PROMOTING SUSTAINABLE AGRICULTURE

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Issue:	Promoting Sustainable Agriculture
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Table of Contents

I. Introduction

Agricultural systems are the world's largest driver of biodiversity loss and deforestation. In a world facing increasing water shortages and droughts, the agricultural sector accounts for 70% of global water usage. Agriculture produces 24% of global greenhouse gas emissions. 10% of the world's population is starving and a third of all food grown is never eaten. Additionally, 60% percent more food will be necessary by 2050, in order to provide sufficient nutrition for the expected population of 9.8 billion. The aforementioned figures are only some of the many points that illustrate the unsustainability of the current agricultural system. In light of the predicted population growth, the global community will need to maintain and increase the level of annually produced food. However, current agricultural practices will not be able to handle this growth. Considering the multifaceted environmental crises facing us - the worsening climate crisis, biodiversity loss, environmental pollution, farmland degradation and so forth - it becomes clear that a fundamental shift in agricultural practices is necessary. Additionally, if one looks at environmental studies, the changing climatic conditions will drastically impact agricultural production. Not only will systems need to be more resilient against droughts and extreme weather but research suggests that many crops may lose their nutritional value. For example, "when food crops like wheat, corn, rice and soy are exposed to CO2 at levels predicted for 2050, the plants lose as much as 10% of their zinc, 5% of their iron, and 8% of their protein content.[1]" Sustainable agriculture offers many benefits - from environmental effects like repairing soil health and aiding biodiversity to increasing productivity and thereby revenue. However, the transition towards sustainable agriculture is not progressing at the speed necessary to provide the growing population with sufficient nutrition without destroying the regenerative capacity of the planet. Therefore, it is necessary that different actors like governments or international organizations take measures to actively promote sustainable agriculture.

II. Definition of Key Terms

A. Agriculture

Agriculture is the practice or science of cultivating the soil for growing crops or raising livestock. Crops that are grown in agriculture do not necessarily have to be used as food, agriculture provides raw

[1] "Climate Change & Nutrition"; Harvard School of Public Health
https://www.hsph.harvard.edu/c-change/subtopics/climate-change-nutrition/

materials for much of the world's fabrics as well as wood for paper and construction materials.

B. Biodiversity

Biodiversity refers to the variety of organisms, meaning plants, animals and fungi in a particular habitat. Biodiversity is essential for both agriculture and healthy ecosystems. [2]

C. Food Security

Food Security is defined as having both physical and economic access to food that is sufficient in quantity as well as safe and nutritious. In order for food security to be present, the supply of food must be reliable. It is also one of the 17 Sustainable Development Goals (SDGs) of the UN.

D. Horticulture

Horticulture is the cultivation of plants in gardens or greenhouses, differing from the field-scale cultivation that agriculture refers to. Horticulture only refers to the growing of plants and does not include animals.

E. Industrial Agriculture

Industrial agriculture is agriculture designed to produce products as efficiently as possible, however, it is only efficient in the short term. It is the large-scale, intensive production of crops and livestock, often resulting in large amounts of greenhouse gasses and harmful waste. Industrial Agriculture often includes the use of Concentrated Animal Feeding Operations (CAFOs), Genetically Modified Crops (GMCs), and overuse of fertilizers or pesticides.[3]

F. Subsidies

A subsidy is a type of government spending that is targeted at specific businesses or sectors of the economy. In order to keep global competition fair, the WTO (World Trade Organisation) regulates subsidies. Their aim can be to stabilize the economy in an acute shock (e.g. Covid-19) or to keep an industry competitive on the global market by keeping the prices down. Subsidies can be used to develop a specific sector (e.g. sustainable agriculture) but can also be incredibly harmful by

[2] https://www.worldwildlife.org/pages/what-is-biodiversity
[3] https://www.nrdc.org/stories/industrial-agriculture-101

supporting unecological products, pushing their price down, and harming environmentally sound alternatives.

G. Sustainable Agriculture

Sustainable Agriculture is agriculture that meets the needs of the current generations and ensures food security without endangering the needs of future generations and the environment. It must nurture social, economic, and environmental sustainability. Such systems “increase profitable farm income, promote environmental stewardship, enhance quality of life for farm families and communities and increase production for human food and fiber needs."[4]

H. Regenerative Agriculture

Regenerative Agriculture is agriculture that seeks to improve the health of the planet and its ecosystems. It is focused on improving soil health, boosting biodiversity, supporting the sequestration of carbon dioxide back into the soil and improving the water cycle.

I. Vertical farming

Vertical farming is the practice of growing crops in vertically stacked layers, often in controlled environments, to maximize crop output per square meter.

III. General Overview

A. Harmful Agricultural Practices

As the global population skyrocketed during the past century, the demand for food has increased as well. Because of this steep increase in the global population, there has been little time to find sustainable methods to produce enough food. This has led to the creation of incredibly harmful agricultural methods, such as industrial farming, the overuse of pesticides, monoculture, and slash-and-burn agriculture.[5]

1. Concentrated Animal Feeding Operations (CAFOs)

Due to the rise in population, the demand for cheap meat has greatly increased. This has given rise to CAFOs, which are essentially factories for producing animal products. They cram hundreds of animals into little cages, often not even providing enough space to move or lie down. Aside from the ethical dilemma of holding animals in cages for their entire life and raising them for

[4] https://www.nifa.usda.gov/topics/sustainable-agriculture#:~:text=Agriculture%20often%20places%20significant%20pressure,maintain%20and%20improve%20soil%20fertility.
[5] https://education.nationalgeographic.org/resource/environmental-impacts-agricultural-modifications/

slaughter or as egg and milk machines, these practices also have detrimental environmental side effects. They produce an enormous amount of waste, which pollutes the air and water of the surrounding era. Additionally, they emit a large amount of CO2 and methane gasses.[6]

2. **Genetically Modified Organisms (GMOs)**

   This term most commonly refers to crops that have been modified to aid growth, but it can also refer to other organisms. For instance, genetic modifications are also used in medicine to alter microorganisms such as bacteria in order to produce insulin.[7]

   GMOs can have many harmful side effects, such as negative effects on human health. In the case of environmental impact, the main issue with GMOs seems to be that they can be created with the ability to withstand specific pesticides, meaning there is no limit to how much farmers can use. Overuse of pesticides can be catastrophic - see below.[8] Additionally, GMO seeds can contaminate fields that are not meant to be genetically modified.

3. **Monoculture**

   The term ‘monoculture’ refers to an agricultural practice in which the same crop is planted in the same place year after year. It requires excessive use of toxic fertilizer, which results in toxic residue in the soil following harvest, permeating the soil and contaminating groundwater. Contaminated groundwater is detrimental to the environment and even harms neighboring and otherwise unaffected ecosystems. The synthetic chemicals also overwhelm plants and cause them to try to build resistances to the compounds. This mandates more inorganic countermeasures, further weakening the environment's ecosystems. Monocultures also compromise soil quality, increasing rain runoff and plant diseases. This eventually leads to degraded and nutrient-poor soil. Different species of plants take different amounts of different minerals/nutrients from the soil and return differing amounts of plant-specific nutrients. If there is only one type of plant being cultivated, this causes the soil to be one-sidedly depleted. This also

[6] https://www.nrdc.org/stories/industrial-agriculture-101
[7] https://ag.purdue.edu/gmos/what-are-gmos.html
[8] https://www.nrdc.org/stories/industrial-agriculture-101#monoculture

leads to increased water requirements, which cause the depletion and pollution of nearby waters. [9]

4. **Slash-and-Burn Agriculture**

Slash and Burn agriculture is most commonly used in tropical rainforests, as well as for animal grazing and dry-rice cultivation. It consists of cutting down any pre-existing plants and then burning down the rest of the land. This results in a nutrient-rich layer of ash covering the plot which provides good conditions for crops. However, after a few years, the soil will become poor in nutrients. Cultivators of this land will need to move and repeat the process somewhere else. The plot of land can recover and be reused after about a decade, however, since the beginning of the 21st century, the rate of slash-and-burn agriculture has increased to an extent that the fields can no longer recover. This results in erosion, deforestation, biodiversity loss, and further emissions of CO2 to the atmosphere, contributing to the overall worsening of climate change. [10] [11]

5. **Pesticides**

There are several types of pesticides, such as herbicides, fungicides, and insecticides. Each of these affects a different kind of pest. They are all harmful to the environment and, depending on the specific version of the pesticide, they also negatively affect non-targeted organisms - damaging ecosystems.[12] By killing all the plants beside the crops in a specific area most pesticides also deplete the soil.

6. **Pollution**

Industrial agriculture does not take environmental side effects into consideration. Often, the waste produced by CAFOs is used as manure. Due to the vast amount of livestock, however, too much manure is produced, which leads to over-fertilization. The chemicals that cannot be absorbed by the soil end up in the groundwater or in nearby lakes and rivers, polluting these.

[9] https://www.gallantintl.com/blogs/environmental-impacts-of-monoculture
[10] https://school.eb.co.uk/levels/advanced/article/slash-and-burn-agriculture/68155
[11] https://www.ecologic.org/our-impact/challenges/slash-and-burn-agriculture
[12] https://www.sciencedirect.com/science/article/abs/pii/S0957582019318683

B. Sustainable Agricultural Practices

Sustainable agricultural practices, as defined above, are agricultural techniques that "nurture healthy ecosystems and support the sustainable management of land, water, and natural resources, while ensuring world food security."[13] These agricultural practices must also "meet the needs of present and future generations for its products and services while ensuring profitability, environmental health and social and economic equity." Our current agricultural system does not meet these conditions. Among many other negative effects, it produces 24% of global CO2 emissions. Agriculture is also responsible for rampant deforestation, as companies search for new arable land, due to the degradation of farmlands caused by monocultures, pesticides and chemical fertilizers.

Additionally, our agricultural system will need to substantially increase its production capabilities. According to the FAO (Food & Agriculture Organisation), 60% more foodstuffs will be necessary by 2050, in order to provide sufficient nutrition for the expected global population of 9.8 billion. Therefore, a three-way transition will be necessary.

First, food waste will have to be reduced drastically. Today, roughly a third of all food produced is never eaten. Considering the vast amount of resources necessary to produce this food and the percentage of the global population lacking sufficient nutrition, this figure must be reduced. Global economic, social and environmental costs of food waste are estimated at around US$2.6 trillion.[14] Global food waste is responsible for approximately 8% of global greenhouse gas emissions[15]. In order to achieve a truly sustainable agricultural system, this amount of food waste must be stopped. This will require better infrastructure for storage, processing and transportation in LEDCs, where lack of such infrastructure is the primary cause of food waste. In high income regions, irresponsible consumer behavior is the main reason for food waste. To address this, public awareness campaigns would be necessary. While such measures - public awareness and transportation infrastructure - may not seem to be directly related to sustainable agriculture, it is self-explanatory that high food waste rates cannot constitute a sustainable approach to food.

Secondly, ecosystems must be protected from deforestation and degradation in order to create new farmlands. For this purpose, old farmland must be restored through regenerative agriculture and farming

[13] https://www.fao.org/sustainable-development-goals/overview/fao-and-the-2030-agenda-for-sustainable-development/sustainable-agriculture/en/
[14] https://drawdown.org/solutions/reduced-food-waste
[15] https://drawdown.org/solutions/reduced-food-waste

must move away from practices that degrade the soil, such as the extensive use of fertilizers and monocultures.

The third point - an extensive one - is closely related to the second point. Agricultural practices as a whole need to shift to be sustainable. There are multitudes of different sustainable practices. All of these are based on the ideas of reducing resource consumption and greenhouse gas emissions, conserving and ameliorating degraded ecosystems while ensuring food security and economic stability. In light of the grave environmental crisis facing us, the necessity of a shift to sustainable agriculture is evident. This section of the research report shall concern itself with presenting some different models of sustainable agriculture. In general, sustainable agricultural solutions can be classified into two broad categories: those that employ more traditional practices (traditional referring to before the advent of industrial agriculture) and those that utilize more modern, high-tech technologies in order to cultivate foodstuffs sustainably.

1. "Traditional" Sustainable Agriculture

a) Regenerative Annual Cropping

Regenerative Agriculture is based on the premise of restoring degraded farmland by increasing its carbon content. This not only improves and sustains soil health - increasing productivity significantly - but also sequesters carbon (pulls carbon out of the atmosphere through natural carbon sinks). Regenerative Annual Cropping is defined by Project Drawdown as "any annual cropping system (excluding rice production) that includes at least four of the following six regenerative practices: compost application, cover crops, crop rotation, green manures, no-till or reduced tillage, and/or organic production."[16] All of these methods have the potential to enhance soil carbon sequestration. An estimated 50% of the soil's carbon content globally has been released into the atmosphere. Solutions that focus on returning this carbon to the soil have a great potential to improve human health, the state of the climate and the financial situation of many farmers. Additionally, through conserving and even regenerating soil health, this agricultural technique eliminates the need for farmers to

[16] https://drawdown.org/solutions/regenerative-annual-cropping

abandon their farmland in search of more fertile lands, as their fields will remain fertile.

b) Agroforestry

Agroforestry is defined as any type of agriculture that incorporates trees or tree-like shrubs. Agroforestry techniques have many benefits in the field of sustainability. This sustainability is not only limited to environmental sustainability: Agroforestry has the potential to boost social and economic sustainability by diversifying income sources.

(1) Silvopasture

In this version of agroforestry, livestock are raised and graze in a field that is a mixture of pasture and forest. Farmers can gain additional income through the trees, the pasture is more resilient against drought and the field sequesters five to ten times more carbon dioxide than conventional fields would. Additionally, raising livestock in a varied environment improves the health of the animals, further increasing gains for the farmers. While it is important to mention that switching from a conventional pasture to silvopasture can be complicated and costly, lifetime savings and profit with this system exceed those of conventional farming, especially if future droughts are considered (against which silvopasture systems are more resilient).

(2) Tree intercropping

Tree intercropping is an agroforestry technique and describes the intermingling of trees and crops. This system has many advantages; it increases the carbon content of the soil and therefore the field's productivity. It is effective in creating habitats for animals and aiding biodiversity. It can also help reduce erosion and the trees can protect crops from wind and rain damage. The trees' powerful root systems can draw up nutrients and minerals for the plants that do not have roots that reach as deep. These systems are also more drought-resistant.

2. “High-Tech” Sustainable Agriculture

“High-Tech” Sustainable Agriculture systems use more modern technologies to be sustainable. All of the following include significantly reduced land use as a benefit. This can protect land from being converted into farmland- however, it should be noted that, unlike most traditional sustainable/regenerative agricultural systems, they lack the ability to regenerate soil. Furthermore, all are quite costly in large scale applications.

a) Hydroponics

Hydroponics is a technique for growing plants in a controlled environment without soil. A nutrient rich water solution is used to provide the plants with the substances they require. There are many different ways of supplying this solution to the plant's roots, such as the Ebb and Flow system in which the roots are periodically flooded or the aeroponics solution in which plant roots hang suspended in the air and are misted with the nutrient solution. Hydroponics have significant benefits as well as drawbacks. These systems have a much higher water efficiency than conventional farming, reducing water usage significantly - the exact amount depends on the system but rates of up to 99% reduction have been recorded. Land use is also reduced by a large percentage. Hydroponic systems are also more productive, as they can grow all year round and the growth rate of the plants themselves is faster, as they are grown in conditions tailored to their well-being. On the other hand, hydroponic systems can be incredibly expensive. Especially on a larger scale, the systems require a lot of expensive technology to monitor acidity rates, humidity etc. in order to keep the growing environment controlled. Costly software is also often necessary to schedule switches in the customized LED lighting. This high rate of automation also makes systems very energy intensive. While this energy can be sourced from solar panels on the roof of the facility, this does not change the fact that hydroponic systems are very sensitive to power outages - which could potentially destroy a whole harvest if the outages are of sufficient length.

b) Aquaponics

Aquaponics is an agricultural technique that combines aquaculture (farming fish and other aquatic creatures) and hydroponics (growing plants without soil). The waste produced by the fish is converted into nutrients for the plants by nitrifying bacteria. When the water is circulated to the plants, they absorb these nutrients and thereby clean the water, which is returned to the fish tanks. Aquaponics has many environmental and economic benefits. The systems have a double output, producing both fish and vegetables. The system also uses approximately 90% less water than conventional agriculture. In contrast to hydroponics, aquaponics does not (or only on a very minute scale) require the addition of extra nutrients, as these are provided by the fish excrement. However, similar to hydroponics, aquaponics requires advanced technology if practiced on a large scale and in the case of aquaponics, due to the fish, the time in which the system can survive a power outage is even shorter.

c) Vertical farming

Vertical farming is the practice of growing crops in vertically stacked layers to maximize crop output per square meter. Often, but not always, vertical farming incorporates controlled environment farming techniques such as hydroponic growing systems. Vertical farming has positive but also negative aspects.

On the positive side, vertical farming has the potential to greatly increase productivity. While the exact figure varies with the specific crop and growing system, vertical farming can be up to 30 times more efficient than regular farming per square meter, due to the all year round production time, controlled growth conditions and maximized growing space. This could allow for much farmland to either be restored or for natural spaces to be preserved.

A factor that complicates the adoption of vertical farming is the large cost of installation. While exact figures may vary, some estimates put the cost of installation of a hypothetical vertical farm with 10 growing-levels at some 850 times more expensive than regular agricultural fields. Due to

these high prices, vertical farming techniques are, as of now, only profitable for high value crops and are unable to compete with conventional farming on crops such as corn, wheat or rice. Vertical farming is economically profitable for crops that have a compact stature in order to maximize the growing space in stacked rows. Therefore plants such as lettuce, spinach, tomatoes, strawberries, kale and cabbage are especially suited. Energy usage is also significant in vertical farming systems. Therefore, it is vital that this energy is sourced sustainably. Otherwise, vertical farms could produce more emissions than they prevent.

It is additionally important to consider that vertical farming is unlikely to replace all conventional agriculture. Rather, vertical farming is a solution intended and suited largely for urban areas, where vertical farms can be built into abandoned areas such as old industrial complexes, bunkers, or public transport stations and can greatly reduce transportation emissions if they can supply fresh produce for the urban population.

C. Methods to Promote Sustainable Agricultural Practices

Sustainable agriculture holds multifaceted benefits and is undoubtedly necessary in order to facilitate food security, environmental protection and to avoid the most catastrophic effects of environmental degradation. However, the shift towards sustainable agriculture is still in its early stages and is not progressing at the necessary speed. Transitioning towards sustainable agricultural systems may - depending on the system and other parameters - come with a need for heavy financial investment. Additionally, many farmers may be hesitant to shift from practices that - though unsustainably so - are currently producing large profits. Therefore, methods to promote sustainable agricultural practices are desperately needed.

1. International Bodies and Organisations

International bodies and organizations play an important role in providing platforms for dialogue between countries. Like many of the pressing issues facing our planet today, the negative effects of unsustainable practices in the agricultural sector transgress country borders. Therefore, international cooperation and regulations are necessary. Bodies like the UN and its many sub-organs are vital in

providing frameworks for talks on multinational strategies aimed at creating such regulations to address the issue.

Specialized agencies such as the UNEP (United Nations Environmental Program) and the FAO can provide opportunities for countries to engage in joint research. These international forums are important places for governments and international cooperations to exchange ideas and know-how to accelerate the transition towards sustainability.

International organizations could and should also be used in order to coordinate aid efforts towards LEDCs and countries struggling to finance the transition themselves. For example, many LEDCs would greatly benefit from improved cooling infrastructure in order to minimize food waste at that stage in the supply chain.

2. Governments

Governments are the actors that have the most leverage to influence the producers in their respective countries. They must take steps to address the multifaceted issue and transition from unsustainable to sustainable agriculture. Examples of such steps are listed below.

a) Funding research

While this may be financially difficult for LEDCs to achieve, research is a vital component in shifting agricultural practices. In order to understand the gravity of the current environmental degradation and pollution that the global community faces, research is necessary. It can examine the current destruction and thereby determine changes that are required as a consequence. This can include researching and forecasting weather patterns that farmers are heavily reliant on. Research into sustainable farming practices does not only include the development of “high-tech” practices but also furthering understanding of more traditional methods. An example for this would be examining the effect of a certain crop on soil health and general agricultural productivity if grown in combination with another crop. Such datasets are vital assets in order to successfully promote the widespread adoption of sustainable farming practices.

b) Educating producers on the viability of sustainable agriculture & facilitating access to information

A common misconception concerning conventional agriculture is that it is economically sustainable. The so-called economic “success” of conventional agriculture rests on a business practice that is not only environmentally and socially unsustainable, but also economically so. Profits are gained through the exploitation of farmland and extensive use of chemical pesticides and fertilizers. While these tactics may increase profits in the short term, in the long run, they result in the degradation of farmland. This leads to an increased usage of chemical supplements, only further destroying the delicate soil balance and destroying the soil's productivity. Eventually, this leads to the expansion of new farmlands - increasing the percentage of land used for agricultural purposes. Additionally, the cost produced through environmental destruction such as greenhouse gas emissions, polluted water and air, destroyed ecosystems, loss of biodiversity etc. amounts to a total of about US$3 trillion every year. As extreme weather events increase - an unfortunate reality of climate change - so will the damage to agricultural productivity. This applies, to a certain extent, to both systems of farming, however, conventional farming systems are less resilient against extreme weather events and have less capacity for water storage in comparison to their sustainable counterparts.

Sustainable agricultural systems, therefore, offer many economic benefits to farmers. By increasing soil health and water storage, many non-high-tech sustainable agricultural practices actually increase revenue by significant figures. Other more “modern” farming systems can also increase productivity through higher efficiency. Providing farmers with the information necessary to make an informed decision to switch to sustainable farming practices (as well as the knowledge to facilitate this transition) is vital. If financially possible, governments would also benefit (economically) from providing financial aid to farmers in order to support such a transition.

c) Discontinue subsidies into non-environmentally friendly agriculture and provide incentives for the adoption of sustainable practices

One reason why unsustainable practices may seem economically viable are governmental subsidies. While these may have positive intentions, such as enabling low income families to have access to meat, they have detrimental impacts on the environment. Additionally, this makes sustainable products seem more expensive in comparison. This means that sustainable products can be prohibitively expensive for some parts of society, furthering the opinion that organic products are something only middle class and rich people can afford. Especially if one takes into consideration that these products (due to less harmful fertilizers etc.) are healthier, it is also socially necessary that governments discontinue subsidies to non-environmentally friendly agricultural businesses and aid sustainable companies. This would also provide farmers with an incentive to switch to these practices and would increase the likelihood of investors investing in these companies.

d) Implementing or raising taxes and regulations on environmentally destructive agricultural practices

Imposing costs and regulations on agricultural practices that degrade natural resources and create high levels of pollution is a necessary means - while it may be an unpopular policy at first - to increase the adoption levels of sustainable practices. Extra costs that businesses would have to pay for environmentally harmful practices could and should be used to mitigate the environmental impacts of their actions. Regulations could include stricter laws and possibly bans on certain types of chemical fertilizers etc. and their usage. These laws could also be used to protect natural lands from being converted into farmland. Additionally, governments should attempt to work together with other governments in international frameworks in order to increase the efficiency of these regulations, such as multilateral bans of certain chemicals.

e) Educate civil society to further behavioral changes

As previously mentioned, the reason why nearly 10% of the world's population is in acute danger of starvation is not because the world's agricultural system produces insufficient amounts of food.[17] It is because large amounts of that food go to waste. For this reason, governments play an important role in educating their populations to decrease food waste. Another topic that governments should attempt to promote is changes in diets, for example by reducing meat consumption due to its large environmental impacts.

3. NGOs & Civil Society

NGOs and civil society actors can play an important role in promoting sustainable agriculture. NGOs (if they are in a governmental system that allows this) can conduct and publish research that can aid the transition. They can also call out businesses - or the government- that do not follow the regulatory standards. Furthermore, NGOs can educate society and push for changes such as dietary shifts.

Civil society also has a significant impact. As the consumers of the products, civil society actors have the power to place pressure on companies etc. to shift to sustainable practices or become more transparent. Depending on the governmental system, civil society actors can also pressure the government for necessary changes.

IV. Major Parties

A. The United Nations (UN)

The UN is an international organization promoting diplomacy and peace. It was created to allow its 193 member states to cooperate and create international policies. The UN has many organs and agencies that work to better the world in various sectors. Two agencies that work to better food security are the WFP and the FAO.[18]

B. World Food Programme (WFP)

The WFP delivers emergency food assistance to people in need. This includes delivering to crisis regions and working with communities to improve food security. Their main goal is to keep hunger from becoming a

[17] https://www.actionagainsthunger.org/the-hunger-crisis/world-hunger-facts/#:~:text=Global%20hunger%20crisis%20in%202023,and%20the%20COVID%2D19%20pandemic.
[18] https://www.un.org/

weapon of war. They were awarded the Nobel Peace Prize in 2022. They monitor and promote sustainable agriculture.[19]

C. United Nations Environment Programme (UNEP)

The UNEP tries to encourage partnerships between and provide leadership to the nations of the UN in order to push legislation to improve environmental policies. Although they are not primarily an agricultural organization, they are very involved in this sector due to the interconnectedness of agriculture and the environment.[20]

D. Food and Agriculture Organisation (FAO)

The FAO is a specialized agency of the UN that leads efforts to defeat hunger. Their goal is widespread food security. They work in over 130 countries worldwide. They work with communities to try to create self-sustaining systems which include sustainable agriculture. [21]

E. Countries

Australia, Germany, Japan, and South Korea all have progressive legislation regulating land and water use. Canada has particularly effective legislation to reduce greenhouse gas emissions.[22]

Saudi Arabia is a country with one of the worst policies when it comes to sustainable water usage in agriculture. Russia is one of the worst in deforestation. Other countries in need of better legislation include but are not limited to China, India, and Indonesia.[23]

F. Sustainable Companies

When it comes to sustainable agriculture, a worldwide transition is necessary. Singular farms adopting sustainable practices will, while necessary for creating the transition towards sustainable agriculture being the norm, not be able to solve the problem. However, companies that pioneer new technologies have an important role-model role to play.

1. Freight Farms

Freight Farms is a Boston based company specializing in agriculture technology. They were the first company (others later also adopted this idea) to manufacture and sell so-called

[19] https://www.wfp.org/overview
[20] https://www.unep.org
[21] https://www.fao.org/home/en/
[22] https://impact.economist.com/projects/foodsustainability/g20/fixing-food-2021-paper/sustainable-agriculture/
[23] https://impact.economist.com/projects/foodsustainability/g20/fixing-food-2021-paper/sustainable-agriculture/

‘container-farms’. Their freight farms are hydroponic farming systems built inside retrofitted shipping containers. Their hydroponic farming system functions with LED lighting and a controlled environment to simulate the perfect growing conditions for plants. Through this precise calibration (which also utilizes special computer software) the containers use 99% less water than conventional agriculture and a single vertical container farm can grow the equivalent of 2.5 hectares in conventional agriculture.

2. **AeroFarms**

AeroFarms is a sustainable vertical farming company based in New Jersey. Worldwide, AeroFarms have the largest indoor vertical farm calculated from annual growing capacity. The company uses Aeroponic growing technology, in which, similar to hydroponics, plants are grown without soil. In this case, however, the plant's roots are periodically misted with a nutrient solution. Aerofarms claim that their solution is up to 390 times more productive than field farming, that they use 95% less water than conventional farming and that they require up to 99% less land as well as zero pesticides.[24] AeroFarms was one of the recipients of the inaugural Global SDG Awards celebrating private-sector leadership in the advancement of the United Nations 2030 Agenda.

G. NGOs promoting Sustainable Agriculture

Sustainable Agriculture and other environmental issues are inseparably intertwined. Without addressing the current industrial agriculture system, it will be impossible to effectively fight the climate crisis, environmental pollution, loss of biodiversity, deforestation etc. Therefore it is only natural that NGOs active in the environmental field are also active in the field of sustainable agriculture. Examples of NGOs important to this issue are the WWF, Greenpeace and Project Drawdown.

V. Timeline

Date	Event
1892	The first gas tractor was built.
1913	The Haber process (also called the

[24] https://www.aerofarms.com/impact/

	Haber-Bosch process) was developed, allowing an industrial production of ammonia. This made it possible to produce chemical fertilizer on a large scale.
1950s	After the war, cheap ammonia fertilizer production and consumption greatly increased and became the primary source of nitrogen for farms.
1970	'Dead Zone' in the Gulf of Mexico was first investigated by scientists. Dead Zones are caused by run-of nitrogen and phosphorus fertilizer that pollute the water. This nutrient pollution causes an excessive growth of algae in a very short time. This algae bloom consumes the ecosystem's oxygen when it decomposes, killing off all other aquatic life due to the lack of oxygen that it causes.
2000	The first plant genome (Arabidopsis thaliana) was sequenced, paving the way for developments in genetic engineering.
2003	One billion acres of genetically modified crops have been planted.
2018	As of 2018, the Haber process produces 230 million tonnes of anhydrous ammonia per year, largely used in fertilizers.

VI. Relevant UN documents

- **A.** https://digitallibrary.un.org/record/3848632?ln=en UN Resolution "Agricultural Technology for Sustainable Development."
- **B.** https://digitallibrary.un.org/record/3954976?ln=en UN General Assembly Resolution: "Agriculture development, food security and nutrition"
- **C.** https://www.unep.org/resources/publication/legislative-approaches-sustainable-agriculture-and-natural-resources

  Legislative approaches to sustainable agriculture and natural resources governance (UNEP & FAO)

VII. Questions to Consider

- Does your country derive a large part of its GDP from agricultural produce?
- Is your country dependent on another country for a large part of its food supply?
- Is your country affected by food insecurity?
- Is your country affected by or expected to be affected by water shortages?
- Is your country especially vulnerable to the effects of climate change (e.g. flooding, drought and forest fires) that have a significant adverse impact on the agricultural sector?
- To what extent does your country's government attempt to promote sustainable agriculture?
- What type of agricultural system does your country have - more industrial farming with large companies running farming operations or predominantly small scale subsistence farming?
- Does your country have high adoption rates of sustainable agricultural practices?
- What sustainable agricultural solutions would be feasible for your country - e.g. would expensive hydroponics solutions be possible for farmers in your country?

VIII. Conclusion

The environmental harm of our current agricultural system is evident. Determining the major problems and researching possible solutions to these are vital steps that have the potential to lead to a sustainable future. Yet while there are many viable solutions that could be implemented, the adoption rates of sustainable agricultural practices are still relatively low. Drastic change with support from and cooperation within the global community will be necessary to effectively promote these changes. This transition is possible and policy suggestions to promote it are available, yet they will need consequent implementation in order to be successful.

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