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Perspective

Climate Change Effects in Pakistan: Challenges Regarding Food Security and Health

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Abstract

Climate change in lay terms means global warming resulting mainly from human activity. According to the 2020 Global Climate Risk Index Report, Pakistan is among the 5 most affected countries in the world due to climate change. The most significant effects of climate change in Pakistan include erratic weather patterns such as unseasonal rains, melting glaciers, flooding, land sliding, heat waves, wild fires, prolonged droughts and desertification of cultivable fertile land. All these changes are likely to lead to food insecurity in the country. Moreover, air pollution and "smog" appear to be a common phenomenon in large cities of the country. This could be the reason for the rise in respiratory diseases. Rapidly melting glaciers are going to make Pakistan among the most water-stressed countries in the world by 2040. All these events pose a great challenge to the scientists in the country, especially in the fields of biochemistry and molecular biology.

Keywords: Climate change effects, food security, health, Pakistan

Introduction

Climate change is referred to as, "Current rapid warming of earth's climate mainly caused by human activity that leads to changes in the weather followed by associated changes in oceans, land surfaces and ice sheets". According to the 2020 Report released by *Germanwatch* about the Global Climate Risk Index, Pakistan is ranked 5th most vulnerable country to climate change [1]. Over the past 20 years, Pakistan's weather pattern has undergone a drastic change. Unseasonal rains are now more common. Their intensity in certain regions of the country has significantly increased. Landslides which are common in Northern areas during the rainy season are taking a heavy toll of life. Glaciers which are the country's major source of soft water are melting at a very rapid pace. As per reports published by the United Nations Development Program and the Pakistan Council of Research on Water Resources, it has been estimated that by 2040, Pakistan would be among the most water-stressed countries in the world [2]. Heat waves are now occurring more frequently even in the mountain valleys of the country. Heat waves in Karachi in 2015 caused hundreds of deaths and hospitalization of more than 65,000 people [2]. Intense flooding almost every year during the past 5 years or so has caused a huge damage to the crops, livestock, houses, and loss of many human lives. Deforestation rate is alarmingly high in the country which further exacerbates soil erosion leading to frequent land sliding. Prolonged droughts in certain regions of

Punjab, Sindh and Baluchistan provinces have led to acute shortage of water for agriculture and consumption by humans and livestock.

Climate Change and Food Security

All these changes are seriously affecting the food security in the country. Since food security is one of the most important components for sustaining healthy life in this country, it would need the most urgent attention of young biochemists to rise to the occasion and help in developing climate resilient crops by adopting modern breeding technologies to produce transgenic plants. According to the University of Minnesota's Institute on the Environment, a significant reduction in crop yield of rice and wheat has been observed due to climate change in various regions of the world [3,4]. There are several stress factors leading to this drop in the yield, however, temperature extremes, water shortage and droughts are the most important ones. For example, if the temperature increases above 35 °C, then activity of "*Rubisco*", a key enzyme in photosynthesis is compromised [5]. Similarly, due to water shortage, during the meiotic phase, the grain size of rice and wheat could drop between 35-75% [5-7]. Prolonged mild drought during the flowering and grain formation time could reduce the yield of wheat up to 92% [5,8]. This shows that climate extremes have enormous impact on yield, therefore immediate mitigation steps would be needed to ensure better yields of crops.

Agriculture is one of the major pillars of Pakistan's economy, however Pakistan had to import food items (wheat, sugar, palm oil, pulses) worth $ 7.55 billion from July 2020 to May 2021 to bridge the shortfall in domestic production of agriculture produce [9]. This is a huge burden on the country's meager foreign exchange reserves. In order to mitigate the influence of various weather related stresses, some smart agriculture measures which are commonly practiced in some of the countries have to be put in place. These include different sowing and harvesting time, appropriate planting density, adoption of economical irrigation techniques and going for crop rotation etc. [5,10,11]. However, attempt to modulate the signaling cascades in plants to ward off the climatic stresses is an attractive strategy. For example, ABA (Abscisic acid) is an important hormone which is involved in different phases of plant development, and it induces many stress-responsive genes during this period [5,12]. Ethylene is another phyto-hormone which is involved in regulating plant growth under climatic stresses such as water-logging, high temperature, nutrient deficiency and drought [5,13]. Further work on signaling cascades is essentially required and would enable scientists to come up with novel strategies for development of modulating agents to mitigate the effects of climate change of plant growth and development.

Genomic strategies are also becoming more popular in mitigating the effects of various weather stresses affecting crop yield. For example, quantitative tract loci (QLT) mapping enables identification of elite germplasm under abiotic stresses, which can then be dissected and used in developing novel cultivar to withstand abiotic stresses [5,14,15]. Genome wide association studies

(GWAS) have also been found to be very useful in developing strategies to overcome biotic and abiotic stresses. Moreover, development of transgenic plants to counter these stresses by genetic engineering is also being practiced in many countries [5,16]. Similarly, genome editing by employing sequence-specific nucleases is another powerful strategy to combat food insecurity [17]. The newly developed CRISPR/Cas9 technique is quite precise, economical and rapid to manipulate the plant genome [18].

Climate Change and Health

Regarding impact of climate change on health in Pakistan, a paper by Zia Mustafa in the symposium on "Changing Environmental Patterns and its Impact with Special Focus on Pakistan", indicated that one hundred and eleven diseases such as malaria, dengue, typhoid and cholera which were already a cause of significant mortality and morbidity in Pakistan were very much climate sensitive and would thrive in warmer regions of the country [19], (http//:pecongress.org.pk/)]. A rapid increase in cases of malaria and dengue has been observed as a consequence of climate change in Pakistan especially after flooding, unseasonal rains and warmer temperatures. Besides malaria and dengue outbreaks, other water-borne and water-washed diseases such as hepatitis, cholera and typhoid are also on the rise [2,20,21]. High levels of pollens, allergens and "smog" are causing number of respiratory diseases in large cities of the country [2]. For mitigation of the spread of these diseases, there is a need to develop a climate resilient health infrastructure. Development of vaccines for dengue and malaria represent a significant breakthrough in recent years [22]. Although these vaccines are available in some of the developed countries, their unavailability and high cost in the developing countries such as Pakistan pose a great challenge to the scientific community and public health leaders. Many deaths due to these diseases occur in Sub-Saharan Africa and South Asia every year. Vaccination of masses at a large scale, though challenging, would significantly reduce the incidence of these diseases in the endemic regions. It is required of the biochemists to facilitate the implementation of this approach for prevention of the spread of these diseases. Another aspect of climate change that has often been neglected is its enormous impact on mental health status of masses following the traumatic events such as flooding, droughts, land sliding and loss of crops and livestock [2]. The most common symptoms/diseases which have been found among them include depression, anxiety, distress, complicated grief, sleep disorders, social avoidance and irritability [23]. Since mental health problems in Pakistan are not easily recognizable because of the dearth of psychiatrists, their treatment options remain quite limited. It is incumbent upon the young biochemists to join hands with psychiatrists and psychologists to embark on research to further explore the impact of climate change on mental health in Pakistan. Mitigation of these illnesses will be a huge challenge in the next decade because the triggers for such illnesses are many and only a multi-disciplinary approach could yield some benefits in combating mental health diseases in Pakistan.

Way Forward

Climate changes have been adversely affecting Pakistan quite rapidly. Therefore, it is necessary that the young scientific community is fully aware of the challenge which lies ahead. Moreover, there is a need to create awareness of students in schools and colleges about the climate change effects by including this topic in school's curricula. Media is a very powerful tool in creating awareness among the people; therefore, it should be continuously used for mitigation of climate change effects. This will help in preparing young minds to address future challenges in this area and make Pakistan a prosperous country with healthy population.

References

1. Abubakar S.M. Pakistan 5th most vulnerable country to climate change reveals Germanwatch report. Dawn, January 16, 2020.
2. Iqbal M.P. Effect of climate change on health on Pakistan. Proceedings of Pakistan Academy of Sciences: B. Life and Environmental Sciences 2020; 57(3): 1-12.
3. http//: www.fao.org
4. Ray D. Climate change is affecting crop yields and reducing global food supplies. 2019; July 12 [www.Greenbiz.com/article/climate-change-affecting-crop-yields-and-reducing-global-food-supplies]
5. Raza A., Razzaq A., Mehmood S.S., Zou X., Zhang X., Lv Y.,Xu J. Impact of climate change on crops adaptation and strategies to tackle its outcomes:A review.Plants 2019;8:34; doi:10.3390/plants 8020034
6. Saini H., Aspinall D. Effect of water deficit on sporogenesis in wheat (*Triticum aestivum L.*). Ann. Bot. 1981; 48: 623-633.
7. Sheoran I.S., Saini H.S. Drought-induced male fertility in rice: Changes in carbohydrate levels and enzyme activities associated with the inhibition of starch accumulation in pollens. Sex. Plant Reprod. 1996; 9:161-169.
8. Araus J., Slafer G., Reynolds M. Royo C. Plant breeding and drought in C3 cereals: What should we breed for? Ann. Bot. 2002; 89: 925-940.
9. Khan M.Z. Pakistan spends $7.5bn on food imports in July-May. Dawn, June 20, 2021. https://www.dawn.com/news/1630378
10. Reddy B.V.S., Reddy P.S., Bidinger F., Blümmel M. Crop management factors influencing yield and quality of crop residues. Field Crops Research, 2003, 84, 1–2, 57-77. https://doi.org/10.1016/S0378-4290(03)00141-2.
11. Battisti R., Sentelhas P.C., Parker P.S., Nendal C., Gil M.D.S., Farias J.R., Basso C.J. Assessment of crop-management strategies to improve soyabean resilience to climate change in Southern Brazil. Crop Pasture Sci.2018: 69: 154-162.
12. Kuromori T., Seo M., Shinozaki K. ABA transport and plant water stress responses. Trends Plant Sci. 2018; 23: 513-522.
13. Dubois M., Van den Broeck L. Inze' D. The pivotal role of ethylene in plant growth. Trends Plant Sci. 2018; 23: 313-323.

14. Kole C., Muthamilarasan M., Henry R., Edwards D., Sharma R., Abberton M., Batley J., Bentley A., Blakeney M., Bryant J. Application of genomics-assisted breeding for generation of climate resilient crops: Progress and prospects. Front. Plant Sci. 2o15; 6: 563.
15. Collins N.C., Tardieu F., Tuberosa R. Quantitative trait loci and crop performance under abiotic stress. Where do we stand? Plant Physiol. 2008; 147: 469-486.
16. Shah S.H., Ali S., Hussain Z., Jan S.A., Ali G.M. Genetic improvement of tomato (*Solanum lycopersicum*) with *AtDREB1A* gene for cold stress tolerance using optimized agrobacterium-mediated transformation system. Int. J. Agric. Biol. 2016; 18(3): 471-482.
17. Liu W., Yuan J.S., Stewart C.N. Jr. Advanced genetic tools for plant biotechnology. Nat. Rev. Genet. 2013; 14: 781.
18. Abdelrahman M., Al-Sadi A.M., Pour-Aboughadareh A., Burritt D.J., Tran L-S.P. Genome editing using CRISPR/Cas9-targeted mutagenesis. An opportunity for yield improvements of crop plants grown under environmental stresses. Plant Physiol. Biochem. 2018; 131: 31-36.
19. Mustafa Z. Impact on Health. "Symposium on Changing Environmental Pattern and its Impact with Special Focus on Pakistan", Pakistan Engineering Congress, p100-117 (http://pecongress.org.pk/).
20. World Health Organization. Pakistan: Malaria and other vector-borne diseases. World Health Organization Regional Office for Eastern Mediterranean. 2020.
21. World Health Organization. Typhoid fever, Islamic Republic of Pakistan. World Health Organization 2018; December 27.
22. The world's first dengue and malaria vaccines: What can we learn about access? Access to Vaccines Index 2017. Report Cards.
23. LEAD, Pakistan. Non-economic loss and damage: Exploring the mental health impact of climate change. 2017.35. Discussion paper, Leadership for Environment and Development (LEAD), Pakistan.