



Sustainable Agriculture and Food Security

About 12,000 years ago, humans encountered the initial phases of today's agriculture. It was a breakthrough for the living strategies of human clan. The development of agriculture then developed the civilization. This breakthrough significantly impacted human survival strategies. The shift from a nomadic hunter-gatherer lifestyle to permanent settlements and farming marked the beginning of the Neolithic Revolution. As Daniel Webster, an American lawyer and statesman of the early 19th century, aptly put it:

"When tillage begins, other arts follow. The farmers therefore, are the founders of human civilization"

But this revolution was also marked by exploitation as it expanded. Feeding people at the cost of wildlife and forests resulted not only in the imprudent use of water but also in undermining the ecosystem and subverting natural climatic conditions.

First Agricultural Revolution

Nearly 40% of our globe is farmland. Out of this, around 1/3 is used to grow crops, while the other 2/3 comprises meadows and grassland for grazing livestock (<https://www.fao.org/sustainability/news/detail/en/c/1274219/>). As a matter of fact, only half of this cropland is used to grow crops for human consumption. The other half is assigned to biofuels and products used in industries. Contemporarily, such arrangements are posing threats to wildlife and forests. Some of these impacts can be categorized as:

a) Deforestation and habitat loss: The agricultural revolution, which caused the expansion of farmland, consequently drove deforestation. To cultivate the land, forests are cleared without considering the loss of habitat. When habitats are eliminated, it leads to a decline in biodiversity, damaging rainforests, forests, wetlands, coral reefs, and savannas. For example, the

plantation of oil palm dislocates lowland forests in Indonesia, while the production of soya bean damages the Atlantic Forests of Brazil and Paraguay.

b) Wildlife deforestation: Deforestation and habitat loss lead to wildlife displacement, which then disturbs the natural population systems of wildlife. Since this damage to the natural ecosystem is caused by the expansion of man-made farmland, species face numerous challenges in their natural living patterns. They lose their homes and struggle to survive.

c) Chemical Pesticides and Fertilizer: The modernization of agricultural techniques introduced the use of fertilizers and pesticides. The obsession with achieving high production rates resulted in the intensive use of these chemicals, which eventually led to the devastation of wildlife. These chemicals contaminated not only the soil but also the water, air, and overall environmental and health conditions of the living organisms in the surroundings.

d) Erosion and Soil Degradation: Soil is eroded and degraded when the top layer, which contains organic nutrients, is damaged. Monoculture farming (growing a single crop on a given field) is an unsustainable practice that causes soil erosion. Similarly, over-tilling of soil degrades soil quality and leads to erosion.

To overcome the negative impacts of these farming practices, advancements are required to introduce sustainable agricultural methods.



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While food production must remain a priority, the conservation of ecosystems and biodiversity must not be secondary concerns. Comprehensive techniques are needed to maintain the stability of natural ecosystems. In simple terms, a second agricultural revolution is urgently needed.

Second Agricultural Revolution

The current challenges posed by traditional agricultural practices necessitate a shift towards revolutionary measures. Sustainable agriculture must be coupled with a stable climate and predictable weather patterns. History has shown that expanding agricultural lands does not guarantee food security; rather, it threatens the future production of natural resources. The ultimate goal is to conserve natural resources to ensure a long-term food supply. Thus, the solution lies not in expanding farmland but in increasing the output of existing farmlands. This objective requires strategies that protect biodiversity, conserve water, and control greenhouse gas emissions and pollution.

Strategies to modernize agricultural practices and replace conventional patterns are being introduced in different regions, such as intertwined crops in one field and livestock farming in wild habitats. Costa Rica serves as a notable example, where farmers have integrated farmlands with tropical habitats. This structure not only doubles the country's forest cover but also provides food and habitat for wildlife. Moreover, harvesting more than one crop on a single farmland aid in natural pollination and pest control.

Innovative techniques have been developed to stabilize the climate and preserve natural biodiversity and ecosystems. Here are some recommended ideas that may serve as tools for the next agricultural revolution and ensure long-term food security.

- a) **Precision Farming:** Instead of indiscriminately applying large quantities of water and fertilizers on farms, their application should be carefully calculated. Sensors placed within the soil can provide data about the specific requirements for water levels and fertilizers. Conventionally, broadcasting fertilizers across the entire cropland causes pollution.
- b) **Vertical Farming:** Through this method of farming, crops are grown vertically in stacked layers. This represents a segmented form of farming that can be incorporated into any building. It is managed indoors with a controlled environment for agriculture. Vertical farming can provide a larger amount of food compared to regular farming. Since it does not require pesticides and fungicides, the harvest is healthier. These indoor farms use about 90% less water than outdoor farming (source: <https://ledibond.com/vertical-farming-vs-traditional-farming/>).
- c) **Hydroponics and Aquaponics:** Hydroponics is a soilless cultivation method of plants, while aquaponics involves the cultivation of fish. They are regarded as sustainable alternatives to conventional farming methods. Since these techniques occur in controlled environments, higher yields are expected compared to traditional commercial farming. While this type of harvest is limited to a certain segment of crops, the yield is not season-bound.



- d) **Agricultural Drones:** Investigating crop health on a large scale has been made possible by drone technology. Drone surveillance can be utilized to acquire multispectral data of growing crops in the field. Gathering information about thermal conditions, accurately determining the requirement for pesticides, and identifying different types of crop diseases enable targeted interventions. The use of this technology mitigates waste or loss of growing crops, thus ensuring food security.

- e) **Genetic Engineering:** The use of modern biotechnology to modify genetic characteristics has proven to be a promising technique in modernizing agriculture. Through this practice, crops with novel traits are produced due to altered genomes. This manipulation is advantageous in terms of enhanced harvest, reduced production costs, increased food and drug production, nutrient-rich crops, decreased use of pesticides, and immunity against pests and insects. Additionally, it contributes to the medical well-being of the expanding human population.

Food Security requires measures to minimize the Food Harvest Loss

The farm yield, once sheltered with various modern farming techniques, may still face the threat of being lost during its journey from farm to table. These losses, known as post-harvest losses, occur when crops, even after reaching maturity, do not reach the market in their entirety. Such losses are a significant blow to the livelihood and food security of small-scale farmers. In addition to the introduction of modern technology for preserving the natural ecosystem, habitat, and farmlands, measures to protect the post-harvest collection of grains are mandatory to design and practice globally.

A report published by WWF in 2021 showed that around 1.2 billion tons of food produced globally is wasted before leaving the farms. According to this report, this problem is generally overlooked in many industrial regions, including advanced countries equipped with modern farming techniques for enhanced output. The report also mentioned that such food wastage also accounts for greenhouse gas emissions, contributing to approximately 8% to 10% of total emissions (source: <https://www.wwf.eu/?4049841/fifteen-per-cent-of-food-is-lost-before-leaving-the-farm-WWF-report>).

Here are some measures that can be taken to prevent post-harvest losses, both in general and in less developed regions in particular:

- a) **Accessing Finance:** Due to the lack of dedicated infrastructure for post-harvest facilities, small-scale farmers are unable to manage the bulk of their farm production. Access to finance for such infrastructure will enable them to establish facilities and acquire equipment like collecting and packing houses and threshers, which may eventually reduce food loss and ensure a significant supply of harvest to the markets.
- b) **Linking Farmers to Markets:** Farmers would be more inclined to control food losses if they have access to easy marketplaces for their yield. Providing farmers with more opportunities to profit from their products will encourage them to invest in improving



infrastructure for food security. A system of steady linkage between farmers and grain markets is necessary to secure crop output for the growing population.

- c) **Installing and Upgrading Grain Drying Equipment:** Inadequate drying of grains before storage is one of the causes of crop yield loss. Properly dried cereals maintain their enzymes and nutritional elements and prevent fermentation and the development of toxins. Educating farmers to use modern drying equipment can shift conventional practices to improved patterns, which will help maintain food supply more efficiently.
- d) **Advancing Storage Facilities for Grains:** Improper storage facilities leave the farm's harvest vulnerable to insect infestation, rodent damage, and microbial infections. These intruders can damage a significant amount of grains. Using improved on-farm storage technology like hermetic bags and metal drums can safeguard the farm output and ensure that healthy grains reach the market.

In addition to the measures mentioned, strengthening transport services for remote rural areas, providing training to farmers, establishing commercial storage houses, and keeping track of crop production statistics while continuously devising innovative policies can aid in securing food supply and controlling post-harvest food losses.

In conclusion, all the efforts required in any of these sectors demand responsibility and considerate behavior from all stakeholders. Educating and spreading awareness about the profound values of the natural ecosystem and habitat is the foremost step that must be taken at a societal level where food security should be a concern for every individual benefiting from the yield of this planet.

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