

Review

# The 21st Century Agriculture: When Rice Research Draws Attention to Climate Variability and How Weedy Rice and Underutilized Grains Come in Handy

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**Abstract:** Rice, the first crop to be fully sequenced and annotated in the mid-2000s, is an excellent model species for crop research due mainly to its relatively small genome and rich genetic diversity. The 130-million-year-old cereal came into the limelight in the 1960s when the semi-dwarfing gene *sd-1*, better known as the “green revolution” gene, resulted in the establishment of a high-yielding semi-dwarf variety IR8. Deemed as the miracle rice, IR8 saved millions of lives and revolutionized irrigated rice farming particularly in the tropics. The technology, however, spurred some unintended negative consequences, especially in prompting ubiquitous monoculture systems that increase agricultural vulnerability to extreme weather events and climate variability. One feasible way to incorporate resilience in modern rice varieties with narrow genetic backgrounds is by introgressing alleles from the germplasm of its weedy and wild relatives, or perhaps from the suitable underutilized species that harbor novel genes responsive to various biotic and abiotic stresses. This review reminisces the fascinating half-century journey of rice research and highlights the potential utilization of weedy rice and underutilized grains in modern breeding programs. Other possible alternatives to improve the sustainability of crop production systems in a changing climate are also discussed.

**Keywords:** climate change; food security; green revolution; modern rice; underutilized grains; weedy rice

## 1. Introduction

The blueprint to achieve a more sustainable future for all, or better known collectively as the sustainable development goals (SDGs), was developed by the United Nations in 2015 as a universal call for action to protect the earth, end poverty, and ensure that humans live in peace and prosperity [1,2]. Agriculture, the largest user of natural resources like water and land in the world, plays a direct role in achieving some of the 17 developed SDGs, especially in terms of water, biodiversity, climate change, poverty, sustainable energy, and cities [3]. The green revolution (GR) succeeded in increasing crop production after the mid-20th century and saved millions of lives [4]. However, a new paradigm of green agriculture, where less resources are used to grow crops, is required in the current century to feed the ever-growing population amid climate change. The Fifth Assessment Report prepared by the