

Review Article

Integrating Environmental Health and Food Security: The Agronomist's Role in Advancing Sustainable Agriculture and Achieving UN Sustainable Development Goals

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Abstract

The review explores the intricate relationship between agricultural practices, climate change, and the United Nations Sustainable Development Goals (SDGs), particularly focusing on SDG 2: Zero Hunger. It highlights the profound impact of climatic variations on crop yields, increased frequency of extreme weather events, and the proliferation of pests and diseases, all contributing to reduced agricultural productivity. This poses significant challenges to achieving the SDGs of eradicating hunger and poverty. Smallholder farmers have adopted various adaptive measures, such as adjusting farming operations, on-farm diversification, and improved soil-water management. However, industrial agriculture, while successful in increasing calorie production, has led to biodiversity loss, soil degradation, and greenhouse gas emissions, thus failing to eliminate hunger and leading to widespread micronutrient deficiencies. Approximately 815 million people are currently undernourished, with two billion suffering from micronutrient deficiencies. The paper emphasizes the necessity for sustainable agricultural practices that enhance productivity while protecting ecosystems. Key strategies include improving irrigation, adopting integrated weed management, using precision agriculture, and reducing post-harvest losses. The review underscores the importance of policy interventions and innovative technologies in addressing the global food security challenge. Effective food security strategies must incorporate sustainable production practices, leverage genetic diversity, and ensure economic and physical access to nutritious food. Addressing food security within the framework of SDGs requires a holistic approach that integrates environmental sustainability, economic development, and social inclusion. Collaborative efforts between governments, scientists, and local communities are vital to achieving a sustainable and food-secure future.

Keywords

Sustainable Agriculture, UN SDGS, Food Security, Climate Change, Zero Hunger, Agricultural Productivity, Integrated Weed Management, Precision Agriculture

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1. Introduction

Climate has a significant impact on agriculture rising temperatures have most adverse effects on crops yield [1]. Extreme weather events are expected to occur more frequently as a result of prolonged shifts in the climate [2] can start and change when outbreaks of pests and diseases occur [3] decreases the efficiency of water and utilization of nutrients [4]. It makes yield fluctuation more [5]. These repercussions would further restrict agricultural production and endanger global attempts to end hunger and starvation, two of the United Nations' seventeen Sustainable Development Goals (SDGs) [6, 7]. Plans for adaptation have been started in response to the effects of climate change. Farmers have been using a variety of adaption plans and tactics in the agriculture sector. The scheduling of farm activities, on-farm diversification, and soil-water executive management through enhanced irrigation, less tillage, etc. are some of the major agricultural adaptations practiced by small-scale farmers worldwide [8]. The General Assembly of the United Nations (GA) recognized the "Zero Hunger" goals of the Sustainable Development Goal in 2015, expressing worries about how sustainable the world's food systems are. By include targets on sustainable agriculture in the larger effort to eradicate hunger, the Zero Hunger goal represents a long-overdue awareness that industrial agriculture affects critical ecosystem processes that are necessary for the supply of food [9]. These well-established effects include eutrophication and aquatic environmental damage, soil erosion, loss of soil organic matter, increased pest pressure, diminished biodiversity, and the production of greenhouse gases [10]. The U.N. Food and Agricultural Organization of the United Nations only recently altered the term "food security" to "food and nutrition security," indicating a rise in micronutrient deficiencies, even if the globe is awash with "calories." Currently, up to two billion people are struggling with a lack of micro nutrients, and 815 million individuals are undernourished [11]. The Sustainable Development Goals (SDGs), which were adopted as part of the United Nations (UN) Agenda for 2030, consist of 17 objectives and 169 targets that provide a path toward a more ecologically friendly world for future generations. The Sustainable Development Goals, or SDGs, are intend to bring down global poverty in order to solve the concerns of sustainability, disparity, and hunger; manage environmental degradation and climate change; and lessen risk management during extreme weather events. Every action performed toward one of the 17 objectives has an impact on the advancement of the others, and they are all interrelated. With this editorial, the magazine "Environmental Sustainability" is starting a series that will deal with those objectives that are directly related to sustainability and the environment in order

to provide insight into the current state of the SDGs. Climate has a significant impact on agriculture; numerous studies show that most crop yields are adversely affected by temperature increases. The purpose of the attached document is to summarize how climate change affects agriculture and food security, particularly focusing on SDG 2: Zero Hunger. It explores adaptive measures adopted by smallholder farmers and critiques the consequences of industrial agriculture. By addressing research gaps, the review proposes sustainable agricultural practices to enhance productivity while protecting ecosystems, offering policy recommendations to achieve global food security goals.

2. Achieving SDG 2: The Path to Zero Hunger Through Sustainable Agriculture and Development Goals

In order to attain social, environmental, and financial stability, the United Nations (UN) has embraced the idea of SD, or environmentally friendly growth "To fulfill the needs of this generation without damaging one power of future generations to continue to provide for their own needs and a fair division of the environmental effects and advantages of GDP growth between and within countries" is the main goal of SD [12]. The United Nations General Assembly issued a resolution in the form of the Millennium Declaration calling on leaders worldwide to figure ht against poverty, hunger, destruction of the environment, and prejudice directed at women, A/RES/55/2). So as to fulfill these pledges, the UN developed the Millennium Development Goals (MDGs), which set targets to be met by 2015. But development was uneven and limited to countries [13]. With the goal to sustain the momentum created by the MDGs and further direct the worldwide SD framework, participating nations agreed the UN Sustainable Development Goals (SDGs) in 2015. The 2030 Agenda included a 15-year strategy to accomplish the Global 17 Sustainable Development Goals (The General Assembly adopted this Resolution on 25 September 2015). With one of the strongest economies in the globe, the USA is also at the forefront of technical advancements, especially in the domains of computers, medicine, pharmaceuticals, airplanes, and military gear [14]. With little leverage and little funding risk, the banking industry also seems to be robust. However, the USA got a "red" grade, which denotes a 25% performance, which is well below the 100% achievement for six of the seventeen Sustainable Development goals [15].



Figure 1. Sustainable Development Goals Index Dashboard for the USA [16].

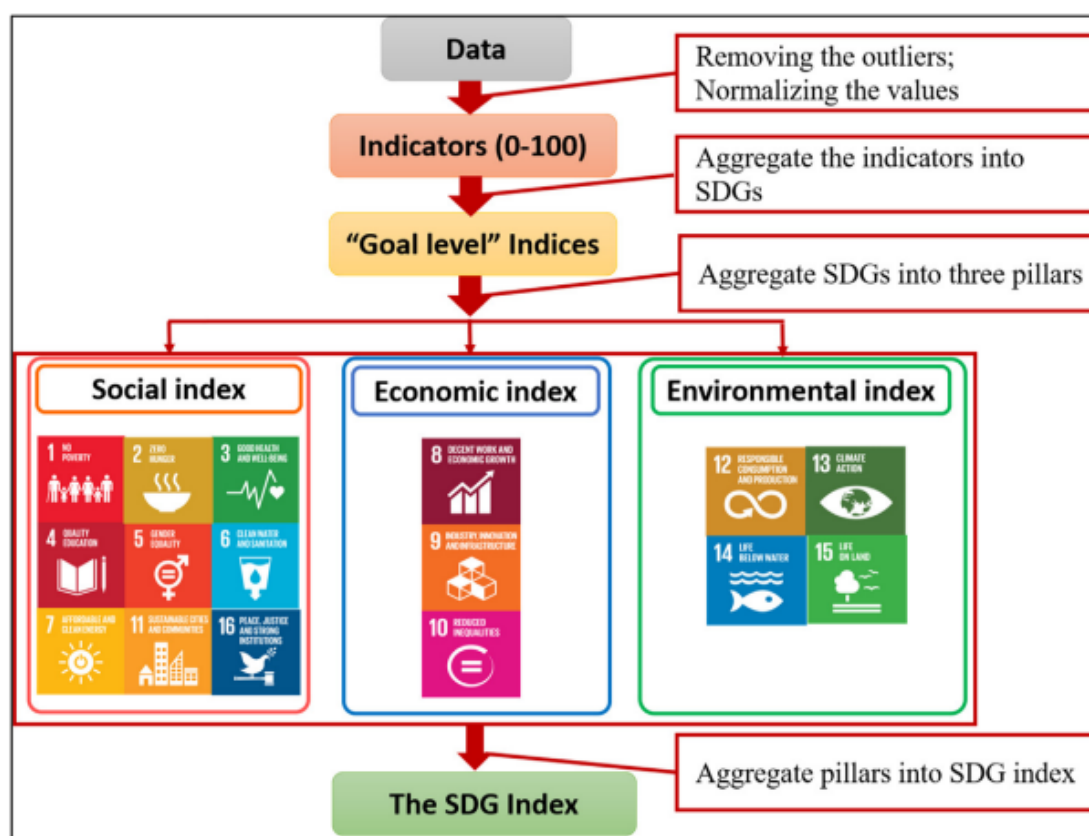


Figure 2. Methodological Framework for Aggregating SDG Indicators into Composite Indices [15, 22, 23].

The USA did not score green (meeting 75–100% of the objectives) for any of the SDGs, despite the fact that the majority of the goals place a significant value on poverty, expanding sustenance, and access to basic services and infra-

structure (SDGs 1–9). In addition to increasing GDP, other economic goals including wealth distribution, innovation, and infrastructure are also crucial for achieving SD. The USA trailed behind on SDGs 8 and 10, but exceeded 50% on SDG 9

[16]. Subnational governments are essential to attaining the SDGs, even though national governments have embraced them. The states have a great deal of power in a federal system. There is a written constitution for every state. Additionally, any power not expressly granted to the federal government by the Tenth Amendment of the United States Constitution remains with the states and the people Constitution. Local governments are established by each state to help it carry out its constitutional duties. In addition to keeping crucial data and enforcing the law, local governments frequently offer local services. As they incorporate the SDGs into the current planning procedures, fill in information and connection gaps caused by administrations, and take the lead in recognizing and meeting local necessities for long-term, significant change, cities all around the globe are learning from one another [17]. Lynch et al. (2019) shown that whether examining cities in the USA of similar dimensions or geographically situated or when comparing findings from the city, state, and global SDG indices, localization is crucial. The practice of taking into account subnational settings in order to accomplish the 2030 Agenda is known as localization. Localization is related to [18]. The most intriguing transnational the venture on the route to SD is the SDGs [19]. The amalgamation of SD components into a three-pillared approach to human well-being that integrates the economy (economic development), society (social inclusion), and environment (environmental sustainability) is the clever and creative message conveyed by the SDGs (UN General Assembly, 2015) environmental, social interactions, and monetary variables or objectives. Three interconnected "pillars" have been employed in the SD three-pillars model [20], "dimensions" [21], "aspects," etc. According to the three-pillar paradigm, SD necessitates a seamless execution of all three pillars.

3. Objectives and Targets of SDG 2: Achieving Food Security and Sustainable Agriculture

"End hunger, secure food insecurity and promote sustenance and promote sustainable agriculture" is the UN (2015) definition of SDG2, a wide goal that includes both sustainable production and food security. Five outcome goals are covered by this aim (Figure 2). There are inherent conflicts and difficulties with this goal.

The primary SDG relationships—which are mostly helpful or in trade-off—are shown by colored arrows. Studies with fewer relationships are indicated through light hues or dashed arrows. Grey text (\$X.X) contains references to specific components of the article that discuss the different targets/goals and how they interact. The five result objectives that make up SDG2 "Zero hunger" may be summed up as follows: 2.1: eliminating hunger and guaranteeing access to enough food that is safe, nourishing, and sufficient, 2.2: eliminating all types of malnutrition, 2.3: increasing

small-scale food producers' revenue and agricultural production by double, 2.4: preserving the genetic variety of farm assets, and 2.5: making sure food production systems are robust and sustainable. The three "mean of implementation" goals established to assist in achieving the aforementioned results are not shown here: 2.a: boosting rural development and agricultural investment; 2.b: avoiding trade barriers and market distortions; and 2.c: improving interaction for the smooth operation of the agricultural market [24].

Food safety and nutrition (FSN) is based on the four pillars of availability, access, utilization, and consistency [25], which governs and was built around the acknowledgment of human rights to appropriate food. This concept is directly tied to the first couple of goals. Achieving SDG 2 requires an understanding of these challenges, particularly Targets 2.1 and 2.2 on malnutrition and a sustainable supply of food. The cost of wholesome meals is a challenge since the food security pillars demonstrate the need of producing enough food ("availability") as well as the consequences of income and food costs ("access" pillar). In addition, the diversification of food sources ("consumption" pillar) comes into contact on malnutrition. The scope of SDG 2 is expanded to include agricultural production methods through Targets 2.3, 2.4, and 2.5. In order to achieve SDG1 ("No poverty"), Target 2.3 places a high priority on small-scale farmers' agricultural income through an increase in farm production. However, this goal should be accomplished without endangering Target 2.5 stresses the value of maintaining genetic variety, whereas Target 2.4 stresses sustainable production methods.

3.1. Addressing Global Food Demand: Ensuring Adequate Food and Reducing Hunger (Target 2.1)

There has long been concern about the ability of humanity to generate sufficient food for its own internal sustenance. The Club of Rome report highlighted the difficulties of continuous economic expansion in a finite planet, while [26] questioned the viability of a continuing population rise [27]. According to current UN estimates, there is expected to be an estimated 9.7 billion individuals on the planet in 2050 (up 25% from 2020), with roughly twice as many people living in Africa. Additionally, additional factors including urbanization, globalization, dietary changes, and changes in the economy will increase food consumption even more [28]. Due to the requirement to produce feedstuffs for expanding animal consumption, the FAO projects that between 2015 and 2050, the overall food calorie demand would rise by 39% [25, 29]. At the same time, agricultural yield will grow more rapidly (40–45%) [30, 31]. With other assumptions about the need for animal products, some writers predict even larger demand by the middle of the century. For example, [32] predict that agricultural demands would grow by 50% by 2050, while [33] predict that food demand will increase by 30%. When comparing estimates from several global model forecasts, [34]

discovered that the rise in food demand from 2015 to 2050 ranged from +43% to 70%, which is somewhat higher than FAO estimates. Even while the models examined differed in their predictions for the future, the majority predicted a far greater rise in the consumption of animal products by 2050,

ranging from 45% to 160%, which is significantly higher than the FAO's projected increase of 55%. Additional empirical estimations [35] with 64–95%, [36] with 81%–102%, and [37, 38] with 76% also corroborate this expectation.

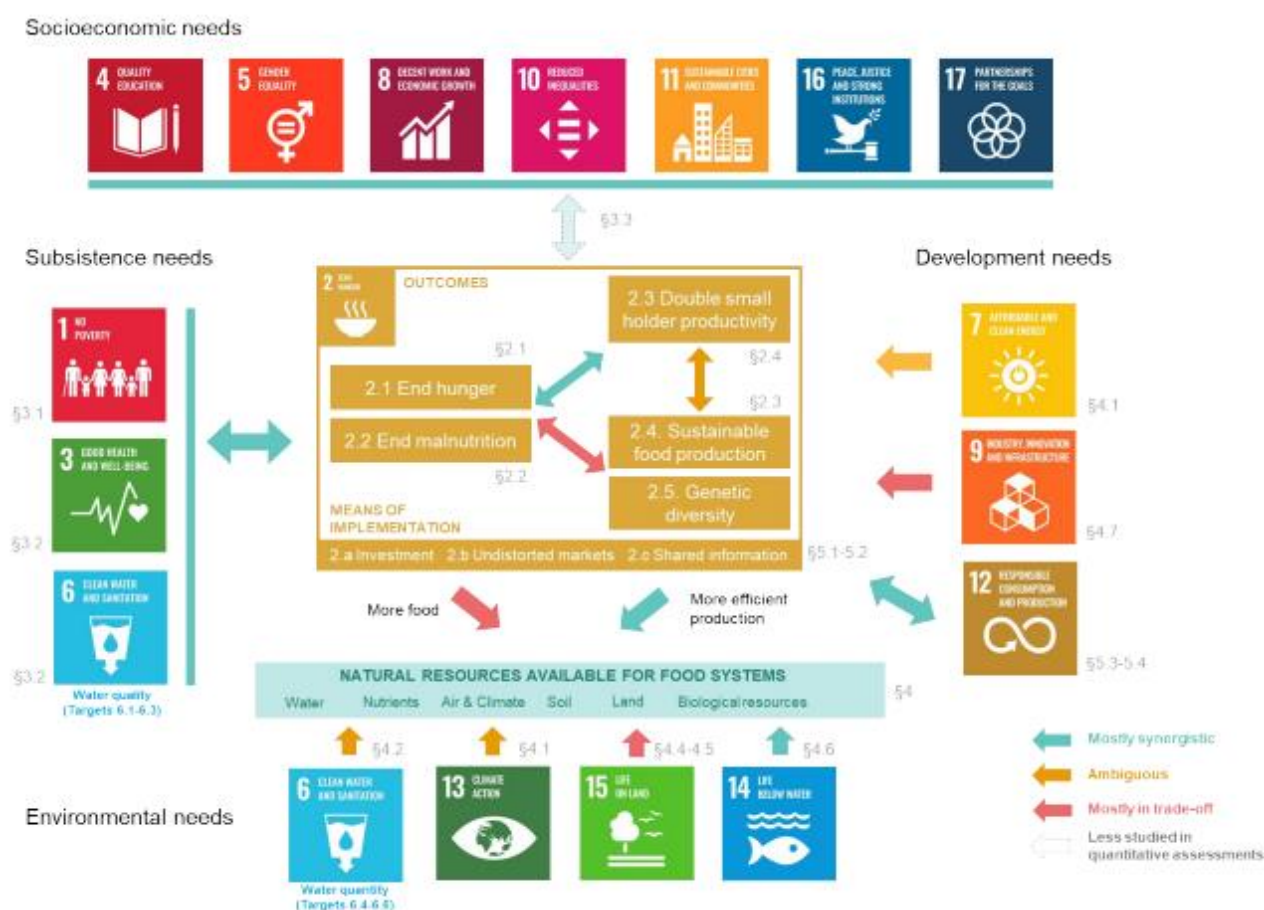


Figure 3. This study examines the goals of SDG 2 and how it relates to other SDGs.

3.2. Navigating Nutrition: Addressing Dietary Needs, Nutrition Transition, and Malnutrition Challenges (Target 2.2)

Just as important as the quantity that we eat is what we eat in order to maintain food security. For this reason and others, the "utilization" centerpiece is fundamental for food security. Animal husbandry provides a useful illustration of many of the challenges associated with economic expansion. As with other goods, the nutrition shift affects our need for nutrients like fat and protein [37]. However, increasing animal production has significant sustainability consequences and is resource-intensive [39]. A third of marine catches are unsustainable [40], and the rapid growth of aquaculture increases resource pressure and causes local pollution [41, 42]. However, eating seafood also offers high-value nutrients [43].

Because of their yield and place of production, several other food items have extremely unique footprints, and trading can have an influence [44, 45]. Therefore, dietary choices can have a significant impact on both the environment and human health [46, 47]. As part of the synergies with SDG3, we go into further detail in Section 3.2 about the health implications of the various nutritional issues linked to food choices.

3.3. Balancing Increased Food Production with Environmental Sustainability (Target 2.4)

As previously said, increasing food production will be necessary to meet nutritional demands and eradicate malnutrition, which might present significant concerns to the food systems and environmental sustainability. Researchers have cautioned about the hazards of breaking certain planetary boundaries [9] as a result of agriculture's development and intensification. The effects of increased agricultural output on

natural resources are well documented [48, 49]. Therefore, Target 2.4, which highlights the need for sustainable food production systems, improved agricultural methods, and en-

vironment conservation, may conflict with Targets 2.1 and 2.2, which are focused on providing more adequate food and nutrition.

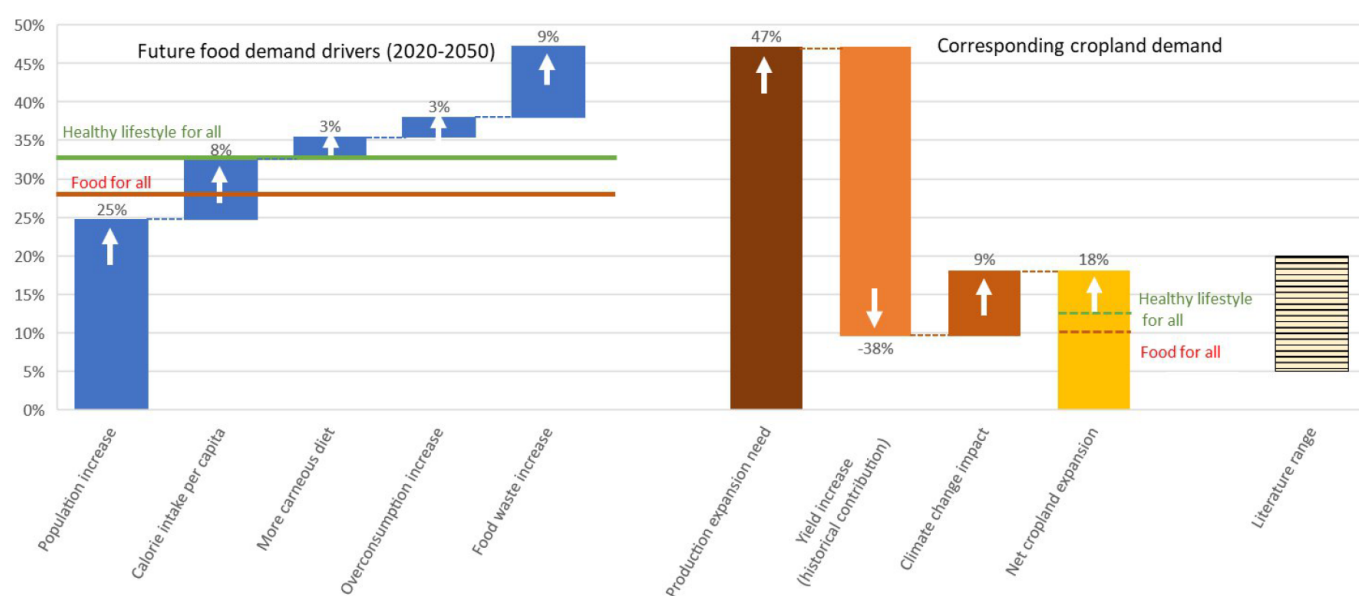


Figure 4. Future food demand breakdown from 2020 to 2050 (yellow bars on the left) and possible agricultural expansion consequences based on stylized assumptions (warm hues on the right).

Population expansion, rising calorie intake per capita due to economic growth, changes in dietary preferences that result in increased consumption of meat and feed, overconsumption, and waste all play a part in the higher overall consumption for food (sum of blue bars = 47%). The final demand increase (brown bar) was barely alleviated by the increase in yields (here based on an average 80% contribution share to match historical data, orange) and the predicted future impact of climate change (dark orange). The literature ranges (striped bar) can be compared to the net farmland growth (yellow). The blue (yellow) bar's "food for all" line represents the amount of food (land) that has increased to provide enough calories for everyone. Every customer who previously had an inactive lifestyle now leads a moderately active lifestyle, which is in keeping with the healthy lifestyle line. Sources: UN DESA population growth; the impact of livestock consumption and per capita consumption [50, 51], based on the GLOBIOM model; Impacts of waste and overconsumption [37]; impact of climate change: RCP8.5 data from [52]. The spectrum of literature includes Smith et al. and Stehfest et al. [51, 53].

3.4. Enhancing Agricultural Productivity for Sustainable Food Security (Targets 2.3 & 2.5)

The assumption that technological advancement might minimize effects on natural resources and keep up with future

increases in food demand is the basis for the majority of conventional arguments against a Malthusian future [54, 55]. Agricultural productivity has increased significantly in the past, shifting from an era of global productivity gains during the Green Revolution that relied on inputs and machines to one that has focused on knowledge during the last three decades [56]. As more and more inventions and new technologies appear, there is still room for productivity to grow [57]. And since they may boost income and give lower food costs, productivity increases will be essential for future food security [38, 58], as long as they also assist small producers and net food sellers (see also Section 5.2 on the importance of trade). Thus, SDG target 2.3, which emphasizes smallholders' production and income, seems to be completely in line with SDG 2's goals for food security.

4. The Critical Role of Agronomists and Weedicides in Mitigating Climate Impact on Food Security

Because of human activities related to food manufacturing, transportation, and consumption, the climate of the globe is changing and other major environmental changes are taking place locally and globally. These changes in the natural environment include those that affect freshwater supply, plant and animal life, land cover and soils, and the carbon and nitrogen cycles [59]. While certain regions of the world, par-

ticularly those in northern latitudes above about 558, may benefit from climate change, there is growing fear that these changes, particularly those related to climate, may make it more difficult for people in the developing countries to achieve food security. This is because the negative effects on agriculture, especially in tropical and sub-tropical nations, are often anticipated. [60, 61]. Three primary causes are as follows: First, it is predicted that substantial changes in rainfall and temperature would affect many regions of the developing world. For example, climate assessments for Southern Africa predict that the region will become drier and warmer [62]; the IPCC (2001) predicts that temperatures will rise by 2 to 5.8°C over the next few decades, and the region will experience more variable rainfall, making it generally drier, particularly in the east [63]. It is also projected that severe occurrences (such as droughts and floods) would occur more frequently and with greater severity [64-66]. Second, because of their high rates of poverty, geographic exposure, and frequently significant reliance on agriculture and ecosystems, emerging economies are more vulnerable to the direct effects of climate change [60]. Third, agriculture is the main source of food for a large number of people in the developing countries, and a decline in agricultural productivity will have an influence on crop output and, consequently, the local food supply as a whole.

4.1. Strategies for Increasing Crop Yields: Challenges and Innovations

There are a number of strategies to raise dietary intake per person, notably extending agricultural acreage, increasing crop yields through the use of agrochemicals, organic fertilizers, biological controls, and improved soil and water management. Furthermore, it might be advantageous to promote the use of pest- and disease-resistant genetically modified organisms, or GMOs, as well as to use higher-performing plants including pest-resistant plant varieties.

In all these initial responses, some worldwide experience has already been acquired. Some of the findings are controversial, but others might be encouraging. It doesn't seem like a

straightforward task to increase the area of agricultural land. In reality, there is currently a decrease in the amount of agricultural land (hectares per person) in every region of the world. For example, in Latin America and the Caribbean, this surface will decrease from 0.40 ha/inh in 1990 to 0.32 ha/inh in 2010; in North Africa and the Middle East, it will decrease between 0.28 to 0.18 ha/inh in the same future frame; and in South Asia, it will decrease from 0.22 to 0.16 ha/inh [69].

Population expansion is somewhat to blame, but soil erosion, fertility decline, salinization, and desertification are other contributing factors to the net reduction in agricultural land. Forest areas, many of which were designated as ecological reserves and natural parks, had to be sacrificed in order to find new territory [69]. The lack of water is another significant issue. In Africa, the Middle East, Asia, and almost everywhere else, there is a shortage of water for agriculture in addition to drinking water. It should be remembered that 50,000 liters of water are needed to create 100 kilograms of wheat, and 200,000 liters are required to generate 100 kilograms of rice. Everywhere, the amount of water available per person is declining, and many nations are now utilizing "fossil" water—which is drawn out of deep water reserves that will run out in 20 to 30 years—for agriculture [70]. Many areas require improved water resource management, and using plant kinds more suited to local climates will improve water usage efficiency. Currently, a more intense use of agrochemicals is likely the fastest response to the need to increase food production. Chemical fertilizers and insecticides are two major categories of substances that are classified as agrochemicals. The massive increase in the use of chemical fertilizers that has taken place worldwide since the 1960s experienced an important contributor in the so-called "green revolution." This is a massive increase in output from the same area of land because of extensive irrigation and fertilizers derived from minerals (potassium, phosphorus, and nitrogen). The commercial cultivation of rice, corn, and wheat has been an internationally acclaimed story [71, 72]. The development of more productive cereal grains such as wheat and rice (dwarf wheat) cultivars also contributed to this revolution.

Food emergencies and their causes, 2003-2004

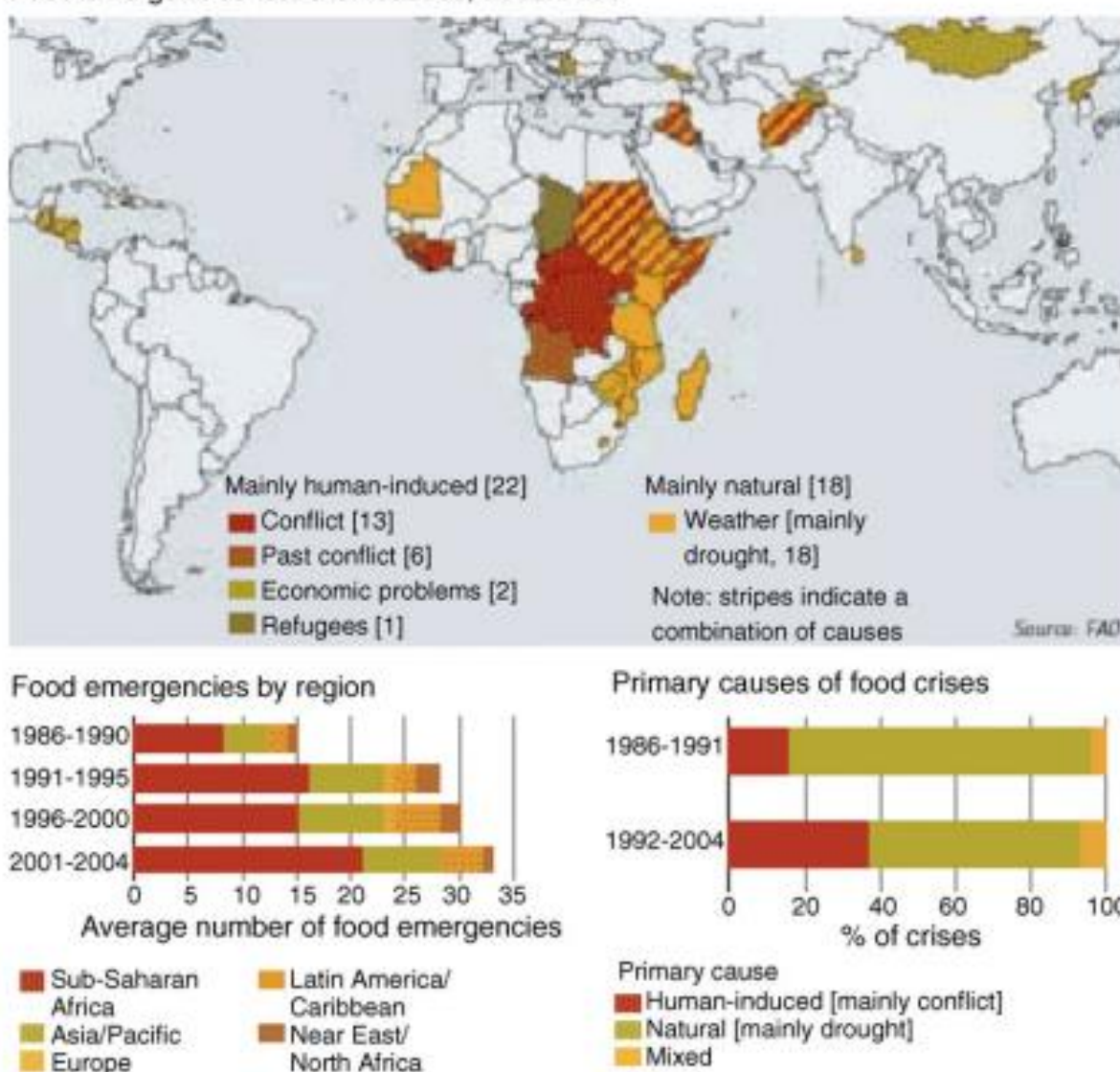


Figure 5. Regions of the world with food emergencies in last years and their causes [67, 68].

4.2 Advancing Sustainable Agricultural Practices in the Cropping System

The greatest agricultural production system, the system of farming with rice and wheat (RWCS), encompasses around 14 million hectares in the southern portion of the In-

do-Gangetic Plains (IGP) [73]. Even if RWCS is essential to guaranteeing the food security and livelihood of millions in the southern Asians in the future [74], Turning down the condition of the earth has impacted the route to success [75], Resources associated with groundwater [76], Cereal-cereal system the term monoculture and rising variations in the climate [77], and shifting socioeconomic conditions [78].

Table 1. Overview of Tillage Methods and Crop Establishment Techniques in the Rice-Wheat-Greengram Rotation (2015-2019) [79-81].

Parameter	Crop	BPT5204 (CV1)	LPTA (CV2)	CV3S1 (CV3)	ZTWS (ZT4)	ZTMS (ZT5)	MS (ZT6)	CTWS (CT4)	CTMS (CT5)
Village		Cultivator 2 passes, tilly village (V1)	Cultivator 1 pass (next village V2)	Zero till	Zero till before transplanting	Cultivator 2 passes + Rotavator 1 pass	Zero till	Cultivator 2 passes	Zero till

Parameter	Crop	BPT5204 (CV1)	LPTA (CV2)	CV3S1 (CV3)	ZTWS (ZT4)	ZTMS (ZT5)	MS (ZT6)	CTWS (CT4)	CTMS (CT5)
Crop establishment	Rice	Manual	Manual	Manual	Manual	Manual	Manual	Manual	Manual
	Wheat	Drill sowing	Drill sowing	Drill sowing	Drill sowing	Drill sowing	Drill sowing	Drill sowing	Drill sowing
	Greengram	~10% missed	~10% missed	~10% missed	Line sowing (Happy Seeder)	Line sowing (Happy Seeder)	100% in interrow	~10% missed	~10% missed
	Rice	Manual	Manual	Manual	Manual	Manual	Manual	Manual	Manual
	Sowing age	25 days	25 days	25 days	18 days	13 days	25–30 cm row spacing	25–30 cm row spacing	25–30 cm row spacing
	Wheat	Drill sowing	Drill sowing	Drill sowing	Drill sowing	Drill sowing	Drill sowing	Drill sowing	Drill sowing
	Greengram	~10% missed	~10% missed	~10% missed	~10% missed	~10% missed	100% in interrow	~10% missed	~10% missed
	Residue management	–	–	–	–	–	–	–	–
Residue management	Wheat	Retained	Retained	Retained	Retained	Retained	Retained	Retained	Retained
	Greengram	Retained	Retained	Retained	Retained	Retained	Retained	Retained	Retained

4.3. Minimizing Post-harvest Losses: A Critical Step in Food Security

Following harvest, the loss is the decrease in the quantity and quality of food produced by food production to be consumed. Quality losses affect the merchandise's acceptability, edible qualities, and nutritional/caloric content. According to Kader (2002) [82], these losses are frequently more common in developed countries. A merchandise's quantity can drop as a result of quantity losses. Qualitative loss is more probably to occur in economies that are developing [83]. A recent FAO study found that while food loss and waste are more common in the succeeding phases of the food chain in countries with higher incomes, they are more common in the beginning phases in low-income areas [84]. United States of America: US\$48.3 billion (€32.5 billion) is spent annually on the disposal of 30% of all food consumed in the US. About fifty percent the water required to produce this food is thought to be wasted as well, since agriculture is the human activity that uses the most water varying factors in the industry, farm-level losses are frequently within 15 and 35 percent. Interestingly, the retail industry as a whole has very high loss rates of about 26%, but retailers only suffer losses of

about 1%. Each year, losses range from US\$90 billion to US\$100 billion [85].

4.4. Best Practices for Using Weedicides in Sustainable Agriculture

CA has a major impact on population growth of weeds as well as thus, weed control. Tillage affects weeds through variations such weed cutting, burying, uprooting, and dislodgement, along with disrupting the soil environment and affecting weed germination, emergence, when maintenance by either promoting or hindering their movement [86]. Depending on the tillage method, the breakdown of invasive species vegetation changes, thus we need to employ different management techniques. For instance, small-seeded weeds proliferate under CA and need particular care [87, 88]. The reduction of tillage might contribute to severe challenges with weed infestations [89]. An important barrier to weed control underneath CA is an evolution in weed dissemination by plants and animals and density, which could lead to decreased agricultural production [90]. The cultivation of land arrangements clearly effects on spray of herbicide deposits at banks, weed their density, and weed dispersion (Table 1).

Table 2. Weed Dynamics under Different Tillage Regimes [86].

Tillage System	Weeds Presence	Remarks	Other Details
	Above ground	Seed bank	Above ground + seed bank
Moldboard plough	<i>Amaranthus</i> spp., <i>Capsella bursa-pastoris</i> , <i>Setaria viridis</i> , <i>Chenopodium album</i> , <i>Digitaria ischaemum</i> , <i>Ambrosia artemisiifolia</i>	<i>Amaranthus retroflexus</i> , <i>Chenopodium album</i> , <i>Plantago major</i>	<i>Amaranthus theophrasti</i> , <i>Chenopodium album</i> , <i>Setaria</i> spp., <i>Digitaria ischaemum</i> , <i>Ambrosia artemisiifolia</i>
Chisel plough	<i>Amaranthus retroflexus</i> , <i>Capsella bursa-pastoris</i> , <i>Setaria viridis</i> , <i>Chenopodium album</i> , <i>Digitaria ischaemum</i> , <i>Ambrosia artemisiifolia</i>	<i>Plantago lanceolata</i> , <i>Polygonum lapathifolium</i>	<i>Amaranthus theophrasti</i> , <i>Chenopodium album</i> , <i>Ambrosia artemisiifolia</i>
Ridge till	<i>Amaranthus retroflexus</i> , <i>Physalis heterophylla</i> , <i>Capsella bursa-pastoris</i> , <i>Setaria viridis</i> , <i>Chenopodium album</i> , <i>Digitaria ischaemum</i> , <i>Ambrosia artemisiifolia</i>	<i>Plantago lanceolata</i> , <i>Polygonum lapathifolium</i>	<i>Amaranthus theophrasti</i> , <i>Chenopodium album</i> , <i>Ambrosia artemisiifolia</i>
No till	<i>Amaranthus retroflexus</i> , <i>Physalis heterophylla</i> , <i>Capsella bursa-pastoris</i> , <i>Setaria viridis</i> , <i>Chenopodium album</i> , <i>Digitaria ischaemum</i> , <i>Ambrosia artemisiifolia</i> , <i>Taraxacum officinale</i> , <i>Elymus repens</i> , <i>Solanum nigrum</i>	<i>Alopecurus myosuroides</i> , <i>Chenopodium album</i> , <i>Setaria viridis</i>	<i>Chenopodium album</i> , <i>Setaria viridis</i>

Newly formed weed seeds that remain on or close to the soil surface may be encouraged to germinate and emerge by CA. Furthermore, the effectiveness of herbicides may be hampered by the additional residues that are handled on the ground in California. It is challenging to control perennial, upright, or creeping weeds under CA because they generate vegetative reproductive elements such rhizomes and tubers [91]. The timing of weed seed germination and emergence varies throughout crop growth, which can lead to issues when choosing when to apply herbicides or other management techniques [92].

There have been conflicting reports of the change in weed

species in the past. Wrucke and Arnold (1985) [93] countered this pattern by pointing out that the spread of broadleaved weeds showed a similar trend under conservation tillage and regular tillage systems, despite [94] reporting an increase in dicot species under no till. After studying a variety of weeds, [95] came to the conclusion that there was no appropriate and consistent trend of various weeds with reduced tillage. Distinct tillage regimes have distinct effects on the establishment of annual and perennial weeds, and there are notable differences in the vigor of various weed species (Table 2).

Table 3. Effect of Tillage Systems on Weed Density and Biomass [96].

Tillage system	Weed density (m ²)							
All weeds	Annual	<i>Chenopodium album</i>	<i>Echinochloa colona</i>	<i>Cucumis prophetarum</i>	Perennial	<i>Cynodon dactylon</i>	<i>Cyperus rotundus</i>	Fresh wt. (kg m ²)
No till	17	62 ab	18	86 a	117 a	300 a	1.37 a	0.27 b
Reduced till	17	83 a	9	33 b	69 b	211 b	0.97 b	0.22 b
Deep till	20	44 b	6	35 b	101 ab	206 b	0.84 b	0.21 b

4.5. Effective Strategies for Integrated Weed Management (IWM)

A crop's health hinges on its successful execution, and integrated weed management (IWM) is a management strategy that focuses on raising consciousness regarding this. They see it as the result of multiple weed control components interacting with one another [97]. The practice of utilizing every technology at your disposal to ecologically friendly practices control weeds from fields while coordinating the use of important and little information about the environment, ecology, and biology of weeds is known as integrated weed management, or IWM. The methodology of deciding matters, weed biology and ecology, integrated weed management (IWM) components commonly used to agricultural patterns, pesticide susceptibility level, transgenic plant ecological difficulties, and weed welfare are the main areas of research on IWM [98]. Gathering environmental data and studying the environmental factors and the natural world of weeds while utilizing all available technology for manipulating them is known as integrated weed suppression, or IWM [99]. Reason why farmers are hesitant to replace herbicides with non-chemical weed management techniques.

1. The "inconvenience" factor generally more challenging and time-consuming to overcome.
2. More money to spend, particularly if there is no decline in the consumption of herbicides.
3. Dangerous; compared to herbicides, control levels are inconsistent and more unpredictable.
4. Herbicides are better at killing plants.
5. More costly than herbicides compared to the degree of control attained.
6. Rising demand for labor; consequences for affordability and pricing.
7. Inadequately supplied or undertrained staff.
8. There isn't much obvious proof of instant success.
9. Not wanting to make the suggestion since it is risky for utilized for agriculture agronomists and consultants.
10. Reluctance to provide suggestions since herbicide the provider returns are lower.
11. No reimbursement after a monitoring breakdown (herbicides are more prone to cause this).
12. May negatively impact the ecosystem (e.g., the breakdown of soil following extensive cultivations).
13. Greater workout than spraying (e.g., rucksack spritzer versus hoe).
14. Temporary goals; unwillingness to dedicate oneself to goals for the future.
15. Indulgence: the conviction that current issues will be accomplished by new herbicides.
16. Reliance on excellent climate conditions (e.g. for prolonged cultivation or a substitute crops).

[100-105].

5. Advancing Agriculture Through Precision Application

The principle of site-specific management (SSM) is to act appropriately at the appropriate time and location. Although this concept is as antique as agriculture itself, there was significant economic impetus to apply consistent agricultural methods to big fields throughout the 20th century's agricultural mechanization. SSM is now feasible in commercial agriculture thanks to precision farming, which offers a means of automating it with information technology. PA encompasses all agricultural production methods that use information technology, such as yield monitors, remote sensing, and variable rate application (VRA), to either monitor or customize input use to achieve the expected outcomes [106].

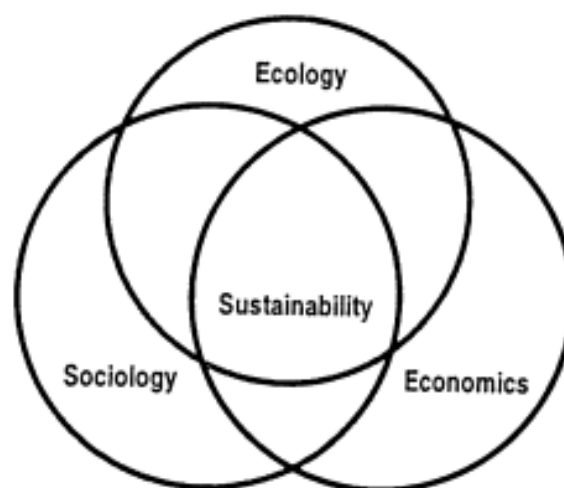


Figure 6. Sustainability as described by the intersection of three disciplines: ecology, economics and sociology.

Define SSM as “the Inputs for agricultural production are allocated in time and space using technological surveillance and oversight applied to the gathering of data, information processing, and decision support” [107]. They point out that although agronomic crops are the main emphasis, the reasoning also apply to horticultural crops and animals subject to electronic tagging. Input management for temporal SSM must be based on knowledge of the life cycles of agricultural products, livestock, or pests. The term growth phase (DS) information is frequently used to describe this temporal information ([108]. For example, DS approaches to management such as utilizing pest scouting to assess the necessity and timing of pest control are widely employed in integrated pest management. Animal husbandry management also makes use of DS management: Individual dairy cows' milk production, food intake, and health are monitored using bar-coding and other sensors [108].

Strategies for Effective Herbicide Resistance Management
Herbicide-resistant (HR) weed populations have grown as a

result of selective pressure resulting from contemporary agricultural management practices. This reaction to herbicides was predicted by Harper (1956), who claimed that "the most efficient extent of deciding on is that that shrinks a community to a small resistant residue which is able to maintain rapid generation." Harper's research contains two fundamental ideas that are essential to managing weed killer resistance today: (1) lowering the degree of selection and (2) stopping the remaining resistant individuals from reproducing. Any special, resistant individuals in the weed population have a selective advantage when herbicides are applied to sensitive weeds before they reproduce. Because their progeny inherits the resistance trait, these fleeing slaves have a greater opportunity of surviving exposure to the exact same herbicide mechanism of action (MOA) if they procreate. Repeated use of the same herbicide or, sometimes, the equivalent MOA creates persistent, unidirectional selection pressure that leads to the proliferation of resistant plants in an invasive plant population. These resistant biotypes are more likely to survive and procreate under such hardship. By selecting for distinct biotypes that have not yet emerged or are not in the optimal development phase when influence is applied, repeating the same control strategies at particular times—whether through the use of herbicides or nonchemical control methods—may also result in the evolution of avoidance of the processes in a weed population [109]. In Asian rice (*Oryza sativa* L.), for instance, traditional hand-weeding has led to selection favoring barnyard grass (The fungus *E. crus-galli* (L.) Beauv.) Communities that phenotypically resemble rice, making it more difficult to distinguish between them at vegetative development stages [110]. As a result, when a specific management strategy is applied consistently without modification, hypersensitivity or evasion is more likely to develop. Glyphosate application in GR crops may have increased the variety of weed-control strategies.

Table 4. Herbicide types commonly used in corn, soybeans and cotton, selective (S) and herbicide-resistant crop enabled (R) Herbicide type (group).

Herbicide type (group)	Corn	Soy-beans	Cotton	Canola
ALS-inhibitors (B)	S	S + R	S	S + R
ACCase-inhibitors (A)	S + R	S	SS	S
HPPD and PDS inhibitors (F) ^b	S	R	R	
Synthetic auxins (O) ^b	S + R	S + R	R	
PPO inhibitors (E)	S	S	S	
PSII inhibitors (C)	S	S	S	
Cell division inhibitors (K)	S	S	S	S

Herbicide type (group)	Corn	Soy-beans	Cotton	Canola
Lipid biosynthesis inhibitors (N)	S	S	S	S
Auxin transport inhibitors (P)	S			
Glyphosate (G) ^c	R	R	R	R
Glufosinate (H) ^c	R	R	R	R

^a Herbicides grouped according to the Herbicide Resistance Action Committee, <http://www.plantprotection.org/hrac>.

^b Auxin and HPPD resistance crops are not commercial but still under development.

^c Glyphosate, glufosinate and paraquat (D) are also used before crop emergence for burndown.

Glyphosate was a novel mechanism of action, and producers are not required to use it on GR crops. But herbicides were good enough for many producers to use it year after year, and as glyphosate usage in GR crops rose, fewer selective herbicides were used [111-113]. For instance, in 1995, before GR crops were available, there were eleven herbicide actives employed on at least 10 per cent of the US soybean land; by 2002, there was just one herbicide active, glyphosate. Atrazine is second in popularity with less than 6% of the overall herbicide volume, while glyphosate continues to dominate the worldwide herbicide market today with 65% of the total volume. 30 The amount of glyphosate used by growers is still rising; between 2005 and 2012, the amount used rose from 30 million to 45.5 million kg.

6. Addressing Global Food Security Challenges: Key Factors and Strategic Solutions

The EU claims that a number of factors, such as a lack of market integration among EU countries, suboptimal business-to-company relationships, a lack of transparency in the food supply chain, and a lack of appeal for skilled workers, are contributing to the decline in competitiveness in the food and drink sector [114]. These issues are not specific to the European Union and are intimately linked to food security challenges in other regions of the world. It can be concluded that there is no single root explanation for the issue of global food security, even though there isn't a single solution.

This section outlines the primary reasons of global food insecurity, which should be considered while identifying the essential components required to create a solution. Food security is defined by the FAO as "a situation in which all people, at all instances, have physical, social, and economic access to sufficient, safe, and nutritious food which meets their nutritional requirements and preferred foods for an active and

healthy life." These problems are appropriately addressed by the writers using this definition. The concept of food security

is based on four main pillars, each with a primary focus (Figure 7).



Figure 7. The Four Pillars of Food Security [115].

Each pillar is of equal importance and must be treated with equal levels of consideration. These four key pillars are [116].

Table 5. Wheat Production and Provision Across OECD and Non-OECD Countries (2008-2022) [117].

Wheat Production and Projections								
Thousand Tonnes								
Country/Region	2008	2009	2010	2011	2012	2013	2014	2022
OECD	264185	275860	274800	276786	278216	278640	278640	288795
Australia	21601	21930	27349	29905	22855	25303	23281	36246
Canada	28611	26529	23174	25261	27205	37529	29404	33820
Chile	1455	1434	1318	1443	1262	1273	1285	1397
Israel	14.5	13.5	17.0	13.9	13.7	12.2	14.2	19.1
Japan	875	906	848	831	831	831	861	946
Korea	31	32	30	31	30	34	35	36
Mexico	4788	4656	3617	3813	3700	3741	3751	3992
New Zealand	416	413	367	384	416	396	397	417
Turkey	17782	20600	19652	21815	20100	22050	19000	19800
United States	68020	60227	60061	54400	61276	57037	55128	44874
Non-OECD	440759	467560	461600	474600	506100	512240	521060	527697
Algeria	3500	6000	2900	4200	4900	3300	3000	3500
Argentina	8281	14500	11500	14700	9200	9200	13900	22000

Wheat Production and Projections								
Thousand Tonnes								
Country/Region	2008	2009	2010	2011	2012	2013	2014	2022
Bangladesh	928	963	972	1003	1108	1118	1129	1557
Brazil	3601	5024	5033	5647	4381	5762	5911	10493
China	113287	115180	114470	117410	120580	121930	126170	137700
Egypt	8523	7387	7429	8374	8795	8846	9279	9800
India	80680	80680	86870	94880	93510	95850	95850	107740
Iran	13732	13972	14400	14000	14400	13400	13200	13700
Iraq	2415	2168	2100	2313	3369	3772	3910	3700
Kazakhstan	12454	17463	9016	22473	9943	13914	13695	16400
Morocco	6114	6925	3903	5410	4750	7120	6841	4550
Myanmar	558	643	657	636	558	557	557	570
Pakistan	21081	24214	23411	25214	23673	24212	23980	26750
Russia	63766	61970	41104	56123	37721	52209	59468	104440
Serbia	2262	2364	1897	2089	2020	2071	2291	3100
South Africa	2012	1896	1650	2033	1915	1780	1896	2180
Syria	4215	4015	3706	3800	4000	2510	2275	1800
Tunisia	1600	1250	1100	1800	1450	1350	1700	1500
Ukraine	25283	20890	17196	22528	15477	22930	24506	20150
Uzbekistan	6020	6220	6240	6360	6430	6460	6480	6650
Venezuela	83	91	100	112	113	118	120	130
Vietnam	90	80	85	84	85	85	85	90
Developing Countries	393279	419739	416436	428020	458378	464496	472373	488045
World	705414	743420	736400	751386	784316	790880	799700	816492

Table 6. Scoring of Food Security Levels: Comparison of 18-Item and 6-Item Modules.

Food Security Level	18-item, households with children	18-item, households without children (10 used)	6-item short form, all households
Food-secure	0	0	0
Food-secure, at risk	1–2	1–2	1
Food-insecure without hunger	3–7	3–5	2–4
Food-insecure, moderate hunger	8–12	6–8	5
Food-insecure, severe hunger	13–18	9–10	5–6†

Food Security in the USA

6.1. The US Congress and USAID Define Food Security as Follows

Constant availability of suitable food and Agricultural Export Development and Assistance Act of 1990 (P. L. 480): Nutrition for a healthy and productive life for all. Additionally, everyone should always have physical and financial access to enough food to meet their nutritional needs and lead productive, healthy lives [118, 119]. Similarly, food security for a household is defined by the US State Department of Agriculture (USDA) as follows: There is always enough food available for each member to lead an active and healthy lifestyle. At the very least, food security includes: (1) easy access to wholesome and secure meals; and (2) the guarantee that one can acquire the appropriate foods in ways that are acceptable in society (i.e., without resorting to emergency food supplies, stealing, salvaging, or other coping techniques) [120].

6.2. Definition and Components

In its simplest form, it means regularly consuming enough food for the following period of time in combination with today and tomorrow. Why is there still uncertainty when everything is so simple manipulation? To assist understand this, consider the several issues this seemingly simple concept raises. Without going too much into the nuances and complexity of the subject, the Food and Agricultural Organization, or FAO, of the United Nations, basically points out that food security is the outcome of food availability, food access, supply stability, and biological usage [121].

6.3. Availability

There are basically two options for distributing food when availability is taken into consideration: imports or domestic production. This calls for careful consideration of the real availability of sustenance at local markets and farms. The smooth operation of market infrastructures, the availability of enough rail and road networks, and the availability of adequate technology for the storage and processing of information all depend on this [122].

6.4. Access

Ensuring everyone can have sufficient material and monetary access to food through growing it, buying it, receiving it as a gift, bargaining or negotiating for it, etc., is known as food access [122]. This idea can be viewed as a set of rights that enable individuals to acquire and maintain the proper nourishment for a suitable diet and level of nutrition. This can be acquired indirectly through local or national interpersonal interactions, including families, support networks, customary rights, access to common resources, and, of course, emergency food aid. Directly, this can be produced in a way that yields food for oneself, sufficient funds, or bartering [123].

6.5. Stability

Although the concept of stability is not new, there is growing worry in the food security discussion about the realization that food security may be lost as well as attained [124]. Consequently, the concept of managing risks is becoming more accepted as a means of combating hunger. Such considerations include stability and vulnerability, which can be related to livelihoods in particular, the broader economy in general, incomes, or even food supplies themselves, with an emphasis on sudden or other shocks like pests, droughts, floods, etc. [124].

6.6. Utilization

The final concept is biological utilization, which essentially refers to a person's ability to absorb food as smoothly or effectively as feasible. Although the "novelty" of the word, the principle is not new. Additionally, studies have shown a substantial relationship between this talent and a person's health status, which is determined by important non-food inputs. The supply of fresh water and sanitation services, suitable health and child care, adequate knowledge of physiological and nutritional requirements, and the proper application of that knowledge have all been shown to be necessary to ensure proper biological utilization [125, 126].

6.7. Challenges to Food Security in the USA

The same validated malnutrition scale was used in each questionnaire year. Ten questions have been presented to each family using the questions and alternate options from the US Department of Agriculture Food Security Survey Module. A 4-level food security status was determined based on the amount of satisfactory responses and grading from Bickel et al., [127]:

1. Excellent protection of food (no positive answers)
2. Relative Food Security (one to two yes answers)
3. Insufficient Food Security (three to five yes answers)
4. Incredibly Inadequate Food Security (6–10 yes answers)

Following that, these categories were divided into two groups: those who were food secure (category 1 and 2) and those who were undernourished (sections 3 and 4) among populations [128, 129]. In comparison to those who perceive food security, those who experience food insecurity usually appear younger, female, members of a racial or ethnic minority, and have less privilege or their level of education [130-133]. Insufficient food supply has been found to be higher among minorities along with people with dietary-influenced persistent illnesses [130, 131, 134, 135]. Furthermore, there is evidence that men and women react differently to food insecurity, which is frequently observed in the differential impact of high BMI and inadequate nutrition in low-income women [136, 137]. While some research has looked into whether trends persist over time, these analyses typically concentrate on changes within subpopulations rather

than the distinctions between them. The global problems of food security. In the course of the convention, poster authors, keynote speakers, and plenary session speakers underlined the many challenges encountered by plant pathologists in particular.

6.8. A List of These Problems Is as Follows

1. A dynamic environment that causes erratic and occasionally disastrous weather events that encourage the emergence of plant diseases.
2. The increased danger of disease and pest invasions due to the rapid movement of pathogens and their vectors.
3. Evolution of pathogens: overcoming host resistance.
4. The requirement for ecologically compatible vector and disease prevention materials.
5. Resilient cultivars are developed and released gradually.
6. The public's skepticism of genetic and sophisticated breeding technology.
7. Adoption of emerging technologies at the field level,

integration of research into practice, and slow technology transfer.

8. A diminished ability to reach out and extend globally.
9. Scientists' limited time to educate the public about the necessity and use of creative technology solutions.
10. The requirement for consistent, dependable funding sources for outreach and research fortunately, there are others who are working on food and nutrition security besides plant pathologists. It need interdisciplinary and multifaceted teamwork to overcome these obstacles. The 2030 Agenda for Sustainable Development (SDGs) are a new set of goals that the world community came up with and agreed upon in 2015 [138].

7. Results

In total, 287,836 family respondents, representing 124,761,416 US families, had food insecurity data available.

Table 7. Weighted Sample Demographics by Food Security Status 2011-2017 [139].

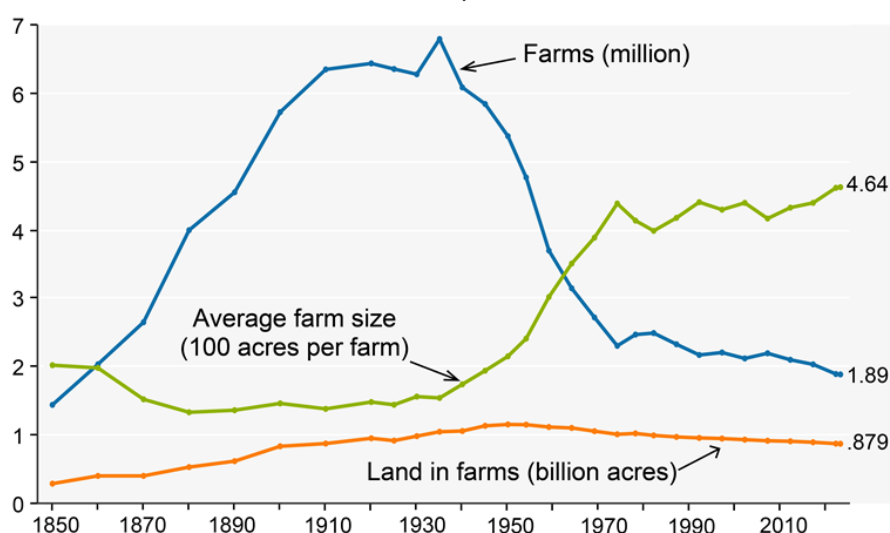
Category	Food Secure	Food Insecure	P Value
Unweighted Sample	n = 254,791	n = 33,045	
Weighted Sample	N = 111,582,148	N = 13,179,268	
Mean Age (years)	50.2	45.9	
Age Group			<.0001
18–34	23.96%	27.23%	
35–49	24.86%	30.52%	
50–64	27.37%	30.47%	
≥65	23.81%	11.78%	
Sex			<.0001
Male	44.11%	34.85%	
Female	55.89%	65.15%	
Race/Ethnicity			<.0001
Non-Hispanic White	71.18%	52.19%	
Non-Hispanic Black	11.12%	23.50%	
Hispanic	11.78%	20.06%	
Other minorities	5.93%	4.26%	
Ratio of Family Income to Poverty			<.0001
<1.00	12.25%	41.49%	
1.00–1.99	16.60%	33.76%	
2.00–3.99	33.41%	20.25%	
≥4.00	37.74%	4.50%	

Table 8. Logistic Models for Relationship Between Food Insecurity and Demographics [139].

Category	Unadjusted OR (95% CI)	Adjusted OR (95% CI)*
Age Group		
18–34	ref	ref
35–49	1.08 (1.04–1.12)	1.62 (1.55–1.70)
50–64	0.98 (0.94–1.02)	1.66 (1.58–1.75)
≥65	0.44 (0.41–0.46)	0.61 (0.57–0.65)
Sex		
Male	ref	ref
Female	1.48 (1.43–1.52)	1.23 (1.19–1.27)
Race/Ethnicity		
Non-Hispanic White	ref	ref
Non-Hispanic Black	2.88 (2.77–3.00)	1.69 (1.62–1.76)
Hispanic	2.32 (2.22–2.43)	1.24 (1.18–1.30)
Other minorities	0.98 (0.90–1.06)	0.78 (0.72–0.85)
Ratio of Family Income to Poverty		
<1.00	ref	ref
1.00–1.99	0.60 (0.58–0.63)	0.64 (0.62–0.67)
2.00–3.99	0.18 (0.17–0.19)	0.19 (0.18–0.20)
≥4.00	0.04 (0.03–0.04)	0.04 (0.03–0.04)

Farms, land in farms, and average acres per farm, 1850–2023

Million farms, billion acres, or 100 acres per farm



Source: USDA, Economic Research Service using data from USDA, National Agricultural Statistics Service, Census of Agriculture (through 2022) and *Farms and Land in Farms: 2023 Summary* (February 2024).

Figure 8. Farms, land in farms and average acres per farm, 1850–2023.

8. Strategies and Policies Addressing Food Security

The following order is made in accordance with the power granted to me as Presidential by the constitution and US laws, and to guarantee the responsible use of regulatory power that impacts agricultural and rural communities:

1. Sec. 1. Command. America's economy, stability, and national security are contingent upon a steady, safe, and affordably priced supply of food, fiber, and lumber. Promoting American agriculture and preserving the rural areas that provide forests, food, fiber, and many of our renewable energy sources is in the best interests of the country. Ensuring that regulatory burdens do not unnecessarily hinder agricultural productivity, negatively impact rural areas, limit economic growth, hinder job creation, or raise the cost of food for Americans and our consumers abroad is also good for the welfare of the country.
2. Sec. 2. The Agricultural and Rural Prosperity Interdisciplinary Working Group was established by them. As a result, the Interagency Task Force on Agriculture and Rural Prosperity (Task Force) was established. Within the parameters of obtainable money and to the extent permitted by law, the Ministry of Agriculture will finance and oversee its operations.
3. Sec. 3. Contribution. (A) The Working Group will be chaired by the Secretary of Agriculture and will include the following members: the Secretary of the Treasury, the Secretary of Defense, the Attorney General, the assistant to the president for domestic policy, and the assistant to the governor for monetary policy are among the other heads of executive divisions, agencies, and offices that the president or secretary of agriculture may occasionally appoint. (B) To fulfill the participant's responsibilities on the Task Force, the member might choose a senior-level individual who serves as a full-officer or member of the member's division, agency, or office.
4. Sec. 4. Aims and obligations of the assigned force. (a) The Task Force will identify legislative, regulatory, and policy changes that will boost rural America's overall standard of life, economic growth, job creation, infrastructure improvements, technological innovation, and energy security. Enhancing and expanding educational opportunities for students in rural communities, particularly in agricultural education, science, technology, engineering, and mathematics; facilitating the State, local, and tribal agencies that implement agricultural, environmental, and rural economic development programs to tailor them to the unique needs of their respective regions; removing barriers to rural America's economic prosperity and quality of life; encouraging the adoption of technological advancements for agricultural production and long-term, sustainable rural development; necessitate departments and executive agencies to use the best available research when approving or assessment crop protection equipment; acknowledge the unique circumstances of small businesses serving rural areas, as well as the different business structures and regional diversity of farms and ranches; ensure the availability of a stable labor pool and increase employment opportunities in businesses that prioritize rural and economic areas; promote changes to the estate tax and the tax value of family-owned or cooperatively-owned businesses to protect familial farms and other agricultural pursuits that are passed down through the generations; ensure that when water users apply for permits to use public lands, Enhancing food safety and guarantee the legislation and regulations adopting federal food safety laws are based on research and take into account the distinctive needs of farms and landowners; encourage the use, export, and production of domestically produced agricultural products; increase the production of sustainable and customary energy in rural areas to contribute to the nation's energy security; and remove obstacles to accessing supplies on public lands for rural communities that rely on mining, recreation, cattle grazing, timber harvesting, and other multiple uses. (a) The Task Force will be coordinated with the Deputy Assistant to President Obama for Intergovernmental Affairs and will provide farmers, ranchers, forestry workers, and other rural stakeholders with the opportunity to propose legislation, regulations, and policy changes. (c) The Task Force must coordinate its work with other regulatory or policy reviews in accordance with Executive Orders 13771 of January 30, 2017 (Reducing Regulation and Controlling Regulatory Costs), 13778 of February 28, 2017 (Restoring the Rule of Law, Federation, and Economic Growth by Reviewing the "Waters of the United States" Rule), and 13783 of March 28, 2017 (Promoting Energy Independence and Economic Growth).
5. Sec. 5. Conclusion: Within 180 days of the date of this decree, the Secretary of Agriculture, after speaking with the other members of the Task Force, shall present a report to the President through the Assistant to the President for Domestic Policy and the Assistant to the President for Economic Affairs. In line with section 4 of this order, the report will suggest any legislative, regulatory, or policy changes that the Task Force decides on are required. The Secretary of Agriculture will provide copies of the final report to each working group member.
6. Sec. 6. Revocation. Executive decree 13575, issued on June 9, 2011, created the White House Rural Council; however, it has since been revoked.
7. Sec. 7. The general principles. Any power legally

granted to a government department or agency, its executive officer, or the director of the Office of Managing and Budget with regard to legislative, administrative, or budgetary initiatives should not be construed as being affected in any manner by this order. (b) This order will be carried out in compliance with current law, based on the availability of appropriations. (c) This order prohibits any party from using any substantive or procedural rights or benefits, either in law or equity, to impose obligations on the United States, any of its departments, agencies, or organizations, its officers, employees, or agents, or any other individual.

9. Conclusions

With an emphasis on SDG 2: Zero Hunger, this investigation emphasizes the complex interrelationships among agricultural practices, climate change, and the 17 Sustainable Development Goals (SDGs) established by the UN. It underscores the profound impact of climatic variations on crop yields, leading to increased frequency of extreme weather events and pest proliferation, thus reducing agricultural productivity. While industrial agriculture has increased calorie production, it has also caused biodiversity loss, soil degradation, and greenhouse gas emissions, failing to eliminate hunger and contributing to widespread micronutrient deficiencies. Sustainable agricultural practices such as improved irrigation, integrated weed management, precision agriculture, and reducing post-harvest losses are essential strategies to enhance productivity and protect ecosystems. Immediate and collaborative efforts are required to integrate sustainable agricultural practices to enhance food security while protecting the environment. Governments, scientists, and local communities must work together to implement effective food security strategies that promote sustainable production, leverage genetic diversity, and ensure access to nutritious food. Policy interventions and innovative technologies must be prioritized to address these global challenges comprehensively. Future research should focus on developing scalable solutions for sustainable agriculture that can be widely adopted by smallholder farmers. Studies should explore the long-term impacts of these practices on food security and ecosystem health. Additionally, there is a need for research on the integration of new technologies and policy frameworks that can support sustainable food production systems and address the remaining gaps in achieving SDG 2.

Abbreviations

SDGs	Sustainable Development Goals
GA	General Assembly
UN	United Nations
FAO	Food and Agricultural Organization
MOA	Mechanism of Action

FSN	Food Safety and Nutrition
MDGs	Millennium Development Goals

Author Contributions

Muhammad Awais Arshad: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

Babur Ali Akbar: Resources, Software, Validation, Visualization

Ahmad Jawad: Formal Analysis, Resources, Software, Validation

Muhammad Huzaifa Mahmood: Funding acquisition, Investigation, Software, Validation

Conflicts of Interest

The authors declare no conflicts of interest.

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