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Climate Change Impacts on Arable Crop Yield

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INTRODUCTION

Global climate change has had a substantial impact on agricultural production in the twenty-first century; yields of crops like wheat, maize, rice, and oilseed rape have decreased in many nations and regions. It is anticipated that when temperatures rise, there will be a surge in extreme weather occurrences. Particularly for main commodities like maize, rice, and soybeans, this tendency increases the uncertainty surrounding agricultural production. Global yields of major food crops could drop by 12–20% by the end of this century if adaptation measures are not taken. For this reason, it is essential to precisely estimate how climate change may affect crop yields in order to guarantee global food security.

Research on the effects of climate change on agriculture employs a variety of techniques, including process-based crop models, controlled experiments, and empirical statistical models. In order to examine the effects of varying climatic circumstances on crop development and yield, field experiments were the first widely utilised method of exposing crops to these environments, either naturally occurring or through artificial climate factors. Empirical statistical models and process-based agricultural models have gained popularity with the development of technology. Process-based crop models quantify the physiological mechanisms and dynamic processes of crop growth and production through computer simulations. Mathematical correlations between crop yield and climate change are established by empirical statistical models. Significant advancements in the development of these approaches have been made over time. For instance, found uncertainty in statistical models pertaining to detrending, collinearity of variables, and research scale.

Analysing the simulation impacts and research standards of current process-based crop models. Studies on the effects of climate change, however, frequently concentrate on particular study techniques, which can create biases and uncertainties. For instance, it is difficult for empirical statistical models to forecast yield-climate connections in the future with accuracy because they are based on scant historical observations.

Leading Effects of Climate Change on Agriculture

Agriculture may be impacted by climate change on a local and regional level. This section describes the main effects.

Variations in the Productivity of Agriculture

Different regions may experience better or worse growing conditions for crops as a result of climate change. For instance, lengthier growing seasons are a result of variations in temperature, precipitation, and frost-free days in practically every state. For food production, a prolonged growing season can offer both advantages and disadvantages. While some farmers could be able to plant more crop cycles or longer-maturing crops, others might need to provide more irrigation during a longer, hotter growing season. Additionally, plants, trees, and crops can be harmed by air pollution. For instance, plants that get high levels of ground-level ozone absorb less photosynthesis, develop more slowly, and become more susceptible to disease. Wildfire danger may also rise as a result of climate change. Rangelands, meadows, and farmlands are all highly vulnerable to wildfires. Changes in temperature and precipitation will also probably increase the range and frequency of insects, weeds, and illnesses. This can result in a higher need for pest and weed management.

For over 100 crops grown, pollination is essential. When pollinators, including bees and butterflies, emerge and when plants bloom can be influenced by temperature changes and variations in precipitation. Pollination may decline if there are discrepancies between the time pollinators emerge and when plants blossom.

Effects on Water and Soil Resources

Because they are unable to relocate, animals with restricted mobility such as oysters are susceptible to hypoxia. It is anticipated that climate change would lead to an increase in the frequency of heavy rains. This might be detrimental to crops as it can erode soil and deplete nutrients. Additionally, agricultural runoff into lakes, streams, and oceans can be increased by heavy rainfall. Water quality may be harmed by this runoff. Runoff can cause aquatic bodies to lose oxygen when combined with the rising water temperatures brought on by climate change. We call this hypoxia. Fish and shellfish can die from hypoxia. Additionally, it may make it more difficult for them to locate food and habitat, which could have a negative impact on the coastal businesses and cultures that depend on such ecosystems.

Coastal farming communities face dangers from storms and sea level rise. Agricultural land loss, incursion of saltwater that can contaminate water supplies, and erosion are some of these hazards. These risks are predicted to get worse due to climate change.

Health Issues for Livestock and Agricultural Workers

Many health risks associated to climate change affect agricultural labourers. These include being exposed to heat and other harsh weather conditions, being around more pests and hence exposed to more pesticides, being around disease-carrying pests like ticks and mosquitoes, and having poorer air quality. These hazards may be increased by variables

such as language problems, limited access to healthcare, and others. The productivity and well-being of animals produced for meat, milk, and eggs can also be impacted by heat and humidity.

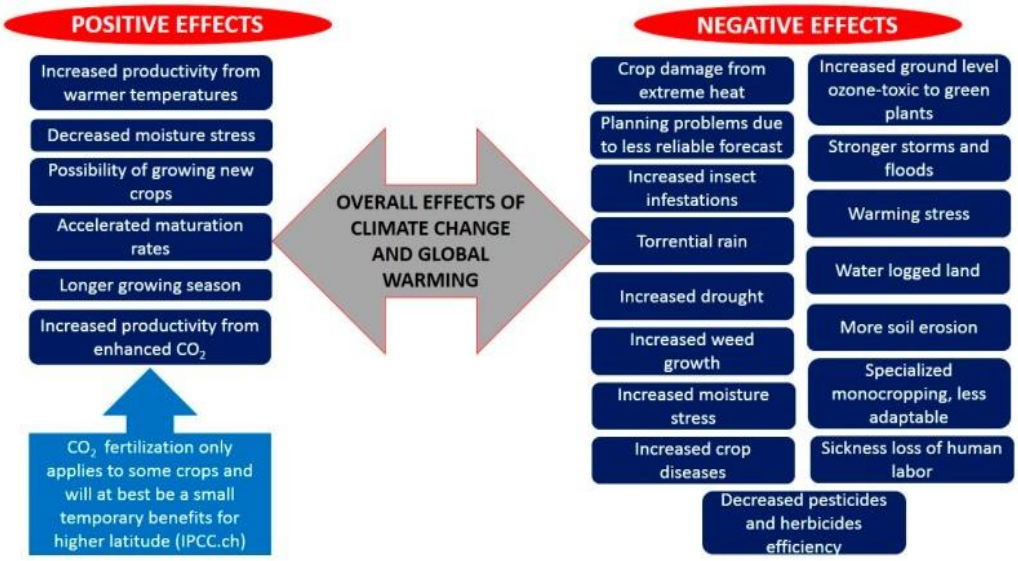

Fig 1: Overall positive and negative effects of climate change and global warming on crops and humans

What Is Possible?

One of the numerous strategies to support the health and well-being of pollinators such as bees and butterflies is to plant a pollinator-attracting garden with native species.

There are several strategies we may take to lessen the effects of climate change on agriculture, such as the following:

- Use climate-smart farming techniques. To help manage production challenges associated to climate change, farmers should grow cover crops, employ tools for climate forecasting, and take other appropriate actions.
- Sign up for AgSTAR. Methane, a powerful greenhouse gas, can be recovered by livestock producers from the biogas produced during the breakdown of manure.
- Cut down on runoff. In order to lessen runoff that is high in nutrients, farmers should apply fertilisers wisely, keep their animals out of streams, and take other measures.
- Increase the resistance of crops. Adopt strategies that have been shown to work by research to lessen the effects of climate change on livestock and crops, such as better pollination and less usage of pesticides.
- Avoid wasting food. By carefully arranging your shopping excursions and conserving food, you can stretch your money and reduce your carbon footprint. Give wholesome, unopened food to food banks and underprivileged people.

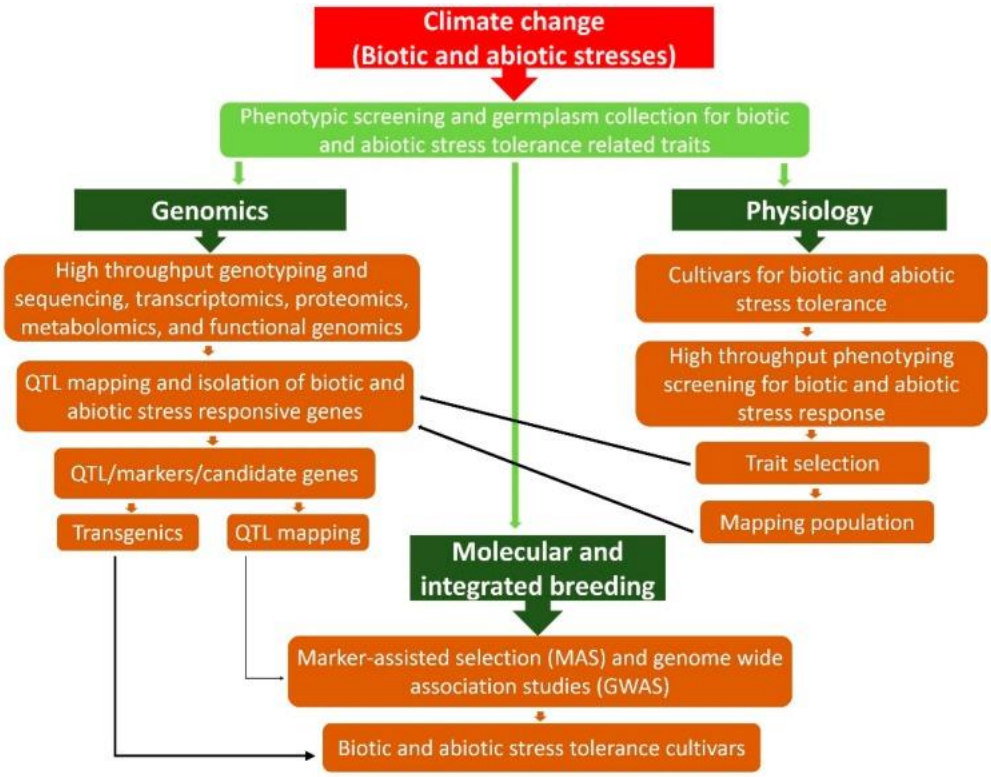

Fig 2: A step-wise presentation of physiological, molecular breeding and genomics approaches to develop biotic and abiotic stress tolerance cultivars

CONCLUSION

Climate changes are alarming the world by hampering agriculture and its products. Industrialization and poisonous gases cause global warming, which ultimately disturbs the world's environment. Climate change has devastating effects on plant growth and yield. Abiotic stresses are the major type of stresses that plants suffer. To understand the plant responses under different abiotic conditions the most pressing current need is to explore the genetic basis underlying these mechanisms. Some bottleneck molecular and physiological challenges present in plants need to be resolved for better plant adaptation under abiotic conditions. Temperature fluctuations and variations in rainfall spells are a very crucial indicators of environmental stresses. Weather variations collectively have positive and negative outcomes but the negative effects are more thought-provoking. It is very difficult to overcome the imbalance in agriculture by climate change. How to tackle this problem and what strategies we should apply are still ambiguous. Hence, researchers need to focus on optimizing plant growth and development in abiotic stresses. For crop resistance against biotic and abiotic stresses, propagating novel cultural methods, implementing various cropping schemes, and different conventional and non-conventional approaches will be adopted to save agriculture in the future.

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