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S&T REVIEW

SUSTAINABLE FOOD SECURITY: HOW TO FEED AN INCREASING POPULATION? A REVIEW

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ABSTRACT

Achieving food security along with combating poverty, meeting climate goals, and reducing pressure on the environment has been a major challenge: rapidly growing population amid dwindling natural resources and an increasingly vulnerable ecological environment. This paper reviews some relevant paperwork to explore the present situation of the food system and the probable solutions for sustainable food security. Today, 690 million people are hungry and overall food demand is estimated to rise by 50% with the increase in population reaching about 10 billion by 2050. Meanwhile, the supply system loses 1.3 billion tons of food produced every year. Also, the world is facing the problem of hunger and obesity simultaneously. By 2050, adequate feeding of the growing population will necessitate an extra 593 million ha generating 7.4 quadrillion calories, which is more than 1.5 times as produced in 2010. Furthermore, 1/4th of total greenhouse gas (GHG) emissions are attributed to the agriculture sector alone so, we have the dare to meet the increasing global food demand while minimizing adverse environmental impact. The paper's main contribution lies in the analytical study of different food security approaches. The paper shall help the policymakers to focus on the best measures while formulating a strategy to combat hunger and climate change at the same time. It suggests giving major attention to the breeding programs, increasing cropping intensity, intercropping, rediscovering NUS, more plant-based diet, reduction of food loss and reforestation, peatland restoration, and efficient water utilization for sustainable food security.

KEYWORDS

Intercropping, Reforestation, Food

1. INTRODUCTION

Sustainable food security has three dimensions viz. productivity, resilience, and connectivity. (FAO, 2015). It will necessitate the availability and accessibility of adequate food, proper food usage, and predictability of these situations along with maintaining environmental resilience (Helland and Sörbö, 2014). Low-income people are disproportionately affected by food insecurity, which increases the risk of hunger and malnutrition. (Fan and Brzeska, 2016)

Overall food consumption is expected to grow by more than half, and demand for animal-based meals by almost three quarters as the world's population hits 9.8 billion in 2050 (UN, 2017) and wages rise across the globe. Satisfying growing demand while preserving the environment is the most pressing challenge today. Meat and other animal products play a critical role in this issue. (Federico et al., 2019)

Current agricultural and food systems must be transformed to provide adequate nutrition in an eco-friendly manner. Hunger and malnutrition are still an issue, and demand for food is expected to climb by almost 60% in the next few decades (FAO, 2012a; FAO, 2012b) while the natural resources such as land, water, energy, and numerous raw materials are already in the verse of waning. To feed this quickly rising population in a healthy, egalitarian, and environmentally responsible manner while also building resilience into the system, a multidimensional and integrated global plan is required, with various approaches being discussed here.

2. PRESENT SCENARIO AND CHALLENGES

Roughly 6.90 hundred million people (almost 9% of the present population) are starving presently, and the number is rising at a rate of 10 million per year and approximately 60 million in the half a decade. About 26.5 percent of the earth's population (about 2 billion) is subjected to food insecurity (serious + modest extent of food insecurity); almost 7.5 hundred million people (about 1/10th of the world's people) are subjected to severe food insecurity. Stunted children account for 21.3 %, overweight children share for 5.6 %, and wasted children stand for 6.9% among a total of 680 million children under 5. If present trends persist, the population impacted by starvation would exceed 8.4 hundred million by 2030, deviating the world from the path to gain Zero Hunger by 2030. (FAO et al., 2020) While hundreds of thousands of people are suffering from undernourishment around the world, the supply system loses 1.3 billion tons of food produced every year (FAO, 2011). Many countries are grappling with the dual burdens of hunger and malnutrition along with overweight and obesity, with one in every three people suffering from some type of malnutrition. (International Food Policy Research Institute, 2016).

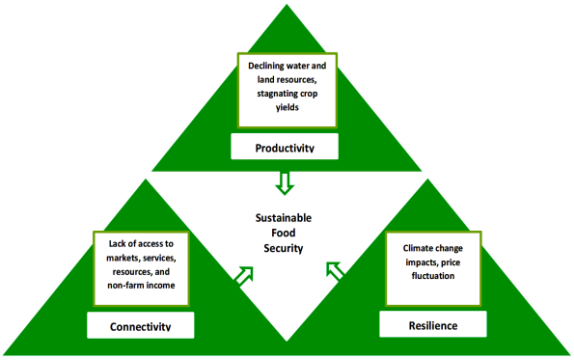

Figure 1: Three Aspects of Long-Term Food Security. Source: FAO, 2015.

An unprecedented challenge for the global food and agriculture production systems is to feed an increasing global population and minimize the environmental impact and conserve natural resources for future generations. Growing population, rising income, increasing hunger and malnutrition, food loss and waste, adverse climate change effects, loss of biodiversity, overexploitation of natural resources and resource scarcity can undermine the global potential to meet its food demand now and in the future.

Animal protein will be more abundant in the meals (Sundström et al., 2014) of almost 10 billion populace in 2050 (UN, 2017). The extra 3 billion populace will consume a meal higher in non-veg and dairy products, requiring major modifications in food supply chains over the next two decades (Kearney, 2019). Another issue: the edible crops diverted to biofuels could have fed 400 million people. (Helland and Sörbö, 2015). In the same way, the next challenge is the rapid urbanization which has drawn a demarcation in the purchasing power. While urban consumers will acquire goods at a high cost., food security of poor communities is vulnerable to a rise in global food costs in nations with weak socioeconomic safety nets (Shenggen and Joanna, 2016). Furthermore, reliance on imported goods has become a significant difficulty since some nations implement food export bans during times of scarcity. It is believed that about a quarter of all cultivated fields are deteriorating to some degree, limiting their ability to generate food in the coming days. (International Soil Reference and Information Centre, 2013).

The climatological change will have an impact on the agricultural farm by bringing progressive precipitation and temperature shifts as well as causing weather extremes (Gornall et al., 2010). Holistic evaluations that incorporate all of the climatic change's effects (including benefits in food products, for instance, higher lands can now be farmed due to rise in temperature and its demerits such as changes in precipitation patterns, extreme weather events, and reductions in water availability) suggest the net result will reduced yields (Parry et al., 2009; Knox et al., 2012). To fulfill the future food needs of an expanding population, productivity growth and more efficient use of inputs would be required, which could be costly to the environment. (Grafton et al., 2015). We must conquer three major hurdles viz; food gap, land gap, GHG mitigation gap to feed nearly 10 billion population effectively while also allowing the world to accomplish climate targets, eliminate poverty, and lessen pressures on the balanced ecosystem.

Table 1: Food, land and greenhouse gas (GHG) emission mitigation gap between 2010 and 2050(projected)

Food Gap	Land Gap	Greenhouse Gas (GHG) Emission Mitigation Gap
• **The amount required to meet projected food demand in 2050, minus the food grown in 2010.** • **Estimated to be 7.4 quadrillion calories (more than 1.5 times as grown in 2010).**	• The agri-land area required in 2050 minus the area required in 2010. • The additional area required in 2050 is anticipated to be 5.93 hundred million ha.	• Yearly emissions from farming and land-use change in 2050 are expected to reach 15 gigatons minus an aim of 4 gigatons for agriculture's proportional contribution to keeping global warming below 2°C above pre-industrial temperatures. • Expected to be 11 Gt.

Reference: World Resources Report: Creating a Sustainable Food Future.

In 2020, the covid pandemic has led to the deterioration of the nutrient adequacy of the world's poorest people further. In addition to this pandemic, unprecedented Desert Locust outbreaks have obscured the financial outlook in ways that nobody could have predicted, thus the situation can only improve if we respond swiftly (FAO et al., 2020). "Are we going to be able to feed the world in the coming days??" has been a burning question.

3. Approaches for Sustainable Food Security

We are likely to get into a scarcity if we continuously desired greater calorie meat-based diets, overdraft groundwater, let arable land deteriorate, waste valuable food, contaminate the environment with a large number of agrochemicals, and promote unsustainable irrigation projects (McLaughlin and Kinzelbach, 2015).

We have to adopt some approaches to ensure tenable food security in the future.

3.1 Increasing productivity

The most potentially significant connection between wage, nutrition security, and environmental needs is productivity increment. Earlier, farmland expansion contributed significantly to increasing agriculture production (Macedo et al., 2012; Levers et al., 2016); but, hereafter, additional food must be obtained from the very same area of farmland via efficient land utilization to be ecologically sound (Wu et al., 2014a; Wu et al., 2014b). Otherwise, biodiversity protection, greenhouse gas emission reductions, and hydro-meteorological change management will be hampered (Wua et al., 2017). An increase in cropping intensity might enhance the number of yields annually(Mauser et al., 2015), and it may provide a viable alternative to expanding cropland (Dias et al., 2016; Meng et al., 2017). Enhanced flexibility in management strategies and breeding initiatives focused on enhancing yield potentials are two of the main areas where food insecurity and environmental issues can be mitigated most effectively in the context of 2050 (Tester and Langridge, 2010).

Boosting agricultural productivity along with conservation and enhancement of natural resources is an important requisite for increasing global food production sustainably. Farmers should be motivated and directed to conserve biotic and abiotic aspects of nature minimizing the adverse impact of agriculture on the environment, for they have a pivotal role in improving agricultural productivity on a sustainable basis since they are the ones engaging with the changing process of natural resources. They need to update their outdated traditional approaches to more productive and environmentally friendly novel approaches; for instance, precision farming, drip irrigation, organic farming, and integrated pest control.

3.2 Rediscovering Neglected and Underutilized Species (NUS)

NUS is resilient to various biotic and abiotic stresses and is suitable for growing in weather and condition where other crops can't be produced. So, they should be explored, developed, and exploited to address the nutritional demands of a growing population. NUS can be the answer to the serious state of food security (Acga, 2018). Earlier, the traditional farming system included diversity; however, now, modern agriculture has concentrated on a small number of species, and internationalization has resulted in globally similar diet and food production (Khoury et al., 2014). Only 12 crops and 5 animal species account for 75% of global food production (FAO, 1998); this lack of diversity poses a threat to human nutrition, food system stability, and resilience (Frison et al., 2011; Beddingtonet al., 2012).

Today, the great majority of edible food crops and animals are inadequately covered by research and innovation due to modern agriculture's limitation of crop and animal diversity. Consumer awareness of the advantages with NUS, as well as research and development have a significant role in the long-term adoption of NUS, amplifying their impact on food security, economic production, and climate change resilience.

3.3 Changing Diets

Just a 3/10th global switch from ruminant meat toward other diets will nearly close the acreage gap and reduce GHG emissions by half (Searchinger et al., 2018). Almost a third of the globe's cereal produce is utilized as animal feed, leaving just around a 1/3 for human consumption. Changing our food selection to more vegetarian diets gives both health and environmental benefits (Willett et al., 2019). The meat should be replaced by vegetarian meat, cultured meat, and/or insect-based meat replacements. Because the structures and biochemistry of meat and dairy products are basic, they will be easier to replace. In addition, future animal proteins and energy must be created from non-human food sources, such as fodder, grasses, hay, or by-products. (Kearney, 2019).

The widespread consensus among people about a sustainable diet mainly coincides nutritional and balanced diet (Clark et al., 2019; Mac , 2013; Ruini et al., 2015). Sustainable diets are those that have minimal impacts on the environment and contribute to food and nutrition security as well

as good health for current and future generations, as stated by the United Nations Food and Agriculture Organization(FAO) (FAO, 2010). A substantial intake of vegetables and fruit characterizes a hygienic and eco-friendly diet while reducing protein intake. To help stop climate change, anyone who cares about the world and its inhabitants can make one easy choice: eat vegan.

3.4 Reducing food loss and food waste

Every year, one-third of all human food produce (1.3 billion tons of food) is lost and squandered throughout the distribution network (Schanesa et al., 2018). Source reduction, repurposing or reprocessing surplus foods, recycling food as animal feed, recovering energy for biofuels production, nutrients as compost, or raw materials for the industry are the hierarchy of strategies for reducing food losses and waste, with incineration or dumping as garbage in landfills as last resorts (Vgsholm et al., 2020).

By boosting efforts to reduce food waste at the source and redistribute surplus food, we can collectively reduce the environmental impact of food loss/waste while simultaneously assisting families and individuals facing food insecurity.

3.5 Reforestation of some lands, restoration of peatlands, and efficient water utilization should proceed immediately

We should adopt reforestation of marginal lands that can't be intensified. Agriculture is the largest source of fertilizer runoff from farm fields, accounting for nearly 7/10th of global freshwater outflows. So, whenever possible, preserve or make more efficient use of water. (Hejazi and colleagues, 2014). Agroforestry is commonly promoted as a low-cost means of mitigating global warming. Trees can store carbon in soils and woody biomass, as well as minimize greenhouse emissions from soils. (Verchot et al., 2007; Smith and Olesen, 2010).

Peatland restoration entails rewetting compromised peatlands, which improves carbon sequestration while also decreasing existing CO2 emissions from deteriorated peatlands, hence preventing future emissions while preserving biodiversity. Integrated water management provides significant adaptation benefits by enhancing the resilience of farming systems to climate change scenarios. Enhancing irrigation and holistic management of water resources, such as increasing the urban and rural supply of water and reducing evaporation losses, are significant measures for improving climatic adaptability (Dillon & Arshad, 2016). Many technical advances (for example, precision water usage) can improve water availability and agricultural output dependability in rainfed agriculture areas by adopting various strategies of water collecting, retention, and sensible application through ponds, reservoirs, and public containers.

4. Conclusion

Assuring sustainable food security for this rapidly increasing population is not a cup of tea; however, it can be achieved through the adoption of scientific approaches. Despite all the challenges, we can build a society where everyone has access to enough nutritious food and for this, the government, private sectors, and civil society must act upon the mentioned approaches quickly. A pressing question "Do we have adequate resources to sustain the populace in the future days?" has the only answer, "It depends on the way we manage the resources". And yes, the earth can't sustain us if we continue the present trend of resource exploitation. Creating a sustainable food future - feeding a growing global population while also supporting development and poverty reduction, as well as palliating climate change and other environmental degradation - presents a complex group of problems. The paper contains some insights that differ much from previous work in terms of strategy or priority. For establishing a strategy for sustainable food security, the concerned authorities should emphasize breeding programs, increasing cropping intensity, intercropping, rediscovering NUS, a more plant-based diet, reducing food loss and reforestation, peatland restoration, and effective water management. This paper has provided insight into food security to be about people as much as about finite resources.

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