Recent Research in Science and Technology 2014, 6(1): 46-47
ISSN: 2076-5061
Available Online: http://recent-science.com/

# Designer rice: New concept for climate change

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**Abstract**

Rice is the most important cereal crop that has been referred as global grain because of its use as prime staple food in about 100 countries of the world. Chhattisgarh popularly known as 'Rice Bowl of India'. The rising demand saturation of cultivable field and climate change cause a supply shortage of a crop in the near future. The impact of climate change has serious implications for productivity and production of crops, thus threatening our food security and health and livelihood of millions. By the near 2025, about 785 million tonnes of paddy which is 70% more than the current production is needed to meet the growing demand. To achieve the expected yield and hike the productivity of rice, it becomes necessary to design rice according to change climate. The newly designed plant type was mainly based on the results of simulation modeling and new traits were mostly morphological. The proposed new plant type has low tillering capacity, few unproductive tillers, more filled grains per panicle, plant height of 90-100 cm, thick and sturdy stems, leaves that are thick, dark green and erect, a vigorous root system, 100-135 days crop duration and increased harvest index. Therefore, there is an urgent need for the development of designer varieties to sustain and enhance the productivity and production of agricultural crops even in changing climate regimes.

**Keywords:** Rice, Climate change, Designer crop

## INTRODUCTION

Global climate change has emerged as the biggest challenge before the agricultural production system as the unconscious and injudicious use of natural resources and emission of green house gases, in the name of economic and technological developments have created alarming situation. The temperature may increases up to 4C by the end of 21st century, which may cause extinction of many animals, birds, plant species and biodiversity. The recent sudden drop in food grain growth rate in India to a great extent may be attributed to the adverse impact of fluctuating climate. As predictions go, the climate change unprecedented has already created serious problems for farmers. Rice is the most important cereal crop that has been referred as Global grain because of its use as prime staple food in about 100 countries of the world. Chhattisgarh popularly known as Rice bowl of India " . The rising demand, saturation of cultivable field and climate change cause a supply shortage of a crop in the future. By the near 2025, about 785 million tonnes of paddy which is 70% more than the current production is needed to meet the growing demand. To achieve the expected yield and hike the productivity of rice, it becomes necessary to design new rice varieties with higher yield potential in order to enhance average farm yields. Yield potential is defined as the yield of a variety when grown in environments to which it is adopted, with nutrients and water non limiting and with pests, diseases, weeds , lodging and other stresses effectively controlled (Evans, 1993). Serious concerns are expressed over yield plateau but unforeseen factors like increased magnitude of water stress coupled with high temperature due to climate change can further suppress the productivity, more particularly under stress environment.

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### Selection strategy

Although most of the progress in crop improvement has been made through genetic manipulations but the combination of genetic and physiological analysis can provide insight into a complex phenomenon. The sustained efforts of both physiologists and plant breeder can develop a function technique that would greatly simplify selection procedure. Efficient selection methodology is the key to develop suitable genotypes. However, no one set of selection procedure is likely fit all semi arid and arid environments. Since, they greatly vary with respect to intensities of rainfall, soil type and local temperature during crop growth stages. Therefore the most appropriate selection techniques are to be developed for each situation. Efficiency of selection depends on favourable/ unfavourable growing conditions under which the plants respond. Before practicing the selections in segregating populations a breeder has to define the problems and propose the ideotype.

### Ideotype

A need has always been felt to define a suitable plant Ideotype of rice for different agro-ecological conditions. However, to developed a ideotype, different opinion have been expressed by the physiologists and breeders for dry areas, because of variable conditions and nature of moisture stress and other environmental interacting factors . A number of physiological, morphological and biochemical mechanisms operating in a plant make drought and heat tolerance complex problem. Due to this complexicity the improvement for drought and heat tolerance in rice remains an unfulfilled endeavour. Useful information with respect to crop phenology, root and shoot morphology, physiological traits for different environmental conditions have to be consider to arrive at precise definition of plant ideotype for different agro ecological conditions.

Attempts to defined characters for an ideotype for certain specific situation have been made by several workers. Most of the physiologists differ in their perceptions. Breeders, practically need simple traits and the methodology which can be used in screening a large number of genotypes and their cross combination in segregating generations. Identifying a trait based on extreme and intermediate values and drought and heat indices indicating relative significance of different traits is of great importance. Since the desire ability of traits might be environment specific, a common ideotype cannot be suggested for all environmental conditions.

## A concept on water stress and high temperature

Full potential of genotypes is seldom realized due to heat and moisture stresses. This unique agro climatic conditions demand a modified technology for receding water levels and high temperatures during crucial growth stages. The breeding methodology adopted according to climate change need to be reviewed and the new concept frame work is to be formulated for these harsh environments. It has been observed that the impact of high temperature and water stress and their interactions in rice crop shown under rainfed condition.

Choice of appropriate genotypes which respond batter under limited water availability condition is very crucial in breeding for limited irrigation environment. Their genotypes must have had stable performance under varied environments. Consideration of those phonological stages conceding with the environment having limited water availability has to be given maximum importance. The morphological and physiological traits which have been tested over time and identified to show relationship with yield will constitute important criteria for breeding genotypes for limited water availability.

The newly designed plant type was mainly based on the results of simulation modelling and new traits were morphological. The proposed new plant type has early growth vigour, low tillering capacity, few unproductive tillers , more filled grains per panicle, plant height (90-100 cm), thick and sturdy stems , leaves that are thick , dark green and erect, a vigorous root system, 100-135 days crop duration and increased harvest index under heat and moisture stress condition.

## Ideotype Breeding Approaches

It is clear that the plant type of china “super” hybrid rice has many similarities with IRRI’s NPT design. Both emphasize large and heavy panicles with reduced tillering capacity. it was expected that harvest index could be improved with increased sink size and few unproductive tillers. Other common traits are erect leaf canopy and slightly increased plant height in order to increase biomass production. In the plant type of “Super” hybrid rice, however, panicle covered inside the leaves canopy by increasing the distance between panicle height and plant height. The latter approach was used in developing “Super” hybrid rice in China and appears to be more effective than the farmer in improving rice yield. Another improvement in plant type design of “Super” hybrid rice over IRRI’s original NPT designed was the great emphasis on the top three leaves. Length, angle, shape, thickness, and area of the top three leaves were quantitively defined in the detail in the “Super” hybrid rice design. The initial breeding strategies for the NPT at IRRI were to use genes for large panicle and sturdy stems from tropical japonica germplasm. The second step was to cross the improved the tropical japonica with elite *indica* varieties to produce an intermediate rice type. In breeding for “super” hybrid rice in China , the two-line and three-line method was used to developed F1 hybrid combinations by crossing an intermediate type between *indica* and *japonica* with an *indica* parent in order to use inter sub-specific heterosis. The success of “Super” hybrid rice breeding in China and progress in NPT breeding at IRRI suggest that the Ideotype approach effective for breaking the yield ceiling.

## CONCLUSION

Serious concerns are expressed over yield plateau but unforeseen factors like increased magnitude of water stress coupled with high temperature due to climate change can further suppressed the productivity, more particularly under stress environment. Identification of traits from among the germplasm that could be beneficial in the target environment is one of the impotant steps before recombing it with other desirable characters. The ideotype breeding approach is not an alternative but a supplement to empirical breeding approaches because selection for yield is still needed in ideotype breeding. A new rice ideotype may reqire concurrent modification of crop management such as seedling age, planting geometry, fertilization, irrigation regime, and weed control in order to fully express its yield potential ( Abuelgasim, 1991)

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