is: "deploying technologies to capture and safely store carbon dioxide emissions." Planting forests, such as proposed in the Africa's Great Green Wall project is a proven technology for carbon capture and storage. As pointed out in an editorial in Nature, vol. 605, 5 May 2022, p. 8, on Africa's Great Green Wall: "The project is intended to combat desertification across the width of Africa, and spans some 8,000 kilometres, from Senegal to Djibouti. Its ambition is staggering: it aims to restore 100 million hectares of degraded land by 2030, capturing 250 million tonnes of carbon dioxide and creating 10 million jobs in the process. But it continues to struggle."

Africa's Great Green Wall project provides a platform for a large-scale project to test and develop the best procedures to use in forest planting and restoration in desert environments. Success in this endeavor would hopefully encourage large-scale planting and restoration programs in other environments. The sharing of information gained in large-scale and small-scale projects in on-line forums should be beneficial to all participants.

The difference between this proposal and other cap and trade proposals is that it does not require governmental mandates, and it mainly targets small stakeholders who have little capital, but a strong desire to improve their lot by investing their labor. Entrepreneurs in poor countries with little available capital could appeal internationally for crowd funding for small and large projects that produce sustainable products that employ workers who would otherwise not have employment or would be forced to turn to non-sustainable endeavors.

The contributors of the funds would be paid back with the products produced. As inexpensive cell phones and internet service become more available in underserved countries especially in sub-Saharan Africa, one could imagine that musicians and other performers in those countries could use platforms such as YouTube to attract worldwide audiences that would be willing to pay for access to their work.

With the wide-spread availability of cellphones, innovators will be able to interact with each other to exchange ideas on how to obtain the best results in particular areas. These interactions could take place either through organized online forums or informal discussion groups. Schools at all levels could encourage their students to participate in these forums and discussion groups, and to even plant small gardens to understand first hand the processes of sustainable farming and how these practices can help in the reduction of global warming.



People in countries throughout the World would be able to relate to others the effects of climate change that they have personally witnessed in their localities. Many universities such as the University of California at Davis, Cornell University, The University of Wageningen, and many others are actively involved in implementation of sustainable agricultural practices, as are commercial biochar companies. Their involvement in the forums and discussion groups could be very beneficial. Participants in these groups would be free to pick and choose the guidance that they think will be useful to their particular needs, in contrast to many aid programs in which “experts” attempt to dictate practices.

The ready, online availability of climate change mitigation ideas hopefully will encourage people who may not be personally concerned about climate change mitigation per se to use the information gleaned from these sites to unintentionally contribute to climate change mitigation. For example, they might decide to try urban gardening on unused patches of land in their communities, or to use compost and biochar to improve their existing gardens. The consumption of produce from these gardens could improve community diets.

In summary, an informal, nongovernmental cap and trade program offers the possibility if properly implemented, of reducing carbon emissions, increasing carbon sequestration, improving agricultural productivity, employment opportunities, and sustainability while at the same time, improving health, and educating people on the detrimental effects of climate change. The Covid pandemic has demonstrated that what happened in one part of the World can rapidly affect the lives of everyone else on the planet. The imposed isolation required to combat the pandemic has demonstrated that there are technological tools that allow people all over the World to inexpensively communicate, interact, and share ideas with one another in real time. There are even automatic translation apps that can be used by people who speak different languages. All we need now is the will to use these tools to avert a truly existential threat to the lives of all of us on the only planet we have.

NOTES and IDEAS

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