Preface

Global strains on the food supply due to the ever increasing world population, chronic malnutrition in developing countries, projected economic growth in emerging countries, and the growing frequency of extreme weather events have become major concerns for mankind. According to the United Nations, the world population is projected to increase from 7.7 billion in 2019 to 9.7 billion in 2050, with the population in sub-Saharan Africa (excluding South Africa) doubling by 2050. In addition, over 800 million people, one-ninth of the population of the world, are reported to be undernourished, particularly in sub-Saharan Africa. Furthermore, in developing regions, large agricultural land areas are under adverse environmental conditions, such as insufficient fertilization and soil aridity, and are vulnerable to the adverse effects of climate change. Climate change has led to frequent droughts and other extreme weather events around the world that have threatened agricultural production. Goal 2 of the17 Sustainable Development Goals (SDGs) of the United Nations aims to end hunger, achieve food security, improve nutrition, and promote sustainable agriculture. Therefore, it is necessary to promote sustainable agricultural production activities in developing countries that have not yet reached their agricultural production potential.

In order to establish a stable and sustainable production of agricultural crops in vulnerable developing countries, the Japan International Research Center for Agricultural Sciences (JIRCAS) has been working on the development of breeding materials and basic breeding technologies for highly productive crops that are able to adapt to adverse environmental conditions through collaborative research efforts among international research centers and local institutions in developing regions. Biotechnology, especially genetic modification (GM), is expected to lead to the development of crops with increased tolerance to adverse environmental conditions like drought. JIRCAS has been promoting international joint research projects to enhance the drought tolerance of crops, such as rice, wheat, and soybeans. Throughout our projects in particular, we have shown that the overexpression of genes that encode stress-related transcription factors and enzymes may improve the drought tolerance of transgenic crops.

In this working report, we have summarized the results of our international collaborative efforts to develop genetically modified crops with enhanced drought tolerance. Chapter 1 presents the foundational research results regarding the mechanisms of environmental stress tolerance in plants that we have generated with RIKEN and the University of Tokyo in Japan as well as the applied research results of the development of drought-tolerant crops that we have generated with various local institutions and the research centers affiliated with the Consultative Group on International Agricultural Research (CGIAR). Chapter 2 introduces our international joint research efforts for the development of drought-tolerant rice and wheat with the support of the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan. This chapter also includes two new papers from Japan and Colombia, respectively. Chapter 3 introduces our research on the development of drought-tolerant soybeans, which was implemented as a project of the Science and Technology Research Partnership for Sustainable Development (SATREPS) with the support of the Japan Science and Technology Agency (JST) and the Japan International Cooperation Agency (JICA) in Brazil. The last report of Chapter 3 presents the research on the development of drought-tolerant sugarcane in connection with the project. We have also included a presentation in the Appendix that provides an overview

of the GM research to date, which was imparted at the International Soybean Conference 2018 in Brazil. We hope that the biotechnological breeding technologies and materials produced may contribute to improved food and nutrition security in developing regions.

Finally, on behalf of JIRCAS, we would like to express our gratitude and appreciation to the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan, the Japan Science and Technology Agency (JST), and the Japan International Cooperation Agency (JICA). We thank various local institutions, such as the Brazilian Agricultural Research Corporation (Embrapa) and the research centers affiliated with the Consultative Group on International Agricultural Research (CGIAR), such as the International Rice Research Institute (IRRI) in the Philippines, the International Tropical Agriculture Center (CIAT) in Colombia, and the International Maize and Wheat Improvement Center (CIMMYT) in Mexico, for their considerable support of our research activities. Last but not least, we thank all those who contributed to the papers in this working report.

NAKASHIMA Kazuo
Program Director, Stable Agricultural Production, JIRCAS

URAO Takeshi
Director, Biological Resources and Post-harvest Division, JIRCAS