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TOWARDS A SUSTAINABLE FUTURE: AN IN-DEPTH ANALYSIS OF FOOD AND WATER SECURITY IN THE CONTEXT OF THE SUSTAINABLE DEVELOPMENT GOALS

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Abstract

The Millennium Development Goals failed to address institutional inequalities worldwide, with four of the eight goals relating to water, food, or agriculture. These goals encompass major facets of inequality experienced by humanity. Of the 17 Sustainable Development Goals yet to be achieved, five aim to achieve sustainable development in the water, food, and agriculture sectors. India is the second-largest country in terms of available arable land and is a significant producer of wheat, cotton, and rice, as well as milk, pulses, and spices, which can efficiently feed its entire population. Despite this, millions of people in India suffer from hunger, malnutrition, and stunted growth, as demonstrated by its recent 107th position in the Global Hunger Index. The lack of clean, quality, and quantity of water puts human existence, the environment, and economies at risk. Understanding the complex relationship between food and water is crucial to achieving these goals. This research paper aims to examine India's commitments to achieving sustainable development goals, with particular emphasis on food and water security.

Keywords: Food security, Water security, SDGs, India, Climate Change

INTRODUCTION

According to Brundtland's report (1987) the official definition of “Sustainable Development” is “*Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs*” (*Website*, n.d.-a) . India will be home to around 1.6 billion people by 2050. Eventually, this rate of population growth will bring extended demands for food, energy, water, infrastructure, and other essential resources (Upadhyay & Palanivel, 2011). It seems to be a great challenge in front of India. “*The earth has enough for man’s need but not for man’s greed*," said India’s greatest visionary Mahatma Gandhi. However, many factors such as mismanagement and use of inefficient resources, and high vulnerability to climate change, etc severely limit access to resources (Upadhyay & Palanivel, 2011). Regional cooperation is required for future food and water security (Webb et al., 2006); (FDI Team, 2014).

Despite increased GDP since the 1960s, millions of Indian people are still not having enough access to clean water, food, and sanitation. Though India is the world’s 2nd largest

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producer of wheat and rice 50% of children under the age of 5 years are malnourished (FDI Team, 2014); (Upadhyay & Palanivel, 2011). The factors influencing food and water security are given in Figure 1.

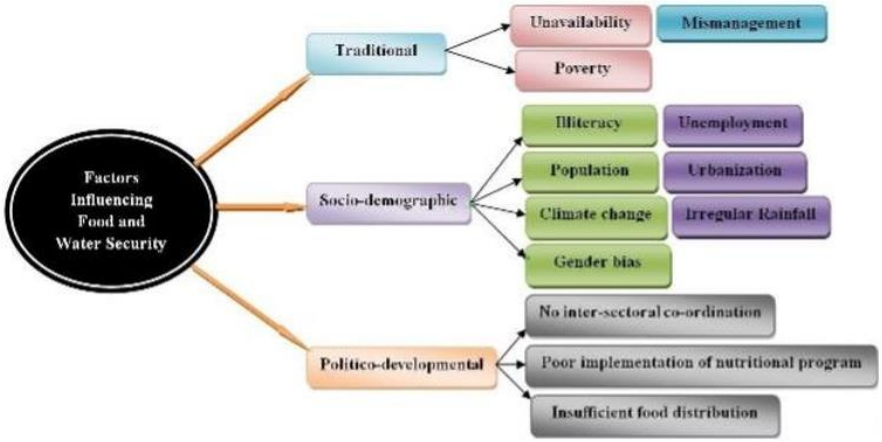

Figure 1: Factors Influencing Food and Water Security

Water, Food, and Agriculture in the Sustainable Development Goals

The Millennium Development Goals (MDGs) were made at the UN Millennium Summit on 8th September 2000, to rid poverty and improve humanity (Nations & United Nations, 2010). Total of 8 goals were set to be completed by 2015. However, out of 8 around four goals were, directly and indirectly, related to water, food, and agriculture viz. Eradicate Extreme Poverty and Hunger, Reduce Child Mortality, Improve Maternal Health, Ensure Environmental Sustainability, etc (Hub, n.d.); (India. Ministry of Statistics and Programme Implementation, 2011); (*Millennium Development Goals Report 2015*, 2015) *(Millennium Development Goals Report 2015, 2015)*. Interestingly, priority was assigned to rural development and agriculture, improvement in environmental conditions e.g. water sanitation and hygiene, women empowerment, and employment, etc (Upadhyay & Palanivel, 2011).

The Food and Agriculture Organization (FAO) of the United Nations developed an agenda to transform our world at the UN General Assembly Summit, in September 2015 and it is adopted by a total of 193 countries (Bruinsma, 2017). The outcome document is *"Transforming Our World: The 2030 Agenda for Sustainable Development" (ICLEI Briefing Sheets, n.d.-a)*. There are a total of 17 Sustainable Development Goals and 169 targets in this agenda to be achieved by 2030 (*ICLEI Briefing Sheets*, n.d.-b). The United Nations has developed websites to inform the implementation of SDGs (Morton et al., 2017).

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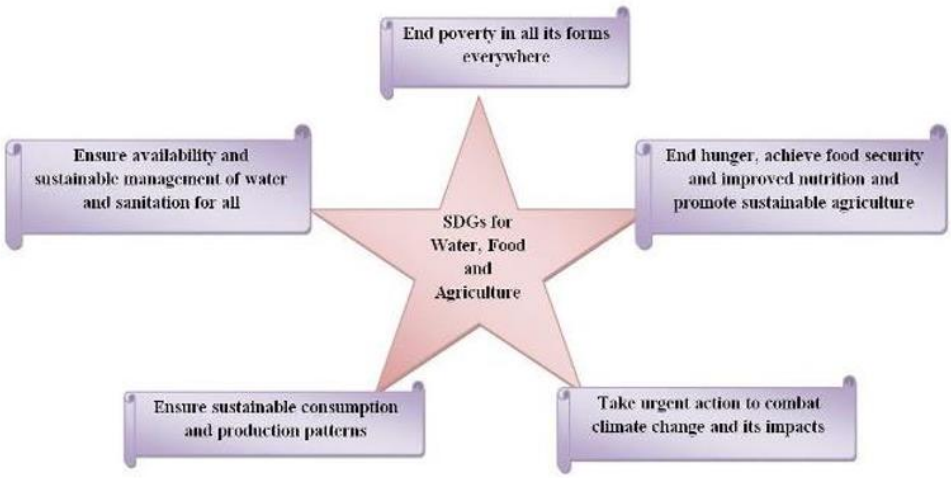

Figure 2: Sustainable Development Goals for Water, Food, and Agriculture

Out of 17 SDGs, five are derived to attempt sustainable development in the water, food, and agriculture sector (Figure 2) viz. End poverty in all its forms everywhere, End hunger, achieve food security and improved nutrition and promote sustainable agriculture, Ensure availability and sustainable management of water and sanitation for all, Ensure sustainable consumption and production patterns, Take urgent action to combat climate change and its impacts, etc (Bruinsma, 2017) (Bruinsma, 2017). However, water, food, and agriculture, these three sectors are interrelated with each other.

India is in 2nd place in the world for available total arable land and World's largest area is under cultivation of wheat, cotton, and rice. India is producing enough milk, spices, pulses, and other agricultural produce through which the whole Indian population can get food (Ahmad et al., 2011) (Ahmad et al., 2011). But unfortunately, millions of people are undernutrition and hungry (Ahmad et al., 2011). The green revolution in the late 1960s led to the indiscriminate use of fertilizers and high-yielding seeds which ultimately resulted in high agricultural produce and India became self-sufficient to feed its population by the 1970s. Eventually, the graph of yield declined in further decades due to the degradation of land and reduced soil quality (Brouwer & Joshi, 2016).

The graph of population growth is consistently increasing. However, demand for food and water is increasing rapidly and here actual 'Sustainable Agricultural Management' plays an important role. Such sustainable agricultural management needs observations for soil quality, storage of grain, and exportability of agricultural produce ("Food Security Challenges in India: Exploring the Nexus between Water, Land and Agricultural Production," 2012) ("Food Security Challenges in India: Exploring the Nexus between Water, Land and Agricultural Production," 2012). It also requires concentrating on water conservation and management used for irrigation purposes. The dynamic change in climate, irregular rainfall, and other meteorological parameters are affecting the production of agricultural produce (Ahmad et al., 2011). There are several past incidents

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of pesticide residue and heavy metal contamination in the food (Chengappa, 2013) (Chengappa, 2013). In the present context, healthy and safe food is a big challenge in the world (Upadhyay & Palanivel, 2011). Therefore, to avoid these problems due to the indiscriminate use of pesticides and fertilizers, farmers should switch to organic farming. There is wide significance of sustainable agricultural practices and organic farming such as it is useful for maintaining chemical-free agricultural fields, improving soil quality, soil microflora and microfauna, microbial counts, reducing contamination of water resources through agricultural runoff, heavy metal, and pesticide residue-free production, exportable quality of agricultural produce, reduce pesticide poisoning incident, low orchard management cost, more profitable to the farmer end and last but not least it is an eco-friendly and sustainable way of agriculture (Tari, 2021).

The impact of SDGs on global development will mainly depend on the world's ability to change to new governance for sustainability that recognizes the roles and responsibilities of sub-national governments (*ICLEI Briefing Sheets*, n.d.-c). According to the 'Voluntary national review report on the implementation of sustainable development goals,' the main focus of India is on '*Eradicating poverty and promoting prosperity in a changing world' (United Nations High-Level Political Forum on Sustainable Development, 2020, n.d.-a) (United Nations High-Level Political Forum on Sustainable Development, 2020, n.d.-a)*. India is also focusing on industrialization, economic growth, infrastructure development, and poverty. However, India is constantly keeping an eye on its commitment to environmental protection. By minimizing emissions and developing more carbon sinks under the Nationally Determined Contributions (NDCs) of India (*United Nations High-Level Political Forum on Sustainable Development, 2020*, n.d.-b) *(United Nations High-Level Political Forum on Sustainable Development, 2020, n.d.-b)*.

FOOD SECURITY AND ITS INDICATORS

The food security assessment is associated with several terms such as hunger, undernutrition, malnutrition, undernourishment, etc. The term Hunger can be defined as distress due to a lack of food. 'Undernutrition' is known as a deficiency of protein, vitamins, minerals, and energy (von Grebmer et al., 2016) *(von Grebmer et al., 2016)*. Malnutrition is broadly associated with both overnutrition and undernutrition; undernutrition is associated with deficiencies. However, overnutrition is the consumption of high calories in food with high or low amounts of micronutrients (von Grebmer et al., 2016) *(von Grebmer et al., 2016)*. According to the Food and Agriculture Organization of the United Nations (FAO), food deprivation, or 'Undernourishment' is nothing but *"The consumption of fewer than about 1,800 kilocalories a day i.e. the minimum that most people require to live a healthy and productive life" (von Grebmer et al., 2016) (von Grebmer et al., 2016)*.

GLOBAL HUNGER INDEX (GHI)

The Global Hunger Index (GHI) is a tool to measure and track hunger at the global, country, and regional levels. The International Food Policy Research Institute (IFPRI) calculates GHI scores every year to track progress. This score is useful to create

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awareness and tracking the proposed targets against hunger. The use of the Net State of Nutrition Index triple burden (NeSNI-TB) is an optimal tool to track the worldwide progress of the state of nutrition (Luo et al., 2020). GHI score is based on the following indicators (*About: The Concept of the Global Hunger Index*, n.d.) (*About: The Concept of the Global Hunger Index*, n.d.).

1. **Undernourishment or Insufficient calorie intake**: Population not meeting their required daily caloric intake (data sourced from the Food and Agriculture Organization (FAO) of the United Nations)
2. **Child Wasting (underweight):** Children aged below five years who have a low weight compared to their height, indicating acute undernutrition (data sourced from a joint database of the United Nations Children's Fund (UNICEF), World Health Organization (WHO), Global Database on Child Growth and Malnutrition, World Bank, Demographic and Health Survey (DHS), Multiple Indicator Cluster Survey (MICS) reports)
3. **Child stunting:** Children aged below five years who have a low height compared to their age, indicating chronic undernutrition (data sourced from a joint database of the United Nations Children's Fund (UNICEF), World Health Organization (WHO), Global Database on Child Growth and Malnutrition, World Bank, Demographic and Health Survey (DHS), Multiple Indicator Cluster Survey (MICS) reports).
4. **Child mortality rate:** The rate of death among children below the age of five years due to insufficient nutrition and unhealthy living conditions (data sourced from the United Nations Inter-agency Group for Child Mortality Estimation (UNIGME)).

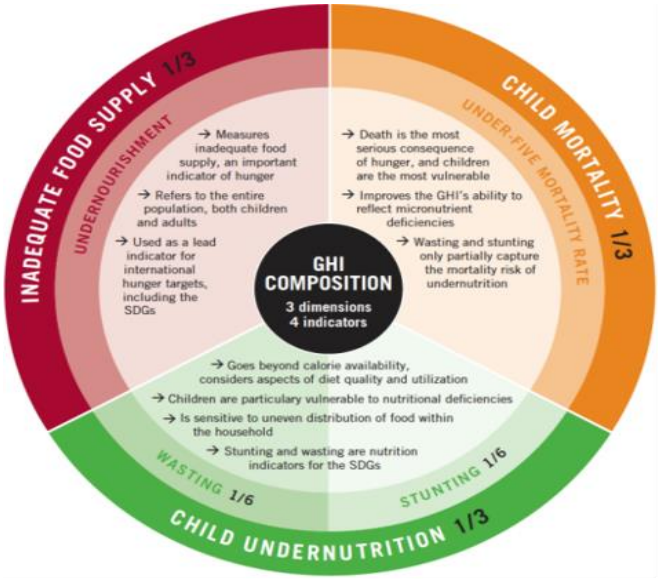

Figure 3: Composition of Global Hunger Index

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Source: ((ifpri) & International Food Policy Research Institute (IFPRI), 2018))(*Global Hunger Index Scores by 2020 GHI Rank*, n.d.-a) *(Global Hunger Index Scores by 2020 GHI Rank, n.d.-a)*

GHI score is calculated by determining values for all four indicators based on available data for each country. Then, a standardized score is given to each indicator and finally, a standardized score is aggregated to get a GHI score for each country. GHI score is measured on a 0-100 point scale. However, 0 is considered the best score i.e. no hunger, and 100 is the highest score i.e. extreme hunger. The severity scale is well explained with the scores i.e. ≤ 9.9, 10.0–19.9, 20.0–34.9, 35.0–49.9, 50.0 ≤ are low, moderate, serious, alarming, extremely alarming, respectively (*Global Hunger Index Scores by 2020 GHI Rank*, n.d.-b). The Global Hunger Index for India in the year 2020 is 27.2 which is considered as serious as per the severity scale. However, India ranks 94th out of 107 countries with a sufficient database (*Global Hunger Index Scores by 2020 GHI Rank*, n.d.-c). Whereas, for 2019 GHI score was 30.3 and India ranks 102 out of 117 countries (*Global Hunger Index 2019*, n.d.) (*Global Hunger Index 2019*, n.d.). One of the news articles from "*The Hindu*" recently emphasized the impact of the Covid-19 pandemic on the hunger index in India which reflects that it affected the progress made in reducing poverty and hunger. As per GHI 2020 report, it is clear that India has the highest incidence of wasted children under the age of five years in the world which ultimately shows acute under-nutrition (Correspondent, 2020).

WATER SECURITY AND ITS INDICATORS

Three-fourths of the 'Earth' surface i.e. 71% is covered by water. Hence, it is called the blue planet. The systematic representation of Global Water Distribution (in %) is given in Fig. 4 data acquired from the book 'Water in Crisis' (*Water in Crisis*, n.d.). It is well understood from the diagram that only a small amount of freshwater can be put to use. Water security is well defined by Grey & Sadoff, (Grey & Sadoff, 2007) "*The availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems, and production, coupled with an acceptable level of water-related risks to people, environments, and economies*."

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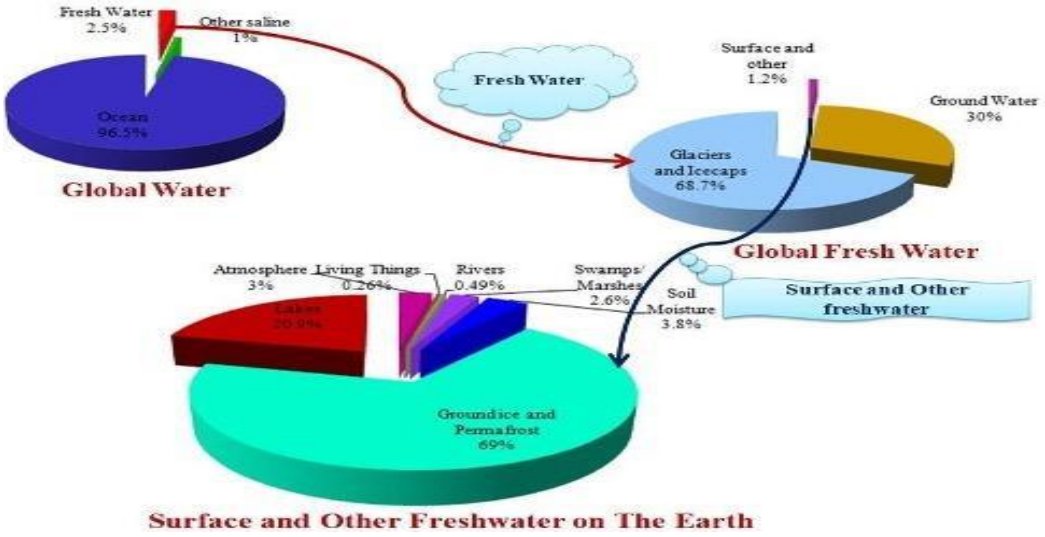

Figure 4: Global Water Distribution

As every coin has two sides, water also deals with people and the environment in positive and negative ways. Positive ways include agricultural irrigation, domestic use, water-associated recreation, an extension of estuarine and wetland areas, aquatic biodiversity conservation, industrial use, and other non-potable use like hydropower generation, However, negative ways include water-related disasters such as floods, droughts, earthquakes due to heavy water pressure of large water reservoirs, waterborne diseases, wastewater discharge in natural water resources, sewage discharge, eutrophication, and pesticide contamination due to agricultural runoff, inter-state water disputes, water supply conflicts and, water scarcity, etc (*Food, Water, Sanitation, and Hygiene*, 2021).

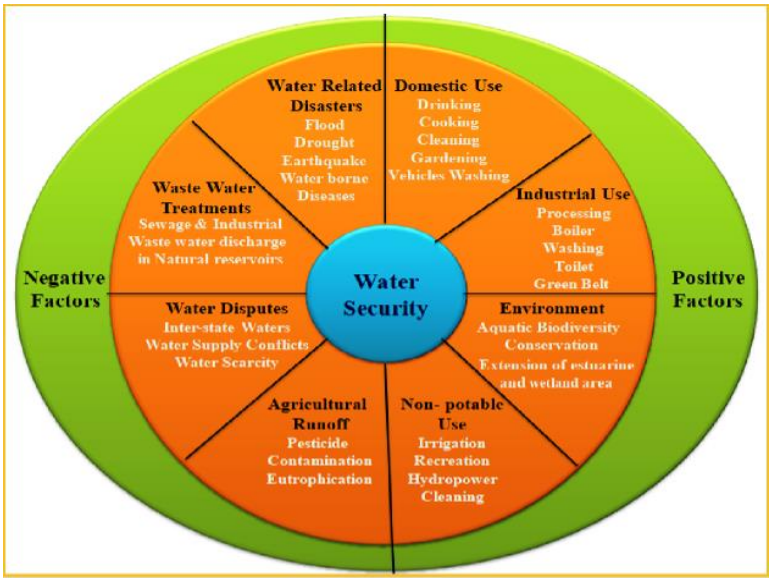

Figure 5: Factors involved in Water security

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The mismanagement of water including misallocation and insufficient infrastructure investment ultimately leads to water insecurity. It leads to a significant threat to future water provision, ecosystem degradation, damages due to environmental pollution, etc (Bank & World Bank, 2021) (Bank & World Bank, 2021)

CLIMATE CHANGE AND FOOD-WATER NEXUS: AN INDIAN PERSPECTIVE

Individuals' entitlement to food can be seen as a claim on society (starting but not ending with the State). It is a right to be free of hunger that stems from the presumption that society has the sufficient economic and institutional capacity to ensure that everybody is well-nourished (Dřeze, 2005) (Dřeze, 2005). Several binding and non-binding international conventions recognize and reaffirm the human right to sufficient food.

The following are a few of the most significant-

- Article 25 of the Universal Declaration of Human Rights (UDHR) acknowledges the right of all individuals to a satisfactory standard of living, which includes access to food (*OHCHR*, n.d.).
- Article 11 of the International Covenant on Economic, Social and Cultural Rights (ICESCR) affirms the entitlement of every person to a decent standard of living, which encompasses adequate food, as well as the essential right to be free from hunger, which is recognized as an independent right (*OHCHR International Covenant on Economic, Social and Cultural Rights*, n.d.) *(OHCHR International Covenant on Economic, Social and Cultural Rights, n.d.)*.
- Article 12 of the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW) acknowledges the entitlement of pregnant and lactating women to particular protection concerning sufficient nutrition. Moreover, Article 14 of the Convention establishes the right of rural women to equal access to essential resources such as land, water, credit, and other services, social security, and satisfactory living conditions (*OHCHR International Covenant on Economic, Social and Cultural Rights*, n.d.) *(OHCHR International Covenant on Economic, Social and Cultural Rights, n.d.) (OHCHR International Covenant on Economic, Social and Cultural Rights, n.d.)* and,
- Article 25 of the Convention on the Rights of the Child (CRC) acknowledges every child's right to the best feasible standard of health. Similarly, Article 27 of the Convention establishes the entitlement of every child to an adequate standard of living, which includes access to food and nutrition, as highlighted in both articles. (*OHCHR Convention on the Rights of the Child*, n.d.) *(OHCHR Convention on the Rights of the Child, n.d.)*A variety of studies and publications have clarified the normative material, state responsibilities, and consequences of the right to food by the Food and Agriculture Organization of the United Nations (FAO), (*Website*, n.d.-b) the Committee on Economic, Social and Cultural Rights (CESCR) and the Office of the High Commissioner for Human Rights (OHCHR), etc. In India, Article 21 of

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> the Constitution guarantees every individual's right to life and personal liberty. However, for the effective realization of this right, it must be read in conjunction with Article 39(a) and 47, which outline the state's responsibilities. As per Article 39(a), a Directive Principle of State Policy, the state must direct its efforts towards ensuring that all its citizens have access to adequate means of subsistence. Additionally, Article 47 mandates the state's primary responsibility to enhance the nutritional quality and living standards of its people. In its landmark decision in the public interest litigation Petition (Civil) No.196/2001, People's Union for Civil Liberties v. Union of India & Others (PUCL), the Supreme Court of India explicitly established the fundamental human right to food and determined a minimum dietary floor for the underprivileged population. As a result, the Constitution establishes the Right to Food as a Fundamental Right that can be enforced by the legislative solution set out in Article 32 of the Constitution (*Website*, n.d.-c).

The PUCL case has left a profound impact on the lives of millions of people in India. In recent years, important advances in government systems have included the maintenance of the Public Distribution System, in which foods are distributed to citizens in extreme poverty; the universalization of the Integrated Child Development Scheme (ICDS), which allows all children to access services provided at ICDS feeding centers (Sachdev & Dasgupta, 2001); and the universalization of the Integrated Child Development Scheme (ICDS), which allows all children to access services provided at ICDS feeding centers; the continuation of the Mid-Day Meal Scheme (MDMS) in schools; and the issuing of court guidelines barring any alteration or discontinuation of any food scheme protected by previous orders without the Supreme Court's approval. In 2013, the Indian government enacted the National Food Security Act (NFSA) to ensure that all Indians have access to food security. The law enables eligible households to purchase up to five kilograms of cereals per person at even lower prices (three rupees per kilogram of rice, two rupees per kilogram of wheat, and one rupee per kilogram of coarse grains). To financially support farmers, the Indian government purchases food grains at a Minimum Support Price, acquiring up to one-third of India's wheat and 15% of its rice production annually. The grains are then distributed to Fair Price Shops, where ration cardholders can purchase them at a reduced cost. Despite being one of the world's largest social security programs, with 810 million Indians having access to its benefits, India still struggles to achieve adequate levels of food security, as demonstrated by various nutrition metrics.

Although poverty and wealth inequality are often cited as major contributors to food insecurity, they tend to play a smaller role in South Asia. South Asian nutrition has not changed as much as it has in Sub-Saharan Africa as a result of economic development and poverty reduction. The “South Asian enigma” is the way of referring to this phenomenon. Malnutrition is lower in developing nations, such as Ethiopia, which is much poorer than India on a per capita basis. India's food security policies are generous and based on calorie supply. They may not, however, encourage the dietary flexibility needed to prevent high rates of malnutrition. Since most farms are rain-fed, Indian agriculture is reliant on the two monsoon seasons. Around June and September, the major monsoon

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(also known as the southwest monsoon) occurs, accounting for almost 80% of the country's rainfall. Although some Indian agricultural systems depend on rivers fed by snowmelt from the Hindu Kush Himalayan range, this source is less important for the majority of the country's agricultural regions.

The Indian government's research institute, NITI Aayog, says that “India is experiencing the worst water crisis in its history.” The country's water demand is expected to be double the available supply by 2030, meaning extreme water shortages for hundreds of millions of people and a 6% reduction in the country's GDP (*Website*, n.d.-d). The agriculture sector uses between 85 and 90 percent of all water consumed in India. Farmers begin to use groundwater instead of surface water when surface water bodies become contaminated or unavailable. India consumes a fifth of all freshwater consumed worldwide, and there is a good possibility that nearly two-thirds of the country's aquifers will be in critical condition by 2032, owing to inadequate water usage.

The PDS guarantees that Indians have enough calories to live, but it does not have the dietary flexibility needed for a healthier lifestyle. Since most developed countries' economies are highly reliant on climate-sensitive sectors like water, irrigation, fisheries, oil, and tourism, climate change poses a significant threat to their social and economic growth (Munang et al., 2013). Water mismanagement, shifting climatic conditions, reduced agricultural productivity, and inefficient farming practices are likely to continue to pose challenges to Indian food security, despite attempts to increase the PDS (PDS i.e. Public Distribution System). Inadequate distribution of food through PDS is also one of the reasons for accelerating food insecurity. Since the criterion for classifying a household as BPL is arbitrary and varies from state to state, the Targeted Public Distribution System (TPDS) has the problem of excluding individuals who are the appropriate candidates for qualifying the subsidy due to non-ownership of a below poverty line (BPL) status. The

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sometimes erroneous segmentation of food grains into above poverty line (APL) and below poverty line (BPL) categories had resulted in a significant drop in food grain consumption. In addition, the poor quality of grains and the lack of service at PDS stores have exacerbated the problem.

FUTURE PERSPECTIVES

India's total water demand is forecast to increase from 750 BCM in 2000 to 1027 BCM by 2025. By 2025, the irrigation market alone is expected to use 730 BCM of water and India receives approximately 4400 km3 of water each year. India's water share in the world is about 4.2 percent and at present, only 29% of overall precipitation is conserved. India has 143 million hectares of arable land, 63 million of which are irrigated. About half of our country's irrigated land is supplied with water via groundwater extraction. Urbanization would have an effect on the amount and quality of water available for agriculture, particularly in peri-urban areas. For India's food security, efforts must be made to achieve an optimal balance between demand and availability of water supplies. In general, water shortage is described as an imbalance in supply and demand. Water is effectively limited where the amount of water demanded exceeds the amount available, at the current price, or undercurrent access conditions. As a result, when demand rises or supplies decrease, water shortages will exacerbate. When contamination degrades water quality, the amounts of unacceptable constituents will rise to the point that the water is unfit for human consumption, agriculture, or aquaculture. Water contamination can damage both surface and groundwater supplies, reducing the amount of water available at a given place or time. Water quality deficiency can cause or worsen water shortage in this way. Unconventional water has the potential to play a significant role in the management of water supplies and farming practices in semi-arid and dry regions. Wastewater recycling and reuse for beneficial purposes including agriculture and landscape irrigation, manufacturing applications, and replenishing a groundwater aquifer (groundwater recharge) will help reduce the effect of climate change on crop yield and water supplies.

REDUCING FOOD LOSSES

Food loss is described by the FAO as “a reduction in the quantity or quality of food and agricultural or fisheries items intended for human consumption that are eventually not consumed by people or have a quality reduction expressed in their nutritional value, economic value, or food safety” (FAO, 2014d). Food losses are most common in the early stages of the food supply chain, especially during harvest, post-harvest handling, and processing, according to these descriptions. Food waste is most common at the end of the supply chain, in grocery or bulk stores, and in consumers' households (FAO, 2014e). Food loss and waste are also considered wastes of inputs, such as the soil, water, and energy used to manufacture crop and livestock goods (Gustavsson et al., 2011). According to Gustavsson et al.(2011), one-third of the food provided for human consumption is either discarded or destroyed at some point in the supply chain, resulting in an annual loss of around 1.3 billion tonnes of food. Interestingly, losses and waste arise

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at any step of the supply chain, from farm processing to consumer demand. Most of the waste happens at the market level in lower-income countries, while much of it occurs at the early and middle stages of the supply chain in higher-income countries (Gustavsson et al., 2011).

SUSTAINABLE PRODUCTION

To Promote Sustainable Production Of Crops, Livestock, And Fish By Both Smallholders And Larger-Scale Producers, There Is A Need For Public Investments And Policies That Encourage Private Investments In Technologies And Management Practices.

To ensure the preservation of water balance at the geographic or basin level, water ministries and purveyors must engage in water accounting and create effective strategies and processes. Water accounting involves estimating the amount of water diverted, applied, and transpired, as well as the water waste, surface runoff, and deep percolation required for irrigation and other purposes. Water accounting is crucial in calculating the future benefits of water-saving infrastructure investments. To promote water conservation practices, incentive programs can be implemented for water users in both irrigated and rainfed conditions. In irrigation, public funding for land leveling and the purchase of drip or sprinkler systems can be useful, even if it does not always result in net water savings. To encourage the general public to use less water, subsidies or rebate for water-efficient equipment or installing drip irrigation in yards and kitchen gardens can be provided. Businesses can benefit from subsidies for improvements in water-saving processes, as well as wastewater capture and disposal.

Water allocation and utilization can be made more effective with the help of regional and national management programs. The China CropWatch System (CCWS) collects high-quality data. Remote sensing is used to gather high-resolution (30 m and above) and low-resolution (250 m to 1000 m) crop and water use information, as well as assess many crop status indicators. Crop growth forecasting, drought monitoring, grain output forecast, crop production forecast, crop planting structure inventory, cropping index tracking, and food supply-demand balance and early warning are all included in the CCWS (Wu et al., 2014). Another area that, if tackled, may yield significant results is the revamping of current direct nutrition programs to allow management by women's Self Help Groups (SHGs) and/or local bodies, as well as the orientation and preparation of community health staff, Panchayati Raj Institution (PRI) representatives, other opinion makers, caregivers, and other stakeholders.

WATER RESOURCE MANAGEMENT AND REUSE

The hydrological cycle plays an important role in the availability of water on the earth. Eventually, water reservoirs on earth are being renewed and recharged timely through precipitation. Being advanced brain animals, now we have to manage and conserve the water available on this planet. The first prime minister of India Jawaharlal Nehru announced publicly that, "*The dams are the temples of modern India*". Because, dams

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would help in integrating the development of agriculture and improvement in the village economy along with rapid industrialization and a hike in the urban economy (Vyas & Nath, 2021). There are so many ways to manage water in several sectors such as industrial, agricultural, domestic, recreation, infrastructure development, black water management, etc.

However, water can be managed through advanced techniques such as advanced common effluent treatment plants (CETP) to treat industrial wastewater ("Common Effluent Treatment Plant (CETP): Reliability Analysis and Performance Evaluation," 2018) ("Common Effluent Treatment Plant (CETP): Reliability Analysis and Performance Evaluation," 2018), proper irrigation techniques viz. subsurface drip/trickle, sprinklers, etc (Sakellariou-Makrantonaki et al., 2007), reuse of domestic wastewater (i.e. greywater) for gardening and vehicles washing, etc (Oteng-Peprah et al., 2018), by adopting rainwater harvesting techniques for building constructions (*Volume 1-Issue 2*, n.d.), sewage treatment plant (STP) (Rajemahadik & Mendapara, 2020), reuse of water by using proper disinfection methods, etc. Interestingly, Tamil Nadu in south India is the first state which has made rooftop rainwater harvesting infrastructure compulsory to all architectural activities with legal provisions of punishment to the culprit. The agricultural sector is the largest water consumer (Vaidyanathan & Jairaj, n.d.). The concept of three 'Rs' i.e. replacement, reduction, and refinement is first described by W. M. S. Russell and R. L. Burch in 1959 (Kirk, 2018).

Furthermore, these 3Rs are used in waste management practices as *Reduce*, *Recycle*, and *Reuse*. However, industrial wastewater is most hazardous for natural water reservoirs. It must be treated with primary, secondary, tertiary, and advanced wastewater treatments before discharging into water resources. Secondly, this recycled water also can be reused for gardening, the development of green belts around industries, washing, toilet flushing, cleaning, and many other non-potable purposes. So that the freshwater burden can be reduced at the source. In this way, the 3Rs can be attempted for the proper management of water.

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