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RK Naresh
Department of Agronomy, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, India

Rajan Bhatt
Krishi Vigyan Kendra, Amritsar, Punjab Agricultural University, Ludhiana, Punjab, India

PK Singh
Director Extension, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, India

Yogesh Kumar
Department of Soil Science, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, India

Himanshu Tiwari
Department of Agronomy, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, India

Ankit Saini
Project Associate, CSIR-IHBT, Palampur, Kangra, Himachal Pradesh, India

Chandra Saha
M.Sc. (Department of Soil Science), ICAR-Indian Agricultural Research Institute, Assam, India

Aman Verma
Ph.D. Research Scholar (Extension Education), Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Himanshu Thakur
Department of Entomology, CSK Himachal Pradesh Krishi Vishwavidyalaya, Palampur, Kangra Himachal Pradesh, India

Corresponding Author:
RK Naresh
Department of Agronomy, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, India

Millet: The super food in context of climate change for combating food and water security: A review

RK Naresh, Rajan Bhatt, PK Singh, Yogesh Kumar, Himanshu Tiwari, Ankit Saini, Chandra Saha, Aman Verma and Himanshu Thakur

Abstract
A rising population translates into a constant demand for food. There is conflict over resources like land and water as a result of this worldwide concern. The quantity and quality of these resources are directly impacted by climate change, which has a negative impact on our food systems and land efficiency, particularly for the production of important cereals crops conventionally grown in the region. In this review paper, an attempt is made to examine the availability of resources like soil and water in various parts of the world. The majority of these studies forecast a decline in the production rates of various grain crops. Additionally, it is well recognized that all the major cereal crops contribute more to global warming than alternative crops like millet, which should be taken into account in reducing global food insecurity. Therefore, this paper predicted how millets crops under the present scenario of climate change could help to ease the strain on the ecosystem as these crops have lower water, fertilizers, and energy footprints as a whole.

Keywords: Climatic change, millets, agricultural productivity, water scarcity, and food security

1. Introduction
One of the largest problems facing the modern world is feeding everyone on the planet. The lack of micro- and macronutrients, shortages in food production that cause supply-demand mismatches, and conflicts that destabilize different regions of the world are all factors that contribute to this problem. Even though some of these causes of hunger can be addressed, the threat of climate change and global warming still exists. As a result, the number of people who experience hunger and malnutrition has decreased slightly from approximately one billion in the years 1990–1992 to 850 million in the years 2010–2012[FAO, 2012]. 2-3 billion people may experience nutritional insecurity as a result of reduced food production rates and the additional strain of feeding a population that will top 9 billion by 2050 [Wheelker and Braun, 2013; Godfray *et al*. 2010] [75, 28]. Land productivity, crop production, and the overall sustainability of our food systems are all said to be directly impacted by climate change and rising world average temperatures. Although predictions suggest that some regions may benefit from climate change through increased productivity and yields, this will not be sufficient to feed the expanding global population [Kang *et al*. 2009] [38]. Furthermore, the majority of scientists concur that crop output would be severely decreased under the influence of climate change and greenhouse gas emissions. Therefore, ensuring food security depends greatly on reducing greenhouse gas emissions in order to control global temperatures. However, one of the main sources of greenhouse gases like methane in the environment is the agriculture industry Intensive farming practices, which are practiced in various parts of the world, typically result in higher emissions [Downing *et al*. 2000; Olesen and Bindi, 2002] [21, 52].

The future of factors influencing agricultural growth viz. soil and water around the world, 50-100 years from now, has been predicted by numerous researchers over the course of the last few decades. These predictions have been compiled and presented. Although there have been prior attempts to analyze the modeling data, they typically only cover a small portion of climate change or a particular location. Higher emissions often result from intensive farming methods, which are used worldwide [Downing *et al*. 2000; Olesen and Bindi, 2002] [21, 52]. Over the past few decades, many academics have used various models to anticipate how soil and water resources would be in the world in 50 to 100 years. These forecasts have been assembled and displayed. Although previous analyses of the requirements have been made, they often only cover a small area of climate change or a specific area.

2. Millets Cultivation

In addition to being a large source of macronutrients including carbohydrates, lipids, and proteins, cereal crops also have a sizable potential to contribute to global warming. Wheat has the biggest global warming potential of all the major cereal crops, with an estimated 4 tons CO2 eq/ha, followed by rice and maize (an estimated 3.4 tons CO2 eq/ha). Additionally, the carbon equivalent emissions from these crops are considerable, averaging 1000, 956, and 935 kg C/ha for wheat, rice, and maize, respectively [Jain *et al*. 2016] [37]. They are widely cultivated and the main sources of nutrition for the entire world's population despite having greater emission rates. Other minor cereal crops, including millets and sorghum, have significantly lower carbon footprints. This is one of the main justifications millets could be one of the crops that lessen the global carbon footprint [Prasad and Staggenborg, 2009] [58]. The FAO (2014) reports that the most widely grown millet varieties worldwide are Pearl, Proso, Foxtail, Japanese Barnyard, Finger, and Kodo (Figure 1).

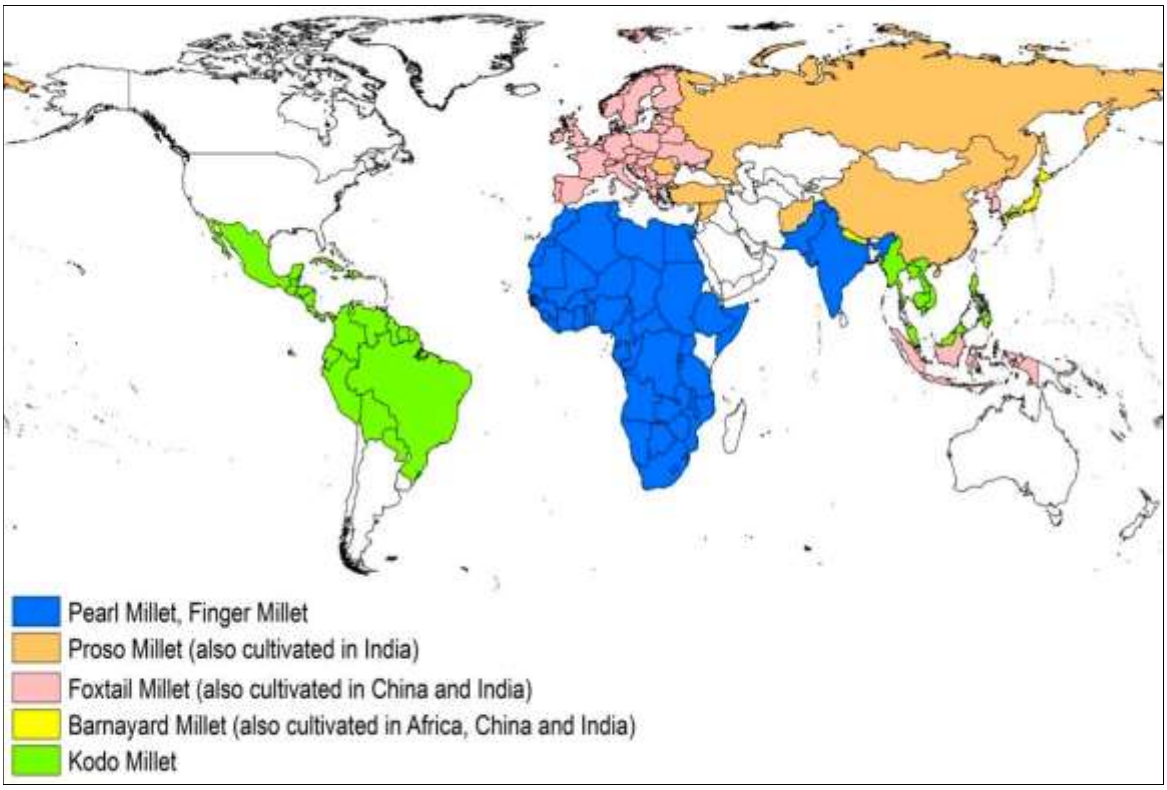

Fig 1: Global Millet cultivations scenarios (Source: Saxena *et al*, 2018) [62, 74]

Different varieties of millets are grown in various parts of the world and require various growth circumstances. These millets have various scientific names as well as common names depending on the place in which they are grown. Millions of people every day consume rice, wheat, maize, and, to a lesser extent, millet as their primary sources of nourishment. The growth pattern of these crops is determined by temperature and water availability. While wheat is mostly grown in regions with limited water supplies and suitable temperatures, rice and maize are grown where there is a plentiful supply of water. Sorghum and millets are cultivated in regions with limited water supplies. Millets can also be grown in semi-arid and arid areas because of their resilience to biotic and abiotic stresses and their high yield on low-quality soils with little additional input [Prasad and Staggenborg, 2009; Awika, 2011] [58, 5]. Millets typically thrive at quite high temperatures and are xerophilic (love moisture) (can reproduce with limited water input). There are many various species of millets around the world, and they all need different types of soil to thrive healthily. In contrast to sorghum or maize, pearl millet is better at using moisture, allowing it to grow on sandy, poor soils and thrive in dry conditions. Therefore, pearl millets are typically farmed in regions with marginal soil and little annual precipitation, ranging from 200 to 500 mm [Guigaz, 2002] [30]. Pearl millet is the sixth most significant crop farmed globally, according to the FAO (2014). Pearl millet is a traditional crop in India, Pakistan, Central, Eastern, and Southern Africa, and Western Africa, particularly in the Sahel, and along the southern coast of the Arabian Peninsula [ICRI, 1996]. In parts of Africa and India, it is seen as a crucial crop for ensuring food security [Passot *et al*. 2016] [54]. *Eleusine coracana* L., popularly known as finger millet, is cultivated in some regions of Africa and India. When production figures are taken into account, it ranks sixth among the country's principal cereal grains in India, behind wheat, rice, maize, sorghum, and bajra [Devi *et al*. 2014] [19]. Compared to other cereal crops, it can grow at higher temperatures and on more salinized soils. Temperatures between 11 and 27 °C, soil pH ranging from 5 to 8, and moderate rainfall are ideal for cultivating finger millet [Upadhyaya *et al*. 2008] [70].

China, India, and Russia are the three countries that grow proso millet. According to some theories, proso millet evolved in Central and Eastern Asia before migrating to Russia, India, the Middle East, and Europe (Roshevits, 1980; Baltensperger, 1996) [60, 6]. It is an essential crop throughout the Middle East, including Iran, Iraq, Syria, and Turkey, as well as Afghanistan, Kazakhstan, Northwest China, Australia, Central and Southern India, Russia, and the USA [Zarnkow *et al*. 2009] [78]. Proso millet is a short-season crop that is typically grown for 60–75 days. It needs an average annual rainfall of less than 600 mm, and an ideal daily temperature is 17 C [Zarnkow *et al*. 2010] [77]. Foxtail millet seeds from the Neolithic and Bronze periods have been discovered in numerous locations throughout Europe, the Middle East, Eastern, and Central Asia. Currently, the Korean peninsula, China, India, Indonesia, Europe, and the former USSR all farm a significant amount of this millet. Foxtail millet is ideal for use as a catch crop because of its quick ripening mechanism and strong photosynthetic efficiency [Leder, 2004] [42]. Additionally, it is nutrient-dense and has strong resilience to pests and illnesses [Vetriventhan *et al*. 2012] [71]. Despite receiving just one pre-sowing precipitation, this crop yields well [Dwivedi *et al*. 2012] [22]. Additionally, according to Zhang, *et al*. 2007 [79], foxtail millet is more water-efficient than sorghum and maize. Two varieties of barnyard millet that are grown commercially are *Echniochloa utilis* and *E. frumentacea* [Yabuno, 1987] [76]. *Echniochloa utilis* is often referred to as Japanese barnyard millet, but *E. frumentacea* is also called Indian barnyard millet, sawa millet, and billion-dollar grass. This variety of millet, which is produced extensively in India, China, Japan, Pakistan, Africa, and Nepal [Gomashe, 2017] [29], is regarded as a minor cereal. In India, barnyard millet comes in second to finger millet in terms of annual production (87,000 tonnes) and productivity (0.86tons/ha) [Padulosi *et al*. 2009] [53]. It is a crop that tolerates drought, matures quickly, and has excellent nutritional properties [Wallace *et al*. 2015].

In India, Kodo millet first appeared. This millet is thought to have been domesticated some 3000 years ago [House *et al*. 1995; Arendt and Dal Bello, 2011] [32, 2]. The tropical and subtropical climates are ideal for kodo millet [Arendt and Dal Bello, 2011, Hulse *et al*. 1980] [2, 33]. When grown for 80 to 135 days, Kodo millet is considered to have the strongest drought resistance of any minor millet and to produce a respectable yield.

3. Millets for Food and water security

Food security exists when all people, at all times, have physical, social and economic access to safe, sufficient and nutritious food meet their dietary needs and food choices for an active and healthy life. The four pillars of millets food security are availability of food, access to food, utilization of food and food security. (Tiwari, *et al.,* 2023) [12, 66]. Millets are a perfect crop for adapting to people's shifting dietary preferences and climatic conditions because of their short lifespan, high photosynthetic efficiency, nutritional richness, and mediocre resistance to pests and diseases. (Vetriventhan *et al.,* 2012) [71]. A quantitative examination of shifting monsoon cereal output in India revealed millets as a potential solution for guaranteeing food security and environmental resilience. Millets are a wise food choice because they're beneficial for your health, the environment (requiring less water to grow), and the farmer (being more tolerant of shifting weather patterns). High levels of proteins, niacin, fiber, thiamine, riboflavin, methionine, lecithin, and a negligible amount of vitamin E can all be found in millets. They are rich in minerals including iron, magnesium, calcium, and potassium. The nutritional benefits of millet may help prevent cancer, lower the risk of heart disease, limit the formation of tumors, lower blood pressure, slow down the rate at which fat is absorbed, postpone gastric emptying, and increase gastrointestinal bulk. The millet are deprived of vital elements, such as dietary fiber, phenolics, vitamins, and minerals, during the milling process (Awika, 2011) [5].

"Millets are also a great source of phytochemicals that are good for your health, such as polyphenols, lignans, phytosterols, phytoestrogens, and phytocyanin's. They serve as immune system regulators, detoxifying agents, antioxidants, and other roles, preventing age-related degenerative illnesses like cancer, diabetes, and cardiovascular diseases (CVD). In addition to their well-known roles in avoiding diseases caused by nutritional deficiencies, some vitamins, minerals, and essential fatty acids also offer advantages in the prevention of degenerative diseases. Millets are safe for those with celiac disease and gluten allergies because they are non-glutinous. They don't produce acids, are simple to digest, and are allergy-free. Millets may offer defense against age-related degenerative illnesses. Millets are protective against several degenerative diseases, including metabolic syndrome and Parkinson's disease. They also lower the risk of heart disease, protect against diabetes, improve the digestive system, lower the risk of cancer, detoxify the body, increase immunity in the respiratory system, increase energy levels, and improve the muscular and neural systems. Resistant starch, oligosaccharides, lipids, antioxidants such phenolic acids, avenanthramides, flavonoids, lignans, and phytosterols, which are thought to be responsible for a number of health advantages, are among the essential elements found in millets. Among these, millets stand out for having characteristics that make them climate-resilient, such as adaptability to a wide range of ecological conditions, reduced irrigation needs, improved growth and productivity under low-nutrient input conditions, reduced reliance on synthetic fertilizers, and minimal susceptibility to environmental stresses. (Tiwari *et al.,* 2022) [67]

Historically, millets served as poor farmers' protection from the whims of the Indian monsoon. Millets may provide us with climate change insurance in the future. Millets can withstand extreme weather, such as drought and high temperatures. They may thrive in the driest, toughest environments. When compared to other cereal crops like rice and wheat, millet has a high nutritional content and is drought-resistant. It also requires less water for growth. (Saxena *et al.,* 2018) [62, 74]. Millets, which are cultivated for both food and fodder, help millions of people, especially small/marginal farmers in rain-fed areas, practice efficient farming by supplying food and a stable source of income. (Kumar *et al.,* 2022) [67]. Millets are grains for the future in a context of climate change and global warming because they are drought, temperature, and pest tolerant. (NAAS 2013) [51].

4. Procedure Approved

According to the information provided, the majority of millets are grown in South America, Europe, Africa, South Asia, Southeast Asia, and China (Figure 1). It implies that these are the regions with the best climatic settings for millets farming. This is the primary criterion employed in this study to choose these particular regions. It makes sense that the amount of millet gathered in Africa has increased, whilst the amount of millet grown in China, South America, Southern Asia, and Europe has decreased (Figure 2).

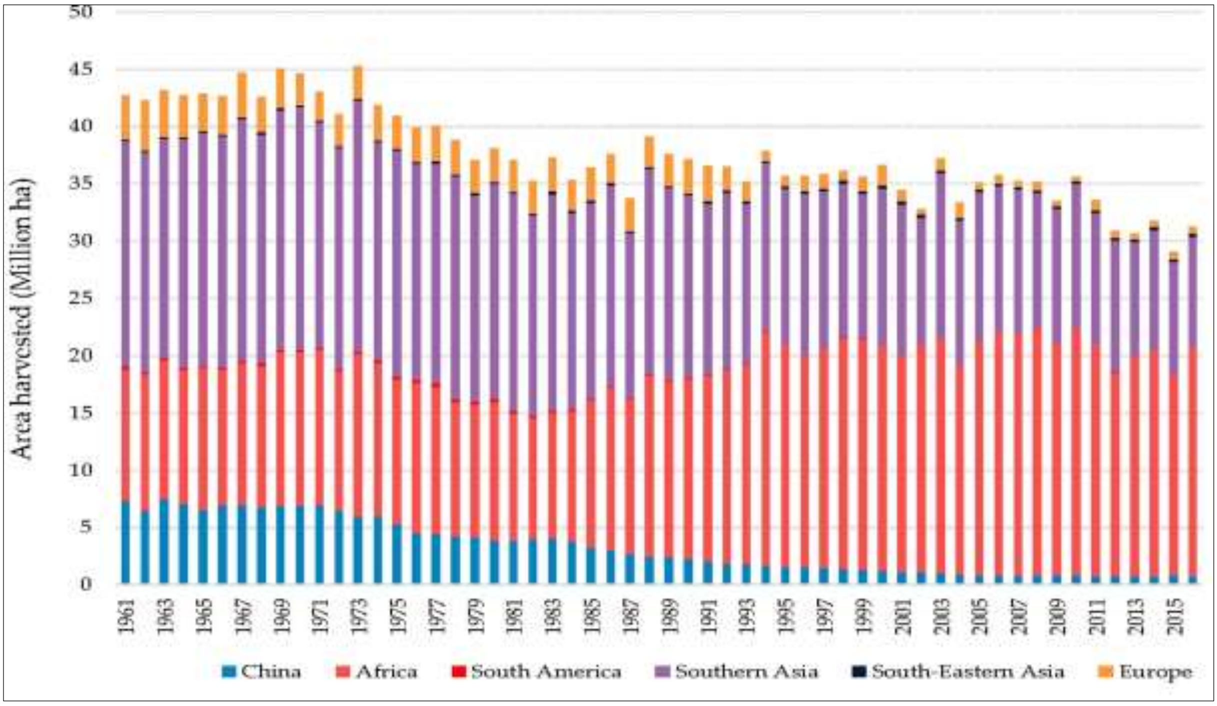

Fig 2: Harvested area of Millet in different regions of the world (Source: Saxena *et al*, 2018) [62, 74]

For South Asia, the cultivated area remained essentially stable between 1961 and 2016. Higher millet yields (hg/ha) were found in China, South America, South Asia, Southeastern Asia, and Europe, but Africa's yields were remarkably stable over the course of the study (Figure 3).

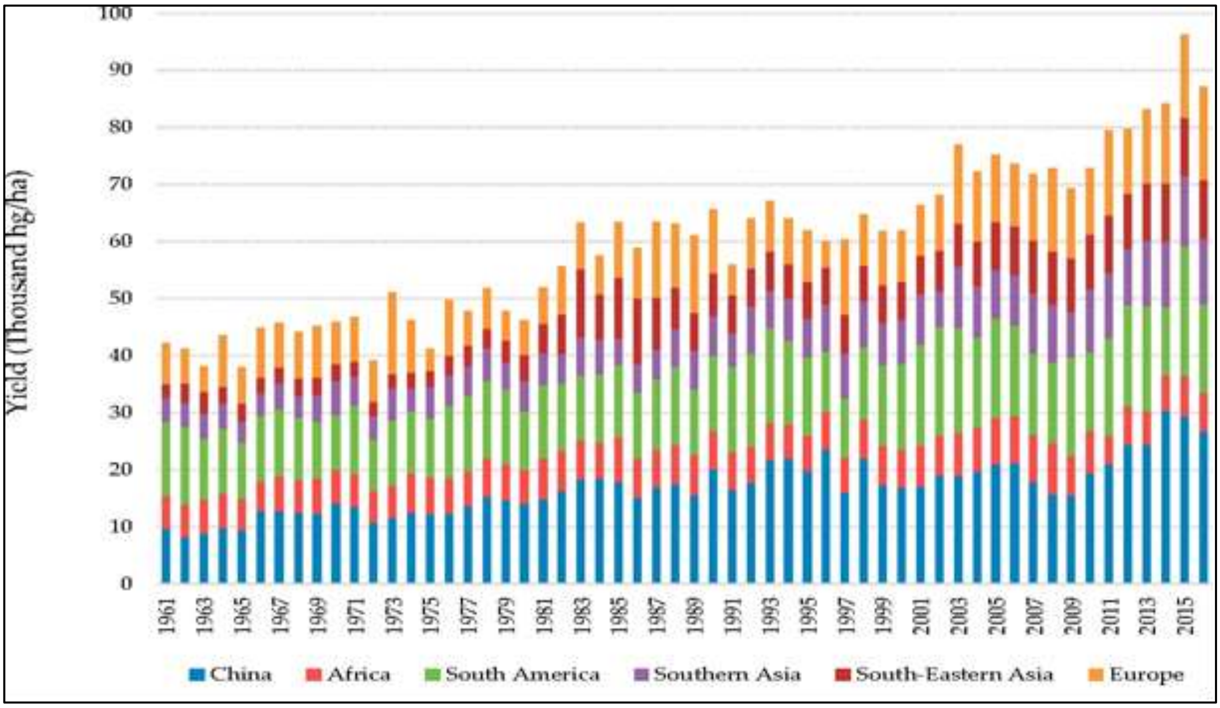

Fig 3: Global Land productivity of Millets (Source: Saxena *et al*, 2018) [62, 74]

Thus, it can be concluded that although millet is being grown in fewer areas in Europe and China, the yield is rising, which raises the idea that there is still a consumption need in these areas. The second criterion was to only include studies from 2012 to 2018 that could offer up-to-date data. The third factor that was taken into account was that each study that was chosen had to cover a sizable portion of the regions that were chosen.

5. Climatic changes and land productivity of agriculture

5.1 Soil Condition Changes

In order to produce fresh water, food, and fibre, soil resources must be preserved and improved globally [Koch *et al*., 2013] [40]. According to estimates, 98% of terrestrial biodiversity and 97% of our food both originate from the soil. The issue of deteriorating soil quality around the world is not being addressed much at the moment. An initiative of the United

Nations Convention to Combat Desertification (UNCCD) has gained attention as it addresses issues that can help combat biodiversity loss and climate change [McBratney *et al.* 2017] [47].

By 2050, the expected human population will have grown from 7.4 billion to 9.1 billion [Godfray *et al.* 2010] [28]. Therefore, a dramatic increase in food, feed, and fiber production rates is required to meet the growing population's desire for nutrient-dense foods. According to Stott and Moebius-Clune (2017) [65], the estimated production rates required to feed a population of 9.1 billion people were higher than they had been for the previous 5000 years put together. Despite these environmental needs, during the past 20 years the United States has lost at least half of its topsoil (rich in organic matter) and an estimated 20 million acres of arable land to develop [USDA, 2012].

According to Stott and Moebius-Clune, 2017 [65], the physical and biological functioning of field soils would be significantly impacted by a further drop in ecosystem services. Microbes have been destroying the soil's organic matter, which contains 58% carbon, for the past 200 years. The soil structure that shields the soil's organic carbon from microbial attack and erosion is destroyed during plowing. Also contributing to the aforementioned problems is the loss of over 66% of the topsoil (A horizon). One of the main reasons for the global decrease in soil quality is soil erosion [Lal, 2001] [23, 41]. Soil structure, the function of plant cover, land topography, and soil disturbances are all factors that contribute to soil erosion. Although soil erosion occurs gradually, it has a significant long-term impact on soil quality [Pimentel and Burgess, 2013] [55]. In flat areas with grass or forest cover, erosion rates range from 0.001 t/ha/year to 1-5 t/ha/year, while in mountainous areas with natural vegetation, rates range from 1 to 5 t/ha/year [Burton, 2010] [18]. Even though soil erosion rates are low, they occur frequently over a long period of time, therefore erosion has a significant potential to move a lot of dirt [Myers, 1984]. 75 billion tons of fertile soil is thought to be lost annually by global agriculture systems [Eswaran *et al.* 2001] [23]. Water erodes roughly 67 billion tonnes of soil annually, according to data for the world's arable land for land quality classes I through VI [Morgan *et al.* 1998]. Future soil erosion rates can be forecast with the help of soil erosion models. While it is conceivable to investigate a small number of catchments and farms to gauge current rates of soil erosion and foretell the best management approaches, it is nearly impossible to carry out such a thorough analysis in each unique area to foretell future soil erosion rates.

5.2 Depletion of underground water levels and Water Resources as a whole

Due to an increase in human population, a change in diet and feeding practices, and a climate change under a global warming scenario, water scarcity has become a global problem (Bhatt and Arora, 2021; Bhatt *et al.* 2020a,b; 2021a,b, 2023; Busari *et al.*2015) [8, 10, 17]. The world's largest farmland ecosystem is under increasing pressure to ensure the sustainability of food production and the security of livelihoods, particularly in light of the many problems posed by diminishing water supplies, stagnant crop productivity, and deteriorating soil quality (Bhatt *et al.* 2019; Bhatt *et al.* 2021; Tyagi *et al.* 2022) [11, 8, 13, 14, 15, 68]. A secure irrigation water supply is necessary to sustainably fulfill the high demands of a growing population with the increasing burden of greater crop output and to meet the daily food and water needs of people, animals, and plants on Earth (Hossain and Bhatt, 2019; Bhatt *et al.* 2021; Arora *et al.* 2022) [11, 8, 13, 14, 15, 4]. Therefore, underground water depleting in the NW Indian region and scientists working on this issue how to reduce its footprint a minimum impact on land productivity and hence the livelihoods of the farmers. The majority of research focused on "blue water" found in lakes, reservoirs, rivers, and aquifers has been done on the future of the world's water supplies [Vorosmarty *et al.* 2000; Islam *et al.*, 2007; Alcamo *et al.* 2007] [72, 35, 1]. It is crucial to take "green water" into account when determining the actual water resources that the population has access to [Arnel, 2004] [3]. Rainwater that seeps into the ground is referred to as "green water." [Gerten *et al.* 2011] [27] and is essential to the majority of agricultural practices [Falkenmark *et al.* 2009, Roast *et al.* 2008] [24, 59] as well as the sustainable development of all terrestrial ecosystems. In addition, Rockström *et al.* 2009 [24, 59] hypothesized that it would be impossible to maintain a balanced diet of 3000 k Cal per person per day in countries with less than 1300 cubic metres of total green and blue water per capita per year. The FAO (Food and Agricultural Organization) likewise supported this value as the target that all developing nations should achieve by 2030 [FAO, 2003].

Food production, economic growth, human health, and ecological services are all impacted because over 2 billion people lack access to clean water. Groundwater depletion brought on by a lack of water can result in crop failure, wildfires, urban water shutoffs, and irreversible soil subsidence. Water scarcity is a result of a number of factors, including population growth and climate change [Jaeger *et al.* 2017] [36]. According to MacDonald, 2010 [45], climate models predict that there will be more droughts in the South Western United States in the 21st century and that these droughts would be more severe, last longer, and be more frequent. Even though there are more people, the amount of food produced would not change. Future food insecurity will result from this [Porkka *et al.* 2016] [57].

A system or prototype known as a hydrological model is one that represents the entire world in a simplified manner. These models are employed to comprehend the hydrological processes and study system behavior. The parameters at play specify the model's properties. Both rainfall information and drainage area are required inputs for all models. Groundwater aquifer features, watershed topography, soil moisture content, and watershed characteristics including vegetation cover and soil qualities are other significant aspects taken into account during modeling. Thus, hydrological models are regarded as an essential tool for managing water and environmental resources [Deviya *et al.* 2015; Sorooshian *et al.* 2008] [20, 64].

5.3 Climate change's impact on land productivity

The number of calories consumed per person per day (kcal/person/day) is used as a measure to assess the global food situation. From 2360 kcal per person per day in 1960 to 2800 kcal per person per day in the present, food consumption has increased. More than 100 million people live in seven developing nations on the planet. Other countries on the list, such as Brazil, China, and Indonesia, have consumption rates that fall between 2900 and 3000 kcal, despite the fact that India, Nigeria, and Pakistan have also improved their consumption rates. Additionally, less than 2200 kcal/person/day of food is consumed in nearly 30 developing nations worldwide [Bruinsma, 2017] [16]. According to FAO (2015), the agricultural sector in these developing nations has suffered significantly from one-fourth of the disasters brought on by climate change in recent years.

According to Lesk *et al*. 2016 [43], recent poor meteorological conditions such as a sharp rise in temperature, drought, and other factors have reduced the productivity of grain crops by 9–10%. By the end of 2050, an additional 2.4 billion people will reside in South Asia and Sub-Saharan Africa. The majority of people who reside in these areas rely on agriculture for their life and means of subsistence. More than 20% of the people currently residing in these areas hardly have enough food to meet their needs, and things will only become worse in the ensuing years. To meet the growing population's demand for food, it is advised that agricultural productivity be boosted by 60% by 2050. Therefore, the emphasis should be on raising agricultural output, which will ultimately result in a rise in income for emerging nations [Lipper *et al*. 2014] [44].

6. Viewpoint

It is clear from the analysis provided in the preceding sections that developed countries as well as emerging countries would have to adapt to changing climatic circumstances. In the most impacted countries by climate change, such as India, China, and Sub-Saharan Africa, there are a few choices that help lessen stress. They can first import food products from nations that have an abundance of fertile land and water resources. However, this can result in a trade imbalance and have a detrimental impact on the nation's GDP and economy. Additionally, the exporting nations will need to improve crop yields, which will put more strain on the existing resources and speed up resource depletion. Some predictions state that climate change may increase yields in a few countries, but this increase wouldn't be sufficient to ensure global food security. The loss of money would worsen poverty in countries like India and China, where a sizable portion of the population depends on agriculture for a living, which would have an effect on GDP. The second choice is to alter how governments manage the resources that are currently on hand. The production of substitutes that demand fewer resources should be supported rather than water-intensive crops like rice, which should gradually lose support. The shift may be slow as the populace gradually modifies their diet with proper inputs from the marketplace, as governments are pushing for consumer education and the building of a commitment to resource conservation for future generations. Change as a workable alternative will be encouraged as the populace learns that maintaining the current agricultural techniques, nutritional patterns, and lifestyles will risk the existence of the succeeding generations in many ways.

What might be done to lessen such negative impacts, one wonders? This important question has numerous possible solutions. With a few significant exceptions, it is clear that the output of major crops like maize, wheat, and rice is increasing globally whereas that of minor crops like barley, millet, rye, and sorghum varies depending on the region (Figure 4).

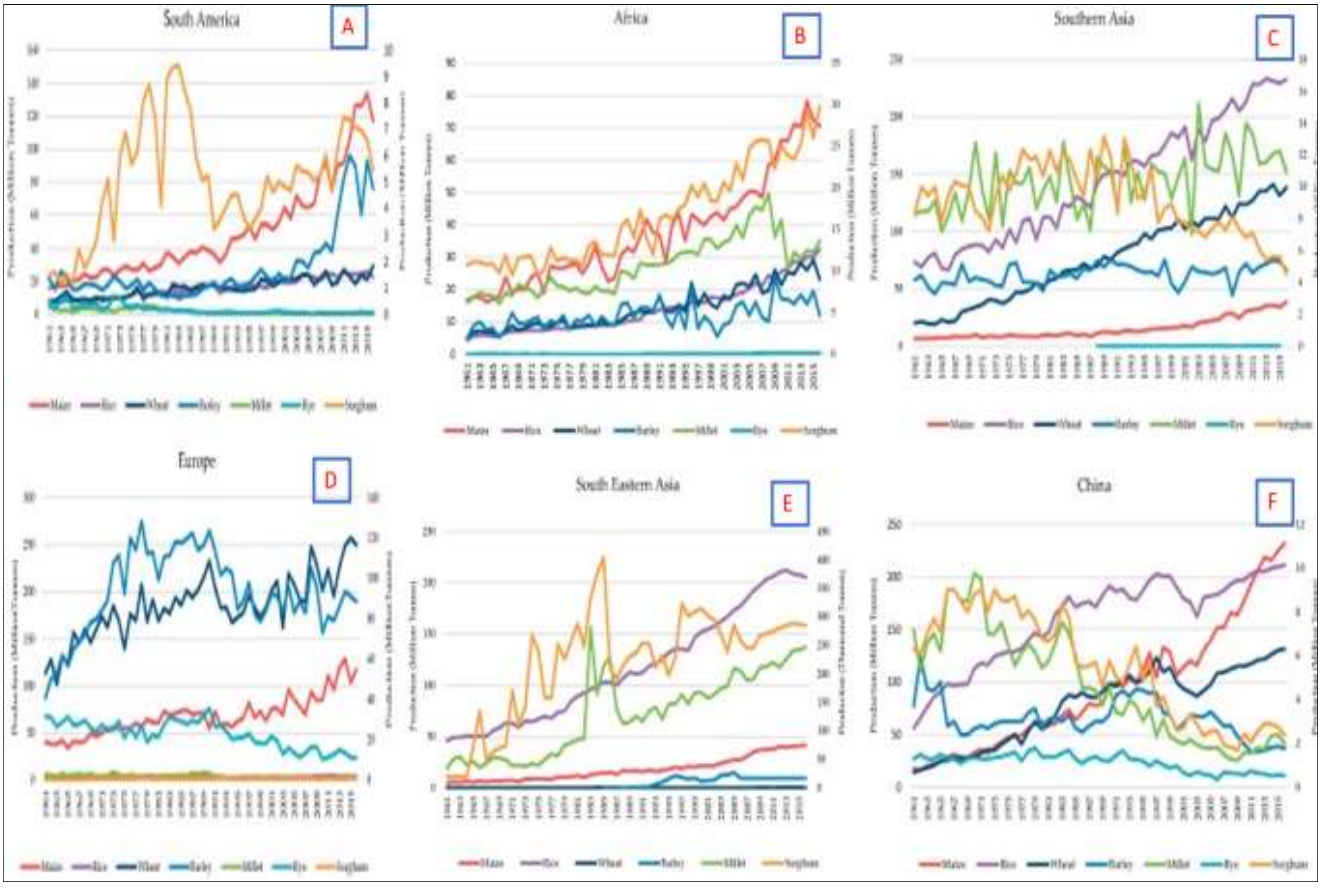

Fig 4: A) South America, B) Africa, C) Southern Asia, D) Europe, E) South Eastern Asia, and F) China produce the top seven cereal crops (primary axis represents Maize, Rice, and Wheat production in million tonnes and secondary axis represents Barley, Millet, Rye, and Sorghum production in million tons). (Source: Figure Modified from Saxena *et al*, 2018) [62, 74]

This graph makes it clear that millets and other low-resource-intensive crops can be grown almost anywhere in the world. Millet is a drought-resistant crop that requires less water for growth than other cereal crops like rice and wheat and has a higher nutritional value [Awika, 2011; Guigaz, 2002] [5, 30]. The current population finds it challenging to incorporate millets into their diets, but if appropriate steps are taken by governments through workable regulations taking into account how critical the problem is. Millets may be grown under challenging conditions, protecting farmers and the agri-food sector from losses. It is not a crop that requires a lot of water, thus the adoption of its cultivation in underdeveloped economies in Asia and Africa is not hindered by a lack of irrigation infrastructure. The drier soil is suitable for growing it. As a result, tillage techniques can be avoided, shortening the time spent cultivating.

The nutritional profile of millet is exceptional, and it is a non-glutinous grain. They become non-allergenic and easily digested as a result. While millet as a food product releases little glucose, making it safer for diabetes people to consume, polished rice releases a high percentage of glucose, which is not good for diabetic patients. Phosphorus, potassium, iron, and magnesium are abundant in millets. Ten times more calcium can be found in finger millet than in wheat or rice [Wang *et al*. 2018] [62, 74]. Globally, India produces the most millet [Khapre, 2017] [39]. Kodo millet and other small millets can be cultivated in unfavorable soil and climate conditions. Millets that have a short growing season can be used in a variety of cropping methods in both irrigated and dry farming environments. Millets are "famine reserves" because they can be kept for a long period of time under the right storage conditions [Michaelraj and Shanmugam, 2013] [48].

With an1111 kg/ha crop output on 15.48 million hectares, millet is grown in India, where 17.2 million tonnes are produced annually. Between 1950-1951 and 2011-2012, this crop's contributions to the production of all food grains decreased substantially, from 22.17% to 6.94% [Michaelraj and Shanmugam, 2013; Malathi *et al*. 2016] [48, 46]. Malathi, Appaji, Reddy, Dattatri, and Sudhakar looked into the growth pattern of millets in India [Malathi *et al*. 2016] [46]. The analysis found that the area set aside for millets cultivation has drastically decreased during the previous few decades. The primary reason for this decline may be government programs that encourage the production of important grains like rice and wheat as well as of crops like oilseeds, cotton, fruits, and vegetables. On an area basis, finger millets' productivity grew by 47.41%, while crop yields rose by 147.49%. On the other hand, crop yield climbed by 255.61% and pearl millet productivity improved by 247.48% on an area basis. These findings imply that crop yield has been rising despite though millets' production area has been drastically reduced.

7. Conclusions

Our review finally concludes that India, China, Western, Middle, and Southern Africa, some of South America, and the United States are the places that would experience negative repercussions in terms of soil degradation, water scarcity, and climate change. These nations will experience circumstances that substantially jeopardize crop productivity and food security, and they might not be able to handle such negative repercussions and the millet is the answer for them to handle the situation. Due to farmers' inability to grow crops under water scarcity uprising conditions, the economies of the countries were certainly affected. Therefore, Government must provide some incentives to attract the farmers to go for low water requiring millets which also has nutritional values and the potential to mitigate the adverse effects of chronic diseases such as diabetes. Finally, farmers of the water-scarce regions will have to move towards millet's cultivation for reducing the water, energy, and fertilizers on one side while on other improving the health status of their nationals.

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