



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2025): 5.20
www.agronomyjournals.com
2025; 8(7): 1624-1632
Received: 02-05-2025
Accepted: 05-06-2025

Mohammed Azharuddin BR
Assistant Professor, Department of
Agribusiness and Food Processing,
Mahatma Gandhi Rural Development
and Panchayati Raj University
(MGRDPRU), Gadag, Karnataka, India

Ruqsar Khanum
Assistant Professor, Department of
Agribusiness and Food Processing,
Mahatma Gandhi Rural Development
and Panchayati Raj University
(MGRDPRU), Gadag, Karnataka, India

Kiran Naik A
M.Sc. Scholar, University of
Agricultural Sciences, Raichur,
Karnataka, India

Saklain Mushtaq
M.Sc. Scholar, University of
Agricultural Sciences, Raichur,
Karnataka, India

Shashank Haverimath
M.Sc. Scholar, University of
Agricultural Sciences, Bengaluru,
Karnataka, India

Mohan KR
Assistant Professor, Department of
Agribusiness and Food Processing,
Mahatma Gandhi Rural Development
and Panchayati Raj University
(MGRDPRU), Gadag, Karnataka, India

Megha MD
Assistant Professor, Department of
Agribusiness and Food Processing,
Mahatma Gandhi Rural Development
and Panchayati Raj University
(MGRDPRU), Gadag, Karnataka, India

Preethi H
Assistant Professor, Department of
Agribusiness and Food Processing,
Mahatma Gandhi Rural Development
and Panchayati Raj University
(MGRDPRU), Gadag, Karnataka, India

Corresponding Author:
Mohammed Azharuddin BR
Assistant Professor, Department of
Agribusiness and Food Processing,
Mahatma Gandhi Rural Development
and Panchayati Raj University
(MGRDPRU), Gadag, Karnataka, India

Bottlenecks in present day agriculture

Mohammed Azharuddin BR, Ruqsar Khanum, Kiran Naik A, Saklain Mushtaq, Shashank Haverimath, Mohan KR, Megha MD and Preethi H

DOI: <https://www.doi.org/10.33545/2618060X.2025.v8.i7u.3437>

Abstract

Present-day agriculture is a complex and dynamic sector essential for global food security, rural livelihoods, and environmental sustainability. Despite significant advancements such as high-yielding varieties, precision farming, and biotechnology, agriculture faces numerous challenges. Major bottlenecks include rapid population growth, climate change, water scarcity, land degradation, pest resurgence, labour shortages, food wastage, and lack of market awareness. These issues collectively strain agricultural productivity and sustainability. Population growth reduces per capita farmland and intensifies food demand. Climate change causes extreme weather events, impacting crop yields. Water scarcity, driven by overuse and mismanagement, undermines irrigation. Land degradation and soil nutrient depletion further diminish output. Pest resurgence from pesticide overuse and labour shortages due to rural-urban migration reduce efficiency. Food wastage and inadequate infrastructure add economic and environmental pressure. Finally, market unawareness, poor access to finance, and limited technology adoption hinder profitability. Addressing these issues requires integrated policy, innovation, sustainable practices, and improved infrastructure.

Keywords: Modern agriculture, climate change, water scarcity, land degradation, food wastage

Introduction

The word agriculture describes the cultivation of crop with soil management. Present day agriculture is a complex and dynamic industry (Abbasi *et al.*, 2022) ^[1] which involves cultivation of various crops such as cereals, pulses. Commercial crops, plantation crops involving high yielding varieties, hybrids, different chemical fertilizers, organic fertilizers, nano fertilizers and pesticides etc.

Present day agriculture can also be termed as Modern agriculture (Thrall *et al.*, 2010) ^[28] which is characterized by the use of advanced technologies such as precision farming, genetic engineering, automation, sensor-based technologies, remote sensing to increase efficiency, productivity and sustainability. In spite of all these technologies and advancements in agriculture field, Present day scenario of agriculture sector is facing many major and minor bottlenecks. Farmers presently face various challenges such as climate change (Azeem *et al.*, 2023) ^[2], resource depletion, water scarcity, land degradation, resurgence of pest and disease labour shortage, lack of market connectivity, market awareness etc.. But the major reasons for facing all the challenges is increase in global population which is led to pressurising agricultural sector in producing more food to feed the growing population.

Overall, present day agriculture plays a crucial role in providing food security, supporting rural economies and preserving natural resources for future generations.

Major bottlenecks of Present-Day Agriculture are

Increase in Global Population: Growing population has been major concern for agricultural sector. Increase in global population has a significant impact on the production of crops and food security worldwide. According to division of UN population, there is gradual increase in growth of population. The estimated global population by the end of the 21st century is 11.2 billion (Sullivan, J. N., 2023) ^[27]. This increase in growth of population led to increased demand for agricultural land i.e., with more people to feed, there is a need for more agricultural land to grow crops, pressure on water resources, urbanisation and industrialisation

have reduced agricultural land gradually. Also increase in global population, majority in India increase in population led to the shrinking of farm land per capita. According to agricultural census, Census of India, IGIDR in 1976 - 77 the per capita farm size was 2.00 ha where as in 2016-16 the average farm size per capita was reduced to 1.08 ha. Zhang *et al.* (2021) [30] has reported the projected global per capita land availability. Due to increase in population in developing countries the arable land per capita reduced from 0.32 ha in 1960 to 0.18 ha in 2025 and in 2050 it will reduced to 0.15 ha. James Ducker (2022) [7] reported that increase in global population is intensifying the pressure on food production which in turn leading to higher food insecurity, more greenhouse gas emissions, large-scale degradation of agricultural land, environmental degradation and food wastage.

Climate Change: According to IPCC, climate change is the change in state of the climate that can be identified by changes in the mean or the variability of its properties and the persist for an extended period, typically decades or longer. The changing climate is leading to more frequent and severe weather events such as droughts, floods, heat waves, storms which have detrimental effect on crop production and food security. Climate change involves change in temperature, change in precipitation patterns, uneven- distribution of rainfall and extreme weather events etc. According to IPCC, carbon is accumulating in the atmosphere at a rate of 3.5 billion tonnes per annum. The global mean temperature is projected to rise 1.4°C to 5.8°C by 2100. In developed countries (41) there is release of 46 per cent of total anthropogenic GHG emission as compared to 54 per cent from

153 developing countries. According to global carbon project 2022 [10], China is the leading country in emission of greenhouse gas followed by USA, India, Germany and Brazil. Causes of greenhouse gas emissions, global warming which led to climate change are rapid industrialization and energy use, agricultural practices, deforestation, consumer practices and transportation etc.. According to global carbon project 2022 [10], in last 100 years, the global temperature had risen by 0.99°C. Snow cover decreased by 10 per cent, mean sea level rise by 1-2 mm per year and also experienced extreme rainfall and drought. Gadapayle *et al.* (2021) [9] reported climate change scenario of past and future. From 1990-2019, average increase in temperature was 0.18°C to 0.61°C in summer and 0.3°C - 0.65°C in winter, whereas average increase in rainfall was up to 15 per cent in central and northern districts of India and 20-25 per cent average increase in rainfall in western ghats. Also reported the rainfall variability where there was >20 per cent rainfall variability in Kharif and >50 per cent in 85 per cent of the districts in India. According to Global Energy Review (2021), the total CO₂ emissions from energy combustion and industrial processes have attained 36 giga tons annually in 2020 when compared to <5 Gt in 1900. This increase in emission of CO₂ over the years is due to industrialisation, urbanisation and power generation. NASA in 2022 [22] reported the rise in global sea level over the years from 1993-2020. The mean sea level in 1995 it was < 5 mm where as in 2021 the mean sea level was increased to > 90 mm over the decade. Increase in emission of greenhouse gas led to the rise in temperature of earth surface which caused melting of glaciers and expansion of sea water resulted in gradual rise in mean sea level over the years.

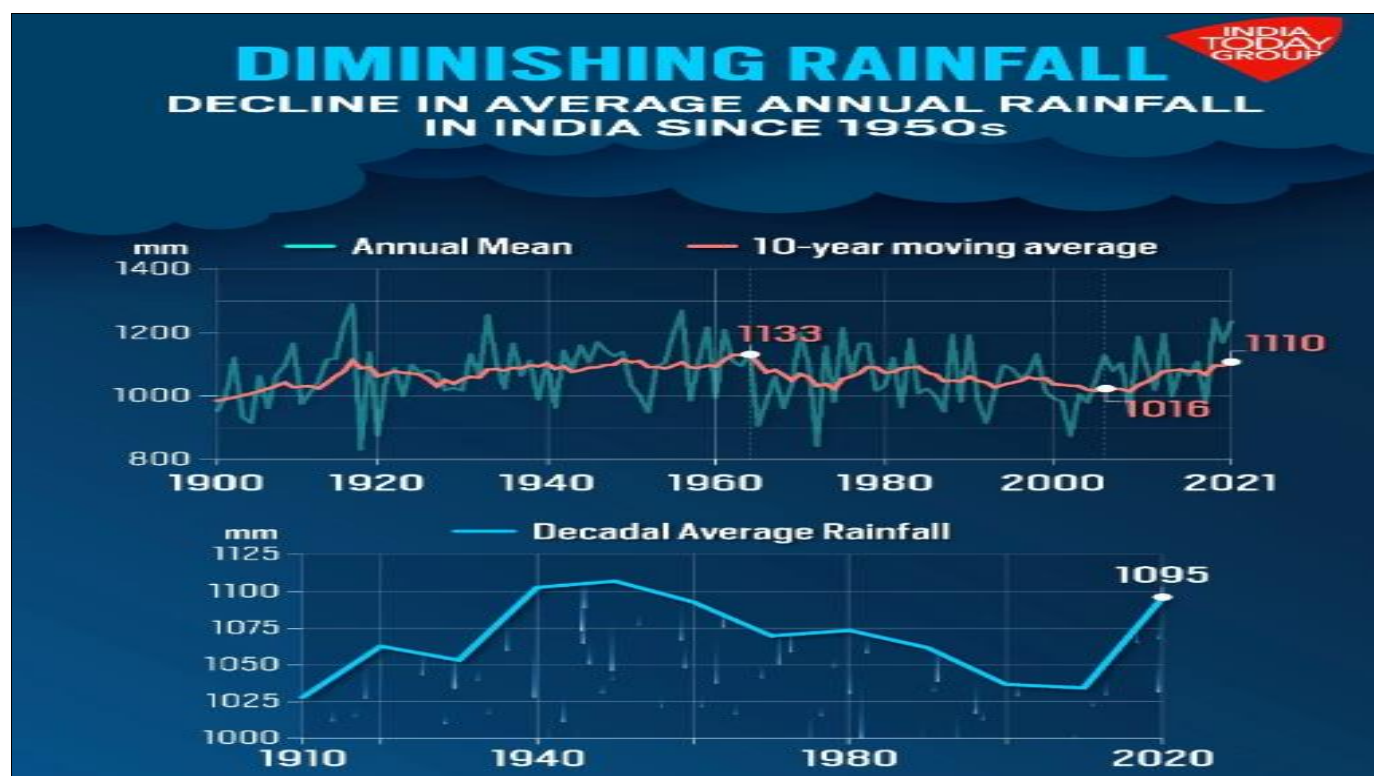


Fig 1: Declining rainfall trends in India

Rainfall: Rainfall is the source of water on the earth surface. But the diminishing rainfall and uneven distribution of rainfall has been major concern for agriculture. According to Ministry of

Earth Sciences, 2021 [18], there is decline in average annual rainfall in India since 1950s.

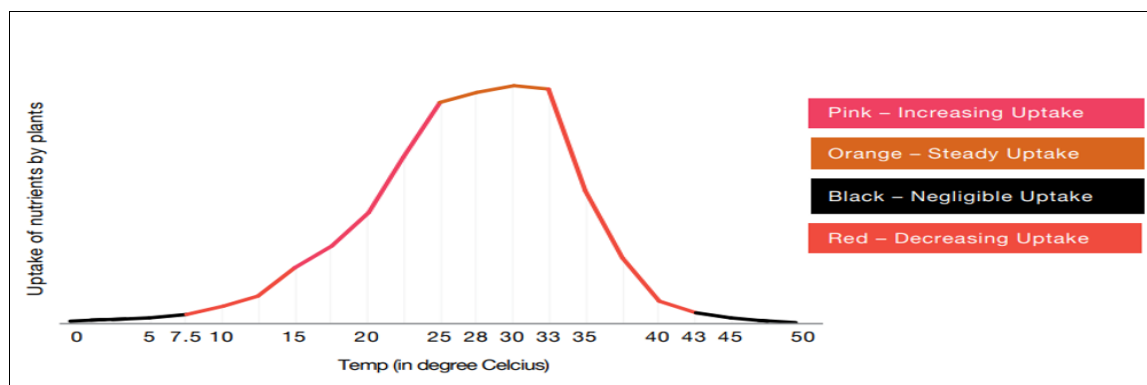


Fig 2: Nutrient uptake effected by increase in temperature

Kakra (2019) ^[15] reported that there is gradual decrease in nutrient uptake with increase in temperature. Increase in temperature decreases the nutrient uptake (Fig. 00). At lower temperature ranging from 0 °C - 75 °C leads to negligible uptake and extreme temperature ranging between 8.5°C - 42.5°C leads to steady uptake of nutrients.

Pratap *et al.* (2014) ^[25] projected the changes in crop yields at maximum changes in temperature and rainfall by 2035, 2065 and 2100. Maximum changes in temperature and rainfall are 1.3° C and 7 per cent by 2035, 2.5° C and 26 per cent by 2065 and 3.5° C and 27 per cent by 2100 respectively. Chakrabarti *et al.* 2012 ^[6] reported the reduction in yield of wheat and chickpea due to effect of high temperature on yield. Increase in temperature gradient by 1.0° C, 2.1° C, 2.5° C and 2.9° C led to drastic decrease in yield 368 g m⁻², 295 g m⁻², 280 g m⁻² and 251 g m⁻² respectively and same decrease in yield of chickpea was observed with increase in temperature. Rangaswamy *et al.* (2021) ^[26] studied fruit weight (g), yield per plant (kg) and yield per hectare (t) of tomato as influenced by elevated CO₂ and temperature levels and reported that treatment with elevated CO₂ (700 ppm) recorded higher fruit weight (90.46 g), yield per plant (5.09 kg) and yield per hectare (54.11 tones) followed by treatment with elevated CO₂ (550 ppm) whereas lower fruit weight (65.88 g), yield per plant (2.91 kg) and yield per hectare (35.65 tones) in the treatment with increase in temperature by 2° C. This increase in yield of tomato crop with increase in CO₂ content and combination of CO₂ + 2° C proves that tomato is temperature loving plant but only increase in temperature decreases the yield. In this crop increase in CO₂ content and increase in temperature was advantageous. Pratap *et al.*, 2014 ^[25] projected the changes in crop yields (%) at maximum changes in temperature and rainfall by 2035, 2065 and 2100. He reported that there is increase in crop yields as there is increase in temperature. Maximum decrease in crop yields due to increase

in temperature is in Pigeon pea followed by Chickpea and wheat. Major decrease is in pulse crop due to their sensitivity to change or variation in temperature.

According to Pathak *et al.*, 2018 ^[23] reported the projection of impacts of climate change on Indian agriculture like Cereal productivity to decrease by 10-40% by 2100, Every 1° C increase in temperature reduces wheat production by 4-5 million tones, Increased water, shelter and energy requirement for livestock; implications for milk production, Increasing sea and river water temperatures are likely to affect fish breeding, migration and harvests, Considerable effect on microbes, pathogens and insects and Increasing temperature would increase fertilizer requirement for the same production targets and result in higher emissions.

Water Scarcity: Water scarcity is a major challenge for present-day agriculture, as agriculture is the largest consumer of freshwater resources globally. Water scarcity occurs when there is not enough water available to meet the needs of agriculture, as well as other sectors such as industry and households. Water scarcity can have several impacts on agriculture. Firstly, it can reduce crop yields and quality, as plants require water to grow and produce food. Secondly, water scarcity can lead to soil degradation, as the lack of water can cause the soil to become dry and compacted, making it difficult for plants to grow. Thirdly, water scarcity can also impact livestock production, as animals require water for drinking and for the production of feed crops. In addition to these direct impacts, water scarcity can also have wider economic and social impacts. For example, it can lead to food shortages and price increases, which can affect food security and exacerbate poverty in rural areas. It can also lead to conflicts over water resources between different users, such as farmers and urban residents.

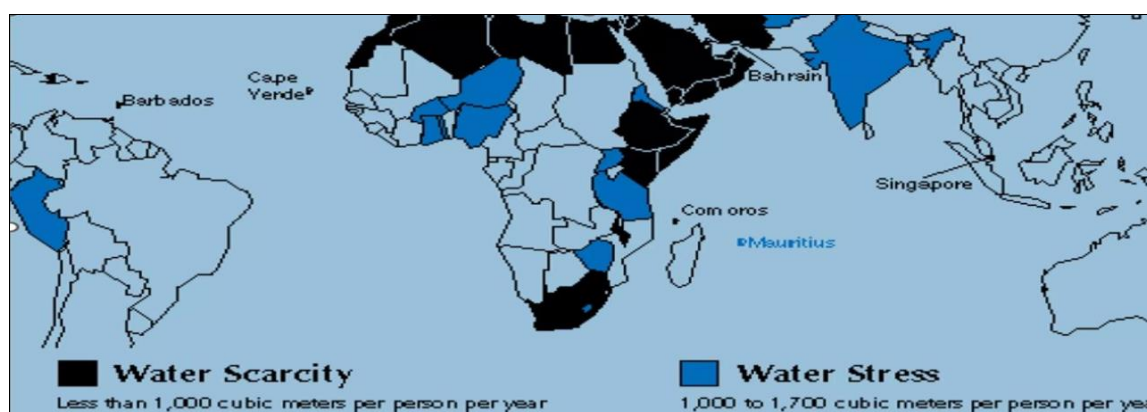


Fig 3: Map showing Water scarcity and Water stress regions of the world - ATLAS Map 2016

In the above fig.00 water scarcity and water stress regions are classified. Water scarcity regions are the regions with less than 1000 cubic meters per person per year which includes majority of the African continent countries. Water stress regions are the areas having 1000 to 1700 cubic meters per person per year which includes Africa and Asia continent countries.

Status of water scarcity in India

India is 13th among 17 highly stressed countries. India has more than three times the population of the other 16 extremely highly stressed countries combined. This implies that more than three-quarters of these populations facing extremely high-water stress live in India. In addition to rivers, lakes and streams, India's groundwater resources are severely overdrawn, largely to provide water for irrigation. Groundwater tables is also declined at a rate of more than 8 cm per year between 1990 and 2014.

Kalhature *et al.*, 2016 ^[16] reported average annual per capita availability of water in India has increased gradually over the years from 2001 to 2050. In 2001 per capita availability was 1816 m³ /year where as in 2050 per capita availability will be 1140 m³ /year. There will be 37.22 per cent decrease in per capita availability of water. This decrease is majorly because of rapid increase in population globally. A per capita water availability less than 1700 m³ is termed as a water-stressed condition while, per capita water availability below 1000 m³ is termed as a water scarcity condition.

Kalhature *et al.* (2016) ^[16] also reported the crop area losses in India due to waterlogging and drought. India has lost 69 million hectares of farmland since 2015. Due to drought, about 35 million hectares of cropped area (where crop loss was 33% and above) was damaged between

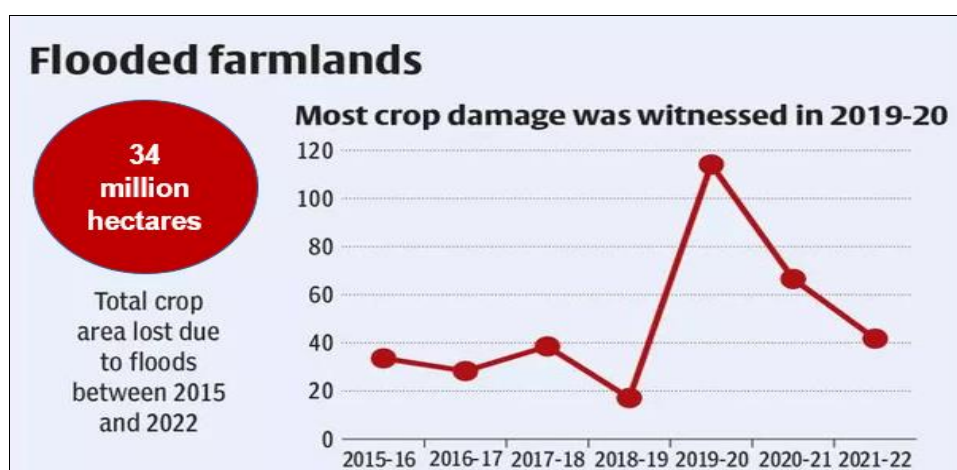


Fig 4: Crop area losses in India due to waterlogging and drought

2016 to 2022 in India. In India Rajasthan, Karnataka, Madhya Pradesh, and Maharashtra were among the most affected states, which faced crop losses from drought and excess rainfall. Other states where floods and heavy rains were predominant factors for crop loss were Bihar, West Bengal, Uttar Pradesh, Assam, Gujarat and Odisha. According to National Commission on

Irrigation and Water Resource Department in 2017 ^[21] India's water requirement was 1100 billion cubic meters, in 2025 it was 1200 billion cubic meters and in 2050 it was 1447 billion cubic meters. India's water requirement is decreasing due to its increase in population and demand for water from other sectors like Industries, Power production and Agriculture.

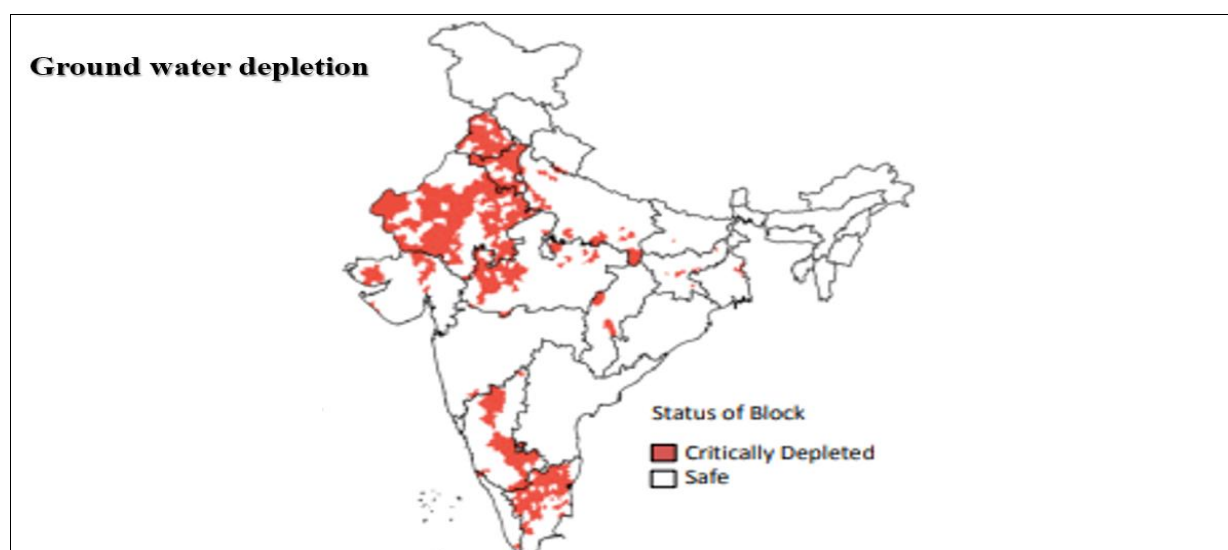


Fig 5: Status of ground water depletion in India, 2022

According to India Central Water Board, regions of Gujarat, Rajasthan, Punjab, Delhi, Madhya Pradesh, Chhattisgarh, Karnataka and Tamil Nadu has critically depleted status of ground water. Total 230 billion cubic meters of ground water is used for irrigation each year in India. Major reasons for ground water depletion are Consecutive weak monsoons, Massive deforestation, Poor rain water harvesting, Pollution of rivers and lakes etc.. The other reasons for drastic depletion in ground water are green revolution, food security, rural electrification, ground water pollution and erratic rainfall. Caparas *et al.*, 2021^[4] reported the probability of crop yield failure defined as at least 10 per cent decline from 1998 to 2017 in different crop with no future irrigation and limited nitrogen.

Land Degradation

Land degradation is a major challenge for present-day agriculture, as it can reduce crop yields, degrade soil quality, and contribute to food insecurity. Land degradation refers to the loss of soil productivity and ecosystem function due to human activities such as deforestation, overgrazing, and unsustainable farming practices. One of the main impacts of land degradation on present-day agriculture is reduced crop yields. Degraded soils are less productive and may not support the growth of crops as well as healthy soils. This can lead to lower yields and reduced quality of crops, which can have economic impacts on farmers and food prices for consumers. In addition to reduced crop yields, land degradation can also lead to soil erosion, which can further degrade soil quality and reduce its ability to support plant growth. Soil erosion can also lead to sedimentation of waterways and water pollution, which can impact aquatic ecosystems and human health. Land degradation can also contribute to food insecurity, particularly in rural areas where agriculture is a major source of livelihoods. As degraded lands become less productive, farmers may struggle to produce enough food to meet their own needs and those of their communities. This can lead to malnutrition and other health issues, particularly among vulnerable populations such as children and the elderly. To address the impacts of land

degradation on present-day agriculture, there is a need for sustainable land management practices that promote soil conservation and restoration. This can include practices such as conservation agriculture, agroforestry, and sustainable grazing management. Additionally, policies and programs that support sustainable land use practices, such as land tenure reform and incentives for sustainable farming practices, can also help to address the impacts of land degradation on agriculture. Land degradation has a significant impact on present-day agriculture, as it can reduce crop yields, degrade soil quality, and contribute to food insecurity. Some of the specific impacts of land degradation on agriculture include:

Reduced crop yields: Degraded soils are less productive and may not support the growth of crops as well as healthy soils. This can lead to lower yields and reduced quality of crops, which can have economic impacts on farmers and food prices for consumers.

Soil erosion: Land degradation can lead to soil erosion, which can further degrade soil quality and reduce its ability to support plant growth. Soil erosion can also lead to sedimentation of waterways and water pollution, which can impact aquatic ecosystems and human health.

Food insecurity: Land degradation can contribute to food insecurity, particularly in rural areas where agriculture is a major source of livelihoods. As degraded lands become less productive, farmers may struggle to produce enough food to meet their own needs and those of their communities. This can lead to malnutrition and other health issues, particularly among vulnerable populations such as children and the elderly.

Loss of biodiversity: Land degradation can also lead to the loss of biodiversity, as degraded ecosystems are less able to support diverse plant and animal communities. This can have negative impacts on ecosystem services, such as pollination and pest control, which are important for agricultural productivity.

Bhattacharyya *et al.*, 2021^[3] reported the extent of land degradation in India. Different departments of the countries in different years surveyed and reported the degraded land. NBSS & LUP in 2004 reported total 146.8 M ha degraded land.

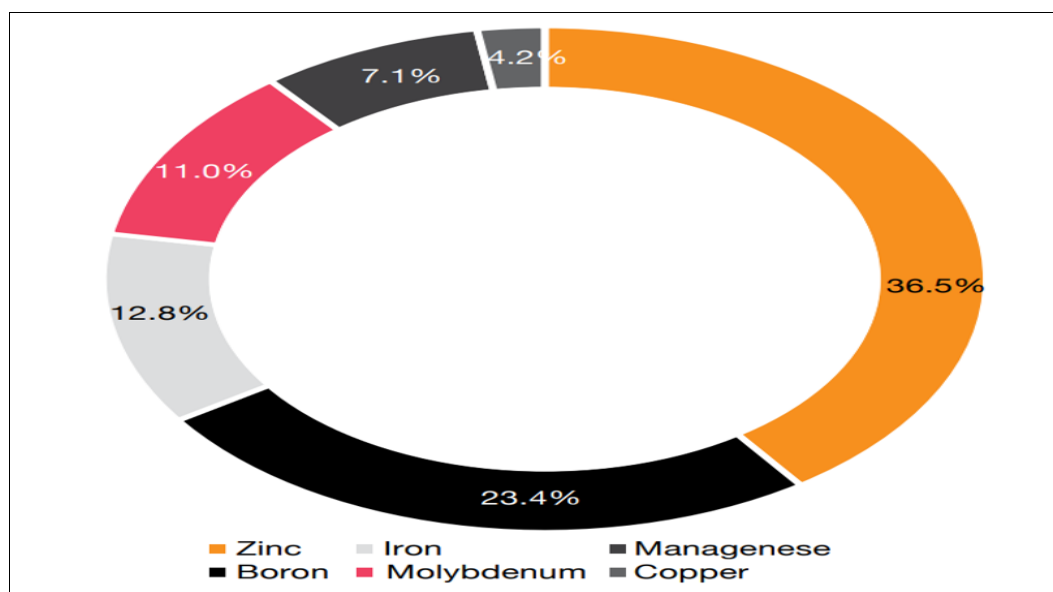


Fig 6: Micronutrient deficiency status in India

Kakra 2019^[15] reported the micronutrient deficiency in soils of India (Fig.00). He reported 23.4 per cent boron deficiency, 36.5 per cent zinc deficiency, 12.8 per cent iron deficiency in Indian

soils.

Farshid (2013)^[8] studied mean comparison of salinity levels of yield components of rice and reported that salinity level at 8

ds/m recorded lower grain yield (12.59 g pot⁻¹), straw weight (24.64 g pot⁻¹), plant height (125.42 cm) and biomass 41.23 g pot⁻¹. Yield of the crop is decreased with increase in salinity level in rice

Pest Resurgence

Rapid reappearance of a pest population in injurious numbers, usually brought about after the application of a broad-spectrum pesticide. Situation in which pest population, after having been suppressed, rebounds to attain a higher population density. In other words, tremendous increase in the pest population brought about by the insecticides in spite of the good initial kill at the time of treatment. 44 per cent of homoptera, 26 per cent mites and 24 per cent lepidopterans have shown resurgence to various broad-spectrum insecticides.

Kumar *et al.*, 2019 ^[17] studied the effect of insecticides on the reproductive rate of *Nilaparvata lugens* feeding on rice and concluded that Cypermethrin 10 EC @ 0.50ml and Bifenthrin 10 EC @ 0.50 ml were less effective compare to other insecticides with reproductive rate 218.33 and 227.63 respectively) and (1.67 and 1.74 resurgence ratio respectively).

Labour Shortage

Labour shortage in present-day agriculture can have significant impacts on the productivity and profitability of farms, as well as on food security and prices for consumers. Some of the specific impacts of labour shortage on agriculture include:

Reduced crop yields: Labour shortage can lead to delays in planting, harvesting, and other farm operations, which can result in lower crop yields and reduced quality of crops. This can have economic impacts on farmers and food prices for consumers.

- **Increased labour costs:** When there is a shortage of labour, farmers may need to pay higher wages to attract workers, which can increase their operating costs and reduce their profitability.
- **Dependence on technology:** In some cases, labour shortages may lead to increased dependence on technology, such as automation and mechanization, to perform farm tasks. While this can increase efficiency and productivity, it can also require significant investment in equipment and training.
- **Food insecurity:** Labour shortage can contribute to food insecurity, particularly in rural areas where agriculture is a major source of livelihoods. As farms struggle to find enough workers to plant and harvest crops, food production may decline, leading to shortages and higher prices for consumers

According to Prabhakar *et al.*, 2011 ^[24] labour shortage is due to less remuneration in agriculture compared to other profession, shift towards non-farm occupation in rural areas, alternate professions offering ample of opportunities, higher input prices and fewer people in agriculture reducing farming can lead to fall in production and productivity.

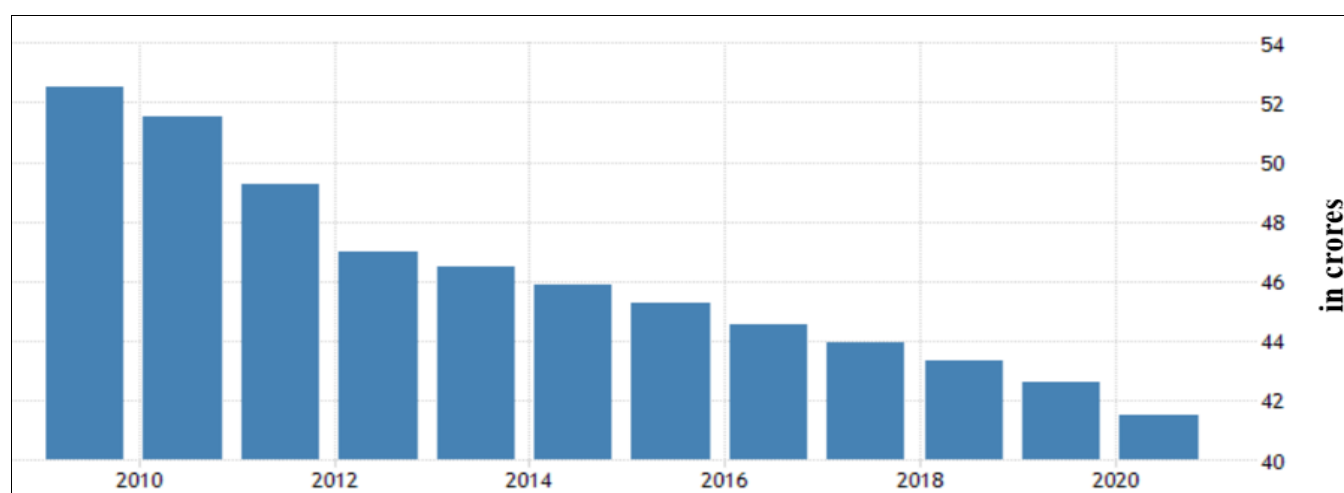


Fig 7: Total agricultural employment in India

Vaishnavi and her associates reported the total agricultural employment in India (Fig.00). In 2010, the population employed in agriculture was > 53 crore and in 2020 the population employed in agriculture was < 42 crore ^[29].

Food wastage

Food wastage has significant impacts on present-day agriculture, both economically and environmentally. Some of the specific impacts of food wastage on agriculture include:

Reduced profitability

When farmers produce more food than is consumed, they may be forced to sell their products at lower prices, reducing their profitability. This can lead to financial instability and lower investment in agriculture.

Increased resource use: Producing food that is ultimately wasted requires significant resources, including water, energy, and land. This can lead to increased pressure on natural resources and contribute to environmental degradation.

Greenhouse gas emissions: Food wastage is a significant contributor to greenhouse gas emissions, with estimates suggesting that up to 10% of global emissions come from food that is produced but not consumed. This can exacerbate climate change and its impacts on agriculture.

Food insecurity: When food is wasted, it means that resources that could have been used to feed people are lost. This can contribute to food insecurity, particularly in developing countries where access to food is already limited.

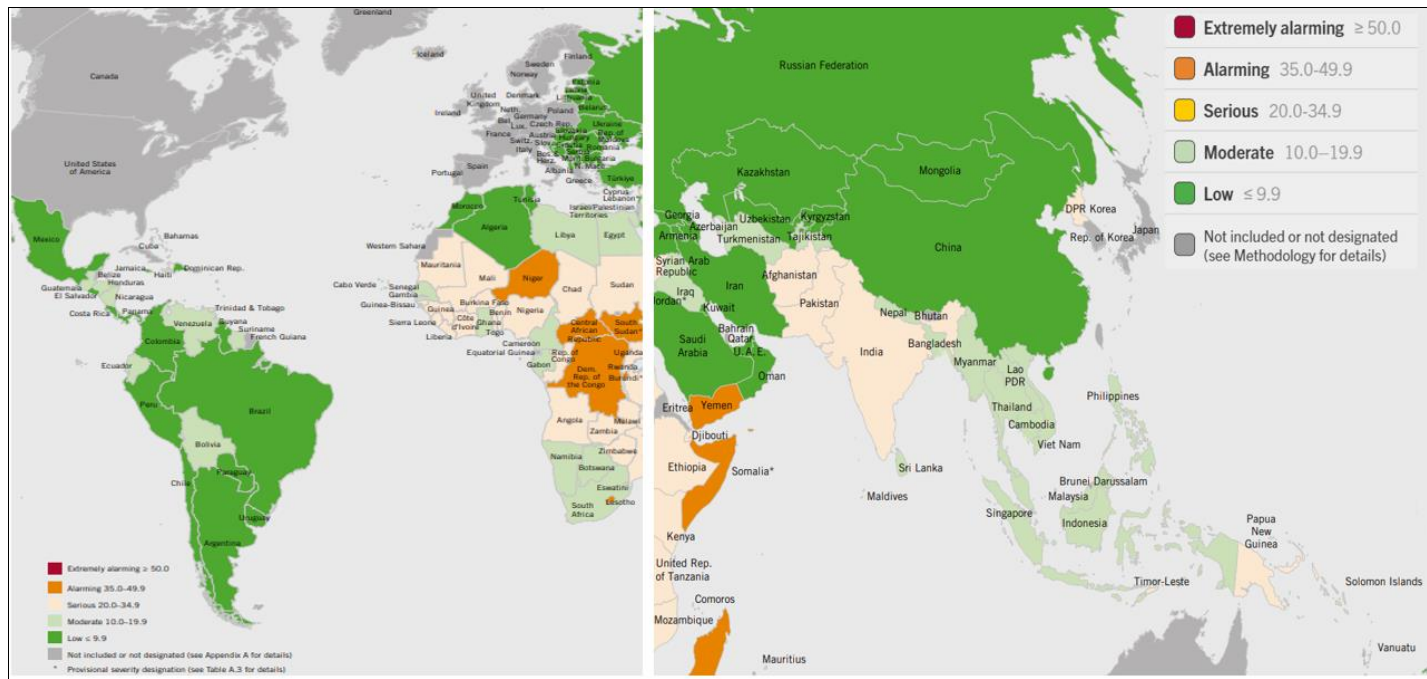


Fig 8: Global hunger index by severity

Grebmer *et al.*, 2023 ^[12] reported that globally 821 million people are affected by hunger. That is approximately every 9 out of 1 is dying due to hunger (Fig.00). India is ranked 107 on the global hunger index where 196 million people are affected by hunger every year. In India annually 68.7 million tonnes of food is wasted in India homes. In simple words it is 50 kg per person.

One third of produced food in India gets wasted or spoilt before it is even eaten. If we reduce this wastage of food annually in India it reduces the pressure on agriculture sector which in turn helps in reducing climate change, improving soil health and reducing methane emission.

Approximate total registered marriage halls in Bangalore City	531
Approximate total marriage functions / day	84960
Average number of plates, food served (84960*1000)	84.96 million
Total food served	0.54 million tonnes
Total food wastage	943 tonnes
Average grams in normal Indian meal	350 grams
No. of people can be fed, a normal Indian meal	2.6 Crore

Fig 9: Food wastages in Bengaluru city

Gowda *et al.*, 2012 ^[11] surveyed the food wastage in Bengaluru city. They reported that more than 943 tonnes of food is wasted every day. Ave3rage grams in normal Indian meal is 350 grams. If this food wastage is reduced 2.6 crore number of people can be fed with a normal Indian meal. Complete population of Bengaluru city can be fed by one meal per day, 38.2 per cent of total population of Karnataka can be fed by one meal per day and 1.84 per cent of India population can be fed by one meal per day.

Lack of Market awareness

Lack of market awareness can have significant impacts on present-day agriculture. Some of the specific impacts include: Reduces profitability: Farmers may not be aware of market demand for certain crops or may not have access to information about market prices, leading to lower profitability and financial instability, Overproduction or underproduction: Without market awareness, farmers may produce crops that have little demand in

the market, leading to overproduction and wastage. Alternatively, they may not produce enough of crops that are in high demand, leading to underproduction and missed opportunities for profit, Limited access to markets: Lack of market awareness can also limit farmers' access to markets, as they may not know how to connect with buyers or understand the requirements for selling their products and Inefficient use of resources: Without market awareness, farmers may not be able to plan their production efficiently, leading to inefficient use of resources such as water, land, and labour.

Lack of Infrastructre

Inadequate storage facilities, poor transportation infrastructure and lack of cold chain facilities contribute to post harvest losses. According to Cold Chain Market In India only about 10 per cent of perishable goods in India are processed and cold storage capacity is significantly lower than the required demand (Fig. 00).

VALUE CHAIN	CCI COMPONENT	REQUIRED (NOS.)	CREATED (NOS.)	GAP (%)
FFV	Packhouses	83,041	675	99%
	Cold Storage - Bulk	6,669	6,026	10%
	Cold Storage - Hub	231	225	2%
	Reefer Vehicles	70,035	11,000	84%
	Ripening Chambers	12,654	1,232	90%
Dairy	Chilling Centres / Bulk Milk Chillers	260,737	52,147	80%
	Reefer Vehicles *	8,733	1,747	80%
	Cold Storage	196	39	80%
Fish	Ice Plants	1,017	272	73%
	Cold Storage**	6,294	624	90%
	Reefer Vehicles	6,104	606	90%
Meat	Cold Storage	37	19	49%
	Reefer Trucks	1,776	910	49%

*excluding insulated tankers **mostly for export

Fig 10: Estimated cold chain infrastructure (CCI) deployment and requirements in India across different value chains.

Market Information Gap

Limited access to timely and accurate market information for farmers hinders their ability to make informed decisions. A study by the National Council of Applied Economic Research (NCAER) found that only about **37% of farmers in India** have access to market information.

Access to finance

Limited access to credit for small and marginal farmers and inadequate financial services for agricultural activities. The National Bank for Agriculture and Rural Development (NABARD) reported that as of 2021 ^[19], only about **55% of the total agricultural households in India** had access to formal credit.

Post-harvest losses: Inefficient post-harvest management practices contribute to substantial losses in agricultural produce.

Technology adoption: Limited adoption of technology and digital platforms in agricultural marketing

As of 2020, the Internet and Mobile ^[13] Association of India (IAMAI) reported that only around 27% of rural India had internet access, which can hinder the adoption of digital technologies in agriculture.

Conclusion

The agricultural sector faces significant challenges, leading to substantial losses in crop area, production, and income. Climate change is a major contributor, responsible for the loss of 69 million hectares of crop area in just six years. Water scarcity results in a 34% agricultural production loss, amounting to an estimated USD 37 billion. Land degradation further exacerbates the problem, leading to an annual productivity loss of Rs. 3654 per hectare. Pests and diseases cause considerable global and national losses, with 13.6% globally and 23.3% in India. Additionally, a 23% loss in food grain production is attributed to labor shortages. Post-harvest, India experiences significant losses of fruits and vegetables (5-13%) and other crops, including oilseeds and spices (3-7%), between harvesting and consumption. These multifaceted issues underscore the urgent need for comprehensive interventions to ensure agricultural sustainability and food security.

Future line of work

To ensure a more resilient and sustainable future for agriculture, it's crucial that we adopt climate-smart farming practices. These approaches not only help farmers adapt to the challenges posed by climate change but also promote the conservation of natural resources and reduce agriculture's impact on the environment. At the same time, research must focus on developing cereal crops that can withstand water scarcity, as drought and limited water availability are major causes of crop failure. Introducing water-resistant cereal varieties can help ensure stable harvests, especially in regions prone to dry spells.

Another important step is to build stable and dependable markets for agricultural produce. When farmers have access to well-functioning markets, they're more likely to receive fair prices for their crops and experience fewer losses after harvest. This calls for better infrastructure, effective price stabilization policies, and stronger value chains. Lastly, it's essential to empower farmers with knowledge about both national and international markets. When they understand market trends, consumer preferences, and trade opportunities, they can make informed choices about what to grow, how to grow it, and where to sell it. This not only boosts their income but also helps reduce food waste and improves the overall efficiency of the agricultural system.

References

1. Abbasi Z, Aslani F, Abbasi S. Challenges and opportunities in modern agriculture: A review. *J Agric Sci Technol*. 2022;24(1):1-15.
2. Azeem A, Bashir MA, Ahmad I. Climate change impacts on agriculture: A review of challenges and adaptation strategies. *Environ Sci Pollut Res*. 2023;30(7):18321-18335.
3. Bhattacharyya T, Roy SK, Pande VC, Pal DK, Ray S. Status of land degradation in India: An overview. *J Soil Water Conserv*. 2021;20(4):316-325.
4. Caparas JT, Ma L, Li Y. Assessing the probability of crop yield failure under climate change and resource limitations. *Environ Res Lett*. 2021;16(5):054044.
5. Central Ground Water Board (CGWB). Ground Water Year Book - India 2022. Ministry of Jal Shakti, Government of India; 2022.
6. Chakrabarti B, Singh SD, Kumar A, Singh R. Impact of

- elevated temperature on growth and yield of wheat and chickpea. *J Agron Crop Sci.* 2012;198(6):441-447.
7. Ducker J. Population, food and natural resources: A global challenge. 2022. [Please provide full source details].
 8. Farshid S. Effects of salinity stress on growth and yield components of rice (*Oryza sativa* L.) genotypes. *Int J Agric Crop Sci.* 2013;5(2):154-159.
 9. Gadapayle R, Rathore LS, Tyagi B, Singh KK. Climate change scenarios for Indian agriculture: An overview. *J Agrometeorol.* 2021;23(3):329-338.
 10. Global Carbon Project. Global Carbon Budget 2022. *Earth Syst Sci Data.* 2022;14:4811-900.
 11. Gowda R, Somashekhar RK, Naik BS. Assessment of food waste in households and food establishments in Bengaluru city, India. *Int J Environ Prot.* 2012;2(2):24-29.
 12. Von Grebmer K, Bernstein J, Ekstrom M, *et al.* 2023 Global Hunger Index: The power of youth in shaping food systems. Bonn: Welthungerhilfe and Concern Worldwide; 2023.
 13. Internet and Mobile Association of India (IAMAI), Kantar. India Internet Report 2020. Mumbai: IMAI; 2020.
 14. Intergovernmental Panel on Climate Change (IPCC). Climate Change 2021: The Physical Science Basis. Cambridge: Cambridge University Press; 2021.
 15. Kakra P. Effect of temperature on nutrient uptake by plants - A review. *Int J Res Pharm Biol Sci.* 2019;6(1):1-4.
 16. Kalhapure R, Kalhapure S, Shinde R. Water availability and its impact on agriculture in India: A review. *Int J Curr Microbiol Appl Sci.* 2016;5(6):11-19.
 17. Kumar D, Kumar V, Singh R. Effect of insecticides on reproductive rate and resurgence of brown planthopper, *Nilaparvata lugens* (Stål) (Hemiptera: Delphacidae) in rice. *Indian J Entomol.* 2020;82(2):212-216.
 18. Ministry of Earth Sciences. Assessment of Climate Change over the Indian Region. Government of India; 2021.
 19. National Bank for Agriculture and Rural Development (NABARD). NABARD All India Rural Financial Inclusion Survey (NAFIS) 2021. Mumbai: NABARD; 2021.
 20. National Bureau of Soil Survey and Land Use Planning (NBSS & LUP), Indian Council of Agricultural Research (ICAR). Status of Land Degradation in India: A Report. Nagpur: NBSS & LUP; 2004.
 21. National Commission on Irrigation and Water Resource Department. Water Requirement Projections for India. Government of India; 2017.
 22. NASA Climate. Sea level: Vital signs of the planet [Internet]. 2022 [cited 2025 Jul 30]. Available from: <https://climate.nasa.gov/vital-signs/sea-level/>
 23. Pathak H, Kumar S, Singh J, Kumar R. Climate change and Indian agriculture: Impacts, vulnerability and adaptation strategies. *Curr Sci.* 2018;114(5):983-996.
 24. Prabhakar VVN, Kumar N, Chand R. Labour shortage in agriculture: Causes, consequences and remedies. *Agric Econ Res Rev.* 2011;24(conf issue):441-447.
 25. Pratap V, Singh R, Kumar D. Impact of climate change on crop yields in India: A review. *Int J Curr Res.* 2014;6(12):10738-10745.
 26. Rangaswamy V, Saravanan S, Palanisamy P. Response of tomato (*Solanum lycopersicum* L.) to elevated carbon dioxide and temperature levels under controlled conditions. *J Environ Biol.* 2021;42(4):845-850.
 27. Sullivan JN. [Please provide full title and publication/source details].
 28. Thrall PH, O'Brien PA, Laine AL. Global change and the future of agricultural disease. *Eur J Plant Pathol.* 2010;129(2):209-221.
 29. Vaishnavi S, Shobha S, Reddy N. Trends in agricultural employment in India: An analysis. *Int J Res Manag Sci Technol.* 2022;10(1):1-8.
 30. Zhang T, Shi X, Zhao X, Liu S. Global per capita arable land area and its relationship with population growth: A review. *Land Use Policy.* 2021;100:104918.