Millets for Food and Nutritional Security for Small and Marginal Farmers of North West India in the Context of Climate Change: A Review

ABSTRACT

600 million people are dependent on the agricultural sector in India, most of them small farmers holding up-to 2 hectares of land. Two thirds of the net sown area, is rain-fed. About two-thirds of this is drought-prone with about 40 million hectares of land being flood-prone. The poorest people tend to be located geographically in more exposed or marginal areas, such as flood plains or on nutrient-poor soils. The poor also are less able to respond due to limited human and financial capacity and have very limited ability to cope with climate impacts, and to adapt to a changing hazard burden. The current food system feeds the great majority of world population and supports the livelihoods of over 1 billion people. Since 1961, food supply per capita has increased more than 30%, accompanied by greater use of nitrogen fertilizers and water resources for irrigation. However, an estimated 821 million people are currently undernourished, 151 million children under five are stunted, 613 million women and girls aged 15 to 49 suffer from iron deficiency, and 2 billion adults are overweight or obese.

Climate change is a significant shift in average weather conditions, becoming warmer, wetter, or drier over several decades or more. Climate change is one of the most defining concerns of today's world and has greatly reshaped or in process of altering earth's ecosystems. Greenhouse gas emissions are the leading cause of the earth's rapidly changing climate. Greenhouse gas emissions cause heat to be trapped by the earth's atmosphere, and this has been the main driving force behind global warming. Human activities majorly responsible for surge in greenhouse gases are predominantly related to energy production, industrial activities and those related to forestry, land use and land-use change. Millets also help mitigate the effects of climate change through their low carbon footprint of 3,218-kilogram equivalent of carbon dioxide per hectare, as compared to wheat and rice, with 3,968kg and 3,401kg, respectively, on the same measure. In the present consequences of adverse impacts of climate change, the millets also attracted the attention of growers and policy-makers as they are less demanding to external inputs, drought-tolerant and register a comparatively lower carbon footprint than other cereals. These beneficial impacts ensured the comeback of millets after the institutional neglect for a few decades. Considering the food and nutritional security of the common people millets can be considered as suitable staples. However, the successful harvest of millets warrants an integration of proven and climate-smart technologies for the fulfillment of the future needs of the ever-growing population. Millets as climate change compliant crops score highly over other grains like wheat and rice in terms of marginal growing conditions and high nutritional value.

Keywords: Food security; agricultural productivity; millets; climate change, food diversity

INTRODUCTION

Tackling hunger and feeding the world population are two of the biggest challenges of the modern world. Reasons contributing to this issue range from deficiencies in the supply of micro- and macronutrients, shortage in production of foods leading to supply–demand imbalances and conflicts destabilizing various parts of the world. Although several of these triggers for hunger can be addressed leading to a slight reduction in the population suffering from hunger and malnutrition from almost one billion in 1990–1992 to 850 million in 2010–2012, the threat of climate change and global warming still lingers (FAO, 2012). Estimates show that the reduction in food production rates along with the added pressure of feeding a population exceeding 9 billion by 2050 could lead to 2–3 billion people suffering from hunger, food and nutritional insecurities (Wheeler and Von Braun, 2013; Godfray et al., 2010).Climate change and increasing global average temperatures are reported to have a direct impact on crop yields, crop productivity and overall sustainability of our food systems. Although some estimates show that a few regions could benefit from climate change due to increased productivity and yields, this will not be sufficient to feed the higher number of inhabitants globally (Kang et al., 2009). Furthermore, most of the scientific community agrees that the current rates of global warming and emissions of greenhouse gas would significantly reduce the overall crop productivity. Thus, reducing the greenhouse gas emissions to control global temperatures plays a crucial role in achieving food security. However, the agricultural sector is one of the primary contributors to greenhouse gases such as methane into the atmosphere. Higher emissions are generally caused by intensive agricultural practices which are being followed in different locations around the world (Olesen and Bindi, 2002).

Food is predominantly produced on land, with, on average, 83% of the 697 kg of food consumed per person per year, 93% of the 2884 kcal per day, and 80% of the 81 g of protein eaten per day^{-1} coming from terrestrial production in 2013 (FAOSTAT 2018). With increases in crop yields and production the absolute supply of food has been increasing over the last five decades. Growth in production of animal-sourced food is driving crop utilization for livestock feed (Pradhan et al. 2013a). Global trade of crop and animal-sourced food has increased by around 5 times between 1961 and 2013 (FAOSTAT 2018). During this period, global food availability has increased from 2200 kcal/cap/day to 2884 kcal/cap/day, making a transition from a food deficit to a food surplus situation (Hiç et al. 2016).

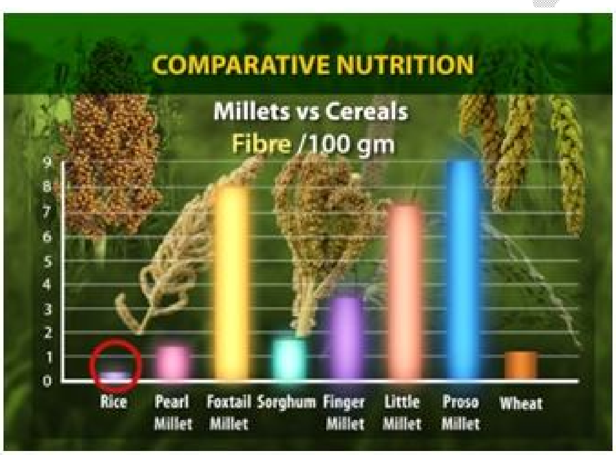
The availability of cereals, animal products, oil crops, and fruits and vegetables has mainly grown reflecting shifts towards more affluent diets. This, in general, has resulted in a decrease in prevalence of underweight and an increase in prevalence of overweight and obesity among adults (Abarca-Gómez et al. 2017). During the period 1961–2016, anthropogenic GHG emissions associated with agricultural production has grown from 3.1 $GtCO_2$-eq yr^{-1} to 5.8 $GtCO_2$-eq yr^{-1}. The increase in emissions is mainly from the livestock sector and use of synthetic fertilizer, and rice cultivation (FAOSTAT 2018). Millets possess immense potential in our battles against climate change and poverty, and provide food, nutrition, fodder and livelihood security. Being hardy crops, they can withstand extreme temperatures, floods and droughts. They also help mitigate the effects of climate change through their low carbon footprint of 3,218-kilogram equivalent of carbon dioxide per hectare, as compared to wheat and rice, with 3,968kg and 3,401kg, respectively, on the same measure. *In the past, millets were a poor farmers insurance against the vagaries of the Indian monsoon. In the future, millets can be our insurance in times of climate change.*

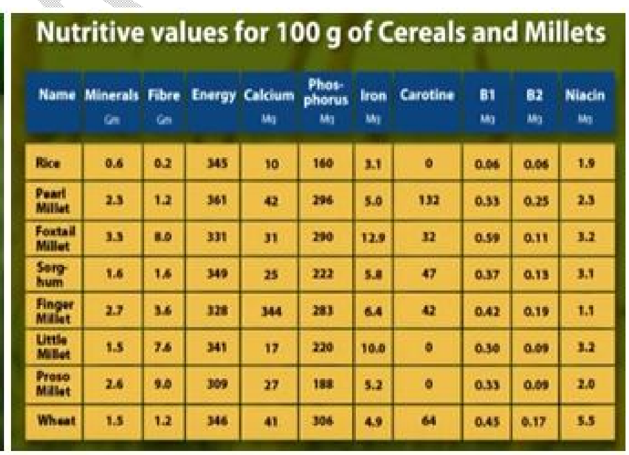
In India, millets are cultivated in an area of 15.48 million hectare producing 17.2 million tonnes with a yield of 1111 kg/ha (Directorate of Economics and Statistics, 2015). Maharashtra, Rajasthan and Karnataka are the top most states of millets cultivation in India. Contribution of millets in total food grain production of India reduced from 22.17 % to 6.94 % over the last six decades from 1950-51 to 2011-12. In spite of all the extraordinary qualities and capacities of millet farming systems, the area under millet production has been shrinking over the last five decades and rapidly, since the Green Revolution period due to relentless promotion of other crops such as rice and wheat for intensive farming in select few resource rich areas under irrigated conditions (MINI). Another major threat that millets facing in the country in the form of an unnatural promotion of maize, which is resulting in maize invasion in various parts of the country owing to the corporate-induced demand for bio-fuels and poultry feed (Michaelraj and Shanmugam, 2013). Over the years, several farmer organizations have been set up to help small and marginal farmers overcome hindrances in millet production and marketing. The prevalent market instability calls for policies that protect the livelihood of farmers. Incentivizing the adoption of inter-cropping and providing crop insurance and support for storage facilities will foster income and food security.

It is the impacts of climate change for which the so far unrecognized millets have received a fair recognition. Global bodies are pushing millets farming with the idea that it reduces agriculture's carbon footprint while ensuring food and nutritional security. In India and other parts of the world, a growing number of farmers are switching to millets cultivation. The CGIAR has suggested that millets are the way forward for countries like India where food security and nutrient security are a major challenge and as water-guzzling wheat and paddy will face tough challenges with temperatures increase due to global warming. CGIAR has estimated that the global production of wheat, rice and maize could decrease by 13 to 20 percent in the coming decades because of climate change. Global agricultural production will have to battle against this loss, even as production needs to rise by an estimated 70 percent to feed the 9 billion people by 2050. In that context, it is noteworthy to mention that against a fluctuating productivity trend in case of major food crops, millets have shown exceptional increase in productivity over the last five decades. As India's agriculture suffer hugely from the vagaries of monsoon, millets which are also known as "famine reserves" for their prolonged and easy storability under ordinary are of great relevance. They are most suitable for mixed and intercropping, thus offer sustainable resources use, food and livelihood security to farmers. Cultivated as dual-purpose crops (food & fodder), millets contribute to the economic efficiency of farming and provide food/livelihood security to millions of households, particularly the small/marginal farmers and the inhabitants of rain fed/remote tribal regions. Research says that a 1% productivity increase could reduce poverty by 0.65%. Increasing productivity is more important in rain fed areas as these are 30% less productive than irrigated areas. It seems that millets could be the answer to fighting climate change, poverty and malnutrition.

In view of numerous benefits conferred by the millets, our farmers should aim at growing more and more of the millets; and we as consumers, should include millets in our daily food basket. Apart from increasing the production and consumption, in today's era of modernization, industrialization and urbanization, we need to adequately process the millets to create a variety of value added nutritious products as per the taste, texture, flavor of the consumers. In this review paper an attempt has been made with a specific objective to attempt has been made to highlight the utility of millet production and the relative contribution of food and nutritional security. It is hoped that the study will assist the policy makers in formulating necessary strategies and policies to increase the production of millets to meet their demand during the changing times to fulfill the nutritional requirements of people.

Millets show us the way out of our food, fodder, nutrition and water crisis, because they are sturdy enough to grow on the poorest lands of the very poor people. They alone can withstand the harshest of climates in the arid and semi arid regions, and continue to offer food and fodder security for the multitudes of our population. Since much of millet farming is ecological, it generates a unique phenomenon called 'uncultivated foods' which shores up the food and nutritional security for the poor. The recent analysis of millets of farming systems has come to the amazing conclusion that millet farming saves nearly six million litres of water per acre, a bonanza for the water starved times we are living in. They can stand up to the most modern crisis of them all, the climate change. Seen from any angle, millets shine forth as miracle grains.





Nutritive values for 100 g of Cereals and Millets

Name	Minerals Gm	Fibre Gm	Energy	Calcium Mg	Phos-phorus Mg	Iron Mg	Carotine	B1 Mg	B2 Mg	Niacin Mg
Rice	0.6	0.2	345	10	160	3.1	0	0.06	0.06	1.9
Pearl Millet	2.3	1.2	361	42	296	5.0	132	0.33	0.25	2.3
Foxtail Millet	3.3	8.0	331	31	290	12.9	32	0.59	0.11	3.2
Sorg-hum	1.6	1.6	349	25	222	5.8	47	0.37	0.13	3.1
Finger Millet	2.7	3.6	328	344	283	6.4	42	0.42	0.19	1.1
Little Millet	1.5	7.6	341	17	220	10.0	0	0.30	0.09	3.2
Proso Millet	2.6	9.0	309	27	188	5.2	0	0.33	0.09	2.0
Wheat	1.5	1.2	346	41	306	4.9	64	0.45	0.17	5.5

Image 1: Comparative assessment of nutrition

Rigorous efforts are needed to mainstream millet farming to improve the ecological balance and the health system of the population, using the 'super grain' as health foods. Incentives should be provided to people growing and procuring nutri-cereals, besides enhancing domestic consumption by creating awareness among the consumers. Farmers should be educated about millet-growing techniques and their process ability. They have many nutraceutical and health-promoting properties and have three times more calcium as compared to rice; they are also rich in antioxidants and score over rice and wheat.

The glycemic index of millet-based products is lower, which ensures slower release of carbohydrates and control of the blood sugar level. Thus, millets are a very good source of nutrition for diabetic people. Millets are gluten-free and can be a substitute for wheat or gluten-containing grains for coeliac patients.

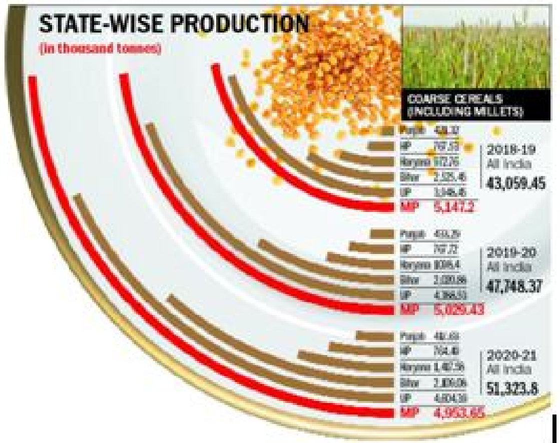


Image 2: State wise production of cereals

Millets Offer a Sustainable Alternative to Major Staple Crops

Millets are a group of diverse small-grain cereal crops grown in marginal soil and under stressed conditions. They comprise about a dozen crop species originated in Asia and Africa, primarily in the third world countries (Gupta *et al.*, 2017). India is the largest producer of millets producing nearly 40 percent of the world's millets despite much negative pressure from competing crops in terms of policies and production supports. The millets' ability to adapt to adverse climatic conditions, requirement of minimal inputs, and superior nutritional qualities are among the specific characteristics of millets rarely found in other common cereals. Millets possess specific molecular, biochemical, and morpho-physiological characteristics that allow them to withstand adverse environmental conditions–drought and poor soil conditions (Bandyopadhyay *et al.*, 2017). Their shorter lifecycle, short stature, and small leaf area may also offer an added advantage. Considering their adaptability to high light, high temperature, and dry weather as C_4 photosynthetic capacity, millets are more efficient than common cereal crops. These mechanisms allow millets to have enhanced photosynthetic rates and lower photorespiration rates, as well as water and nitrogen use efficiency under warm conditions (Bandyopadhyay *et al.*, 2017; Kumar et al., 2022).

Millets are important sources of nutrients and can play a significant role in improving nutritional security and preventing diseases caused by imbalanced nutrition. They are gluten-free and contain as much protein as wheat does. In terms of macronutrients, millets are either similar or superior to major cereals (Kumar *et al.*, 2018). They also contain several micronutrients, vitamins, insoluble dietary fiber, and phenolic compounds, which are essential for health benefits. They are thought to have several health benefits including the ability to address diabetes, aging, cancer, celiac disease, and cardio-vascular disease (Bhat *et al.*, 2018). Millet-based health food items are common and exhibit longer storage life.

Durairaj et al. (2019) observed a significant increase in height, weight, and hemoglobin level of the school children who regularly consumed millet-based health food.

Millets are also rich in micro- and macro-nutrients, total protein, fiber, and resistant starch. For instance, finger millet is rich in calcium (~364 mg per 100 g) and potassium (~320 mg per 100 g), and little millet and barnyard millet have high iron contents (~10–18 mg per 100 g). The total protein is high in foxtail millet and barnyard millet (>10%), and crude fiber is rich in barnyard millet, little millet, foxtail millet, and fonio ~7–14% (Taylor and Emmambux, 2008). In terms of agro-ecological traits, millets have better water-use and nitrogen-use efficiencies that enable them to withstand water-limiting conditions. For example, foxtail millet requires ~250 g of water to produce 1 g of dry biomass, whereas wheat and maize require ~450 and 500 g, respectively.

Image 3: Characteristic Features of Millets

Compared to major cereals, millets are capable of meeting the immediate need for food security in at least five important ways. **(i)** Millets ensure subsistence and income to the marginal population because yield loss or the influence of other external factors (i.e., climate, rainfall, and disease) that impact on productivity is minimal compared to major cereals. Although the area of production and yield of millets are significantly less than for major cereals, millets could provide a better gross return, net return, and benefit–cost ratio. **(ii)** The sustainability of agriculture can be ensured by cultivating millets because they have reduced dependence on synthetic fertilizers, pesticides, weedicides, and insecticides. The global warming potential (GWP) and carbon equivalent emission (CEE) of rice and wheat are the highest among the cereals. The GWP (CO_2 eq/ha) of wheat and rice are 4 and 3.4 tons, respectively, and their CEEs (kg C/ha) are 1000 and 956, respectively (Naser, 2019). However, the carbon footprints of millets could be comparatively lower than those of major cereals (Saleh, 2013; Naresh et al., 2021), although exact values are not available to date. **(iii)** Millet cultivation and use decrease the over-reliance on the major cereals that are limited in number. Of note, the majority of the global population relies on rice and wheat as their staple food, and the intervention of millets could reduce this dependence. **(iv)** Another advantage is the food quality, where millets are established to be highly nutritious with no compromise in taste and texture that are considered to be essential traits for consumer preference. **(v)** Millets can contribute to ensuring diversity in food. Of the tens of thousands of plant species known on Earth, ~7000 species are edible, among which only 20% cater for 90% of global food requirements (Chivenge, 2015). Rice, wheat, and maize make up 60% of all staple crops, resulting in a monotonous diet.

In addition to small millets, underutilized tubers and legumes could add to food and dietary diversification. Among tubers, cassava (*Manihot esculenta*), sweet potato (*Ipomoea batatas*), and taro (*Colocasia esculenta*) are cultivated in African countries, where the tubers, corms, and leaves of these species are consumed as food by economically deprived classes. Arrowroot (*Maranta arundinacea*), Indian shot (*Canna indica*), gonala (*Dioscorea spicata*), purple yam (*D. alata*), air potato (*D. bulbifera*), and elephant foot (*Amorphophallus paeoniifolius*) are a few notable tuber crops that are cultivated in arid- and semi-arid regions (Muthamilarasan, 2019). In the case of legumes, bambara groundnut (*Vigna subterranea*), cowpea (*V. unguiculata*), rice bean (*V. umbellata*), adzuki beans (*V. angularis*), winged bean (*Psophocarpus tetragonolobus*), jack bean (*Canavalia ensiformis*), kidney bean (*Phaseolus vulgaris*), lima bean (*P. lunatus*), faba bean (*Vicia faba*), horsegram (*Macrotyloma uniflorum*), and velvet bean (*Mucuna pruriens*) are meagerly produced in hunger-prone regions (Gulzar and Minnaar, 2019) and these legumes have the potential to develop food self-sufficiency among the population. Therefore, while underscoring the importance of millets in solving hunger and related issues, the collective role of these tubers and legumes as well as millets in ensuring food and nutritional security should not be overlooked.

Why millets are the future crops

Millets are diverse and adapted to different climatic conditions and cropping systems, provide a strong case to enrich biodiversity as well as diversify the food grain basket. Under the climate change scenario, millets are the most dependable food crops the mankind, especially for the resource poor dry-land farmers of the world as they are resilient to climate change and assure sustainable grain production with minimum inputs. Supporting millets is akin to supporting dry-land agricultural ecology (40% of land area that supports 30% of world population) where food insecurity and malnutrition are commonplace. Eradication of hunger is a major priority in these regions as under nutrition accounts for 11 per cent of the global burden of disease and is considered the number one risk to health worldwide.

Rich diversity of millets crops has made them well suited for contingency crop planning and also to address the issues of climate change. The plasticity exhibited has made them flexible for apparent early as well as delayed planting, very low and high rainfall areas, various elevations and different soil regimes. These positive features have not been duly recognized and exploited in the country. The versatile small millets like foxtail millet, barnyard millet, proso millet and little millet would fit in any situations of climatic change and would save the farmers from a total crop failure. The farmers who had shifted from millets to other crops are keen to go back to millets in view of the stable harvests ensured, easy crop production, drought resistance, and eco-friendly production, provided the assured market is in place. Enhanced millets production and consumption directly facilitates improving malnourishment and correcting the slow growth in correction of nutritional disorders such as anemia, surging lifestyle disorders such as diabetes, hypertension, metabolic syndrome, gluten intolerance *etc.* Data on scientific evidences for nutritional and health benefit claims of millets are now available for projecting them as superior nutritious cereals beneficial for human health. In addition, millet foods are being made available in ready-to-eat and ready-to-cook forms.

Table 1: Reasons for decline in millets area and consumption in India

Demand side factors	Supply side factors
• Rapid urbanization	• Increasing marginalized cultivation
• Changing consumer tastes and preferences due to rising per capita incomes	• More remunerative crop alternatives in *Kharif* competing with millets in question
• Government policies favoring other crops such as output price incentives and input subsidies	• More remunerative crop alternatives in *Kharif* competing with millets in question
• Supply of PDS rice and wheat at cheaper price introduced in non-traditional areas of fine cereals.	• Decline in production and quality (as in *Kharif* sorghum because of poor quality of grains due to blackening of grains, f*etc.*ing low price to the farmers)
• Poor social status and inconvenience in their preparation (especially sorghum) and	• Lack of incentives for millet production and
• Lower shelf-life of milled grain and flour of millets	• Development of better irrigation infrastructure / options as in small millets.

Millets for climate smart agriculture

The demand for food will increase proportionally with a growing population. While maize, rice and wheat have been adopted as the major staple cereals, millets and other orphan crops are lagging behind. There is a lesser possibility of crop improvement production as the world is already facing the challenges of dry-lands expansion, soil degradation, and groundwater scarcity (Bisoffi et al., 2021). NRAA (2020) report revealed that after utilizing maximum irrigation potential, about half of the total irrigated land will continue to remain unirrigated. These alarms are forcing us to promote alternatives to major cereal crops. Millets are the best choice among orphan crops and their cultivation can solve this problem as they can be grown on shallow, low fertile soils with a varied (ranging from 4.5 to 8.0) pH (Rathinapriya et al., 2020). There are many types of millet such as finger, foxtail, proso, barnyard, Kodo, little, guinea, browntop, teff, fonio, and Job's tears. Millets can be an easy replacement for wheat and rice. Further, millets like pearl and finger millet can grow up to a soil salinity of 11–12 dS/m, while rice has poor growth and productivity on a soil having salinity higher than 3 dS/m (Rathinapriya et al., 2020). They are considered as a poor man's crop due to their significant contributions to a resource-limited population diet offering several opportunities for their cultivation in developing countries (Figure 1).

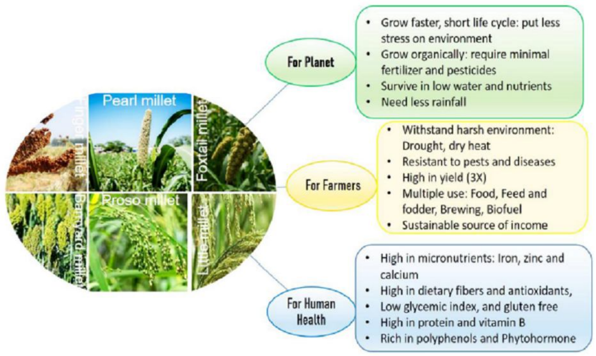


Fig.1: Unique properties of millets for climate smart agriculture, ensuring human health, food and nutritional security

Millets encompass numerous morpho-physiological, molecular, and biochemical properties that confer better tolerance to environmental stresses than major cereals. Molecular mechanisms underlying the plants responses to abiotic stresses include multitude of processes including sensing, signaling, transcription, transcript processing, translation and post-translational protein modifications which are governed by both genetic and epigenetic factors (Figure 2).Among all major abiotic stresses, increased drought and heat due to climate change adversely affect current crop production and alone cause more annual losses. The climate change models predict that drought stress would continue as a major abiotic limitation for food production (Simmons et al., 2020). Many reports show indirect associations between drought and the rise in malnutrition rates, poor health, hunger, starvation, food and water insecurity (Ye and Fan, 2021).

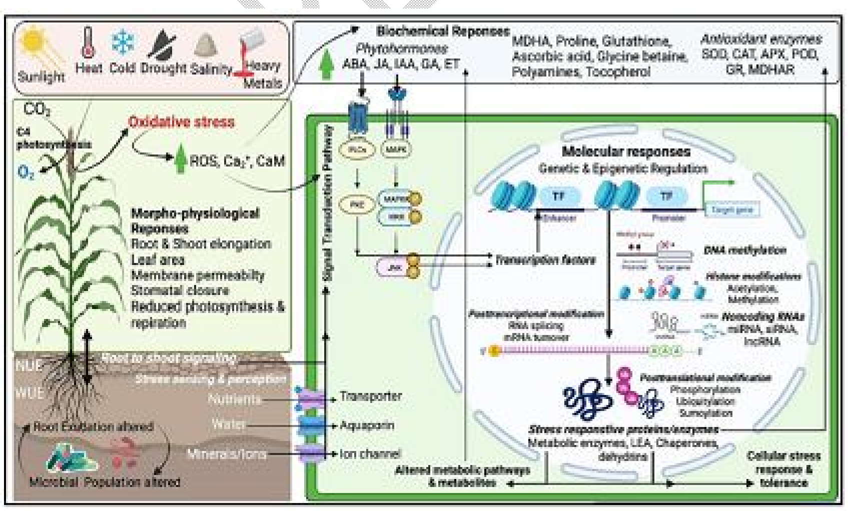


Fig.2: Abiotic stress response sensing, signaling and regulation in millet cells

Millets being naturally drought tolerant stands as best alternative in the semi-arid and arid environments. Millets encompass numerous morphophysioloical, biochemical and molecular traits that confer superior adaptation to drought than major cereals (Figure 3). For example, the rainfall requirement of pearl and proso millet is 20 cm, which is many folds lower than rice as they require more than 120–140 cm (Kumar et al., 2018). The short life-cycle of millets (~10–12 weeks) as compared to other major crops (20–24 weeks) also supports them in stress mitigation. Also, they have a C_4 (Hatch and Slack Pathway) photosynthetic system that is highly advantageous to survive in high temperatures and low moisture. In the C_4 system, the light-dependent reactions and the Calvin cycle are physically separated. Thus, the C_4 mechanism enhances the concentration of CO_2 in bundle sheath, which overpowers photorespiration, and plants can keep their stomata closed during the daytime, thus avoiding water loss (Lundgren et al., 2014). Millets have enhanced photosynthetic rates at warm conditions and confer immediate water and nitrogen use efficiency, which is ~1.5 to 4 fold higher than C_3 photosynthesis (Wang et al., 2012). For instance, *Setaria italica* requires just 257 g of water to produce dry biomass of 1 g, whereas maize and wheat require 470 and 510 g, respectively (Nadeem et al., 2020). Additionally, C_4 photosynthesis provides secondary benefits to millets, including better growth and ecological performer in warm temperatures, enhanced flexible allocation patterns of biomass, and reduced hydraulic conductivity per unit leaf area (Lundgren et al., 2014). These examples offer opportunities for the promotion of these crops to a higher level of production in the changing climate scenario.

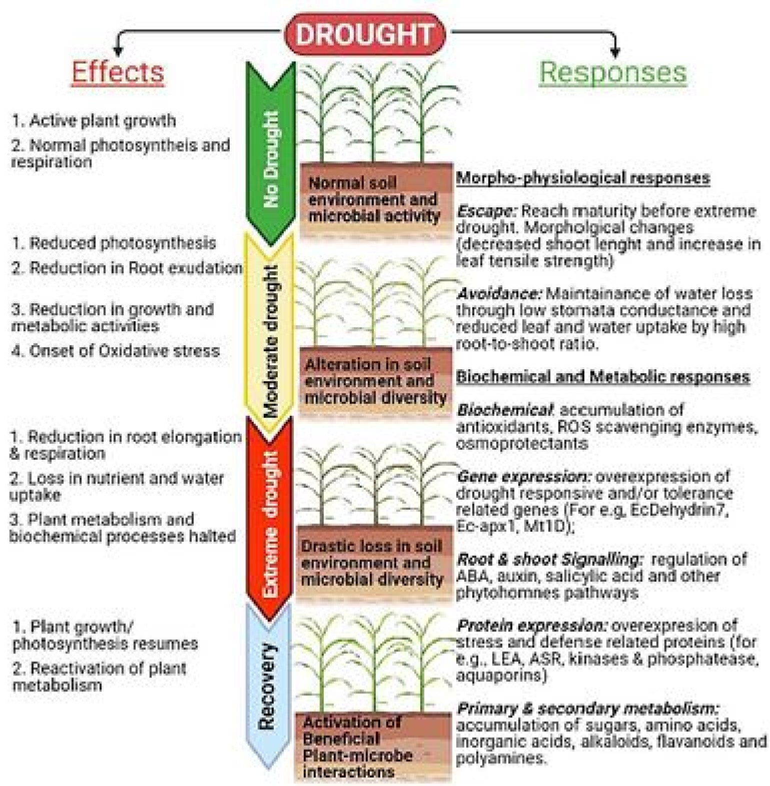


Fig. 3: Drought responses and adaptive strategies linked to numerous morpho-physiological, molecular, and biochemical processes that confer better tolerance to environmental stresses in millets compared to major cereals

CONCLUSIONS

Climate change has already had obvious effects on the environment and put challenges for the agricultural sector globally. Millets have been referred to as 'smart foods' or 'nutri-cereals' because they are better adapted to diverse environmental conditions through water-use and nitrogen-use efficiencies, tolerance to insect pests and diseases, and resistance to environmental stresses. The climate-resilient features and nutritional profiles of small millets have been widely studied, indicating that millets could be the staple crops of choice in hunger-stricken areas. These regions are heavily affected by malnutrition, under nutrition, and premature deaths owing to the non-availability of food in abnormal situations. Millets, the yesteryear staple diet of a majority of people in the semi-arid regions of Asia, especially India, could be the climate-resilient future crop. Millets can counter many of the adverse effects of climate change better than most other food crops. They grow in almost any type of soil – sandy or with varying levels of acidity. They hardly need any fertilizers or irrigation.

Millets are rich in nutrients. While the iron content of barnyard millet is 15.2 mg, that of rice is 0.7 mg. Calcium content of foxtail millet is 31 mg, that of rice 10 mg. While the percentage of nutrients varies with each variety of millet, in general they are richer in calcium, iron, beta-carotene etc. than rice and wheat. Millets are rich in dietary fibred, which is negligible in rice. With no gluten and low glycaemic index, millet diet is ideal for those with celiac diseases and diabetes. Suitable for mixed and intercropping, crops like maize and broad bean; grown with millets, offer food and livelihood security to farmers. Millets can be the wonder crop providing food, nutrition and livelihood security, beating the adverse effects of climate change.

Millets can contribute to sustainable food systems under climate change. Their resilient nature and outstanding potential to survive under low water availability and stressful environments serves as best alternative to staple cereal crops. Therefore, there is an argument to promote them to sustainably address challenges such as increasing drought and heat, food and nutrition insecurity, environmental degradation. The success of efforts to develop rural economies to ensure food and nutrition security and poverty eradication depend on creating supportive agriculture policies, building climate change resilience in agricultural systems and innovations in farming practices managed by smallholders, and the widespread adoption of science and technology.

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Image 4: Millet Map of India