

CHARTING NEW PATHWAYS TO



RICE

Edited by **J. E. SHEEHY**
P. L. MITCHELL and **B. HARDY**

IRRI

World Scientific

Contents

| | |
|---|-----|
| FOREWORD | v |
| PREFACE | vii |
| SECTION 1: SETTING THE SCENE | 1 |
| How the rice crop works and why it needs a new engine | 3 |
| <i>J.E. Sheehy, A.B. Ferrer, P.L. Mitchell, A. Elmido-Mabilangan, P. Pablico, and M.J.A. Dionora</i> | |
| The case for C ₄ rice | 27 |
| <i>P.L. Mitchell and J.E. Sheehy</i> | |
| Agricultural research, poverty alleviation, and key trends in Asia's rice economy | 37 |
| <i>D. Dawe</i> | |
| Catching up with the literature for C ₄ rice: what we know now and didn't then | 55 |
| <i>P.L. Mitchell</i> | |
| SECTION 2: C ₄ RICE FROM THEORY TO PRACTICE | 79 |
| C ₄ photosynthesis: minor or major adjustments to a C ₃ theme? | 81 |
| <i>R.C. Leegood</i> | |
| C ₄ photosynthesis and CO ₂ diffusion | 95 |
| <i>S. von Caemmerer, J.R. Evans, A.B. Cousins, M.R. Badger, and R.T. Furbank</i> | |
| Nuclear regulation of chloroplast development in C ₄ and C ₃ plants | 117 |
| <i>J.A. Langdale, M. Waters, E.C. Moylan, and A. Bravo-Garcia</i> | |
| Balancing light capture with distributed metabolic demand during C ₄ photosynthesis | 127 |
| <i>J.R. Evans, T.C. Vogelmann, and S. von Caemmerer</i> | |
| Redesigning C ₄ rice from limited C ₄ photosynthesis | 145 |
| <i>D.M. Jiao</i> | |
| Overexpression of C ₄ pathway genes in the C ₃ dicots potato, tobacco, and <i>Arabidopsis</i> : experiences and future challenges | 163 |
| <i>C. Peterhänzel, H.-J. Hirsch, and F. Kreuzaler</i> | |
| Molecular evolution of C ₄ photosynthesis in the dicot genus <i>Flaveria</i> : implications for the design of a C ₄ plant | 175 |
| <i>U. Gowik and P. Westhoff</i> | |
| Learning from nature to develop strategies for the directed evolution of C ₄ rice | 195 |
| <i>R. Sage and T.L. Sage</i> | |

| | |
|---|------------|
| The regulation of genes in C ₃ plants that have been co-opted into C ₄ photosynthesis, and implications for making a C ₄ rice <i>J.M. Hibberd</i> | 217 |
| SECTION 3: SINGLE-CELL C₄ SYSTEMS | 233 |
| C ₄ rice: early endeavors and models tested <i>J. Burnell</i> | 235 |
| Breaking the Kranz paradigm in terrestrial C ₄ plants: does it hold promise for C ₄ rice? <i>G.E. Edwards, E. Voznesenskaya, M. Smith, N. Koteyeva, Y.-I. Park, J.H. Park, O. Kirrats, T.W. Okita, and S.D.X. Chuong</i> | 249 |
| <i>Hydrilla</i> : retrofitting a C ₃ leaf with a single-cell C ₄ NADP-ME system <i>G. Bowes, S.K. Rao, J.B. Reiskind, G.M. Estavillo, and V.S. Rao</i> | 275 |
| The ecology and evolution of single-cell C ₄ -like photosynthesis in diatoms: relevance to C ₄ rice <i>J.A. Raven, K. Roberts, E. Granum, and R.C. Leegood</i> | 297 |
| SECTION 4: THE BACKGROUND AND HOW C₄ RICE CAN BE DELIVERED | 315 |
| The promise of systems biology for deciphering the control of C ₄ leaf development: transcriptome profiling of leaf cell types <i>T. Nelson, S.L. Tausta, N. Gandotra, T. Liu, T. Ceserani, M. Chen, Y. Jiao, L. Ma, X.-W. Deng, N. Sun, M. Holfold, N. Li, and H. Zhao</i> | 317 |
| Toward C ₄ rice: learning from the acclimation of photosynthesis in the C ₃ leaf <i>E.H. Murchie and P. Horton</i> | 333 |
| Wild species of <i>Oryza</i> : a rich reservoir of genetic variability for rice improvement <i>D.S. Brar and J.M. Ramos</i> | 351 |
| C ₄ rice: a plant breeder's perspective <i>P.S. Virk and S. Peng</i> | 361 |
| From allele engineering to phenotype <i>P. Hervé</i> | 371 |
| SECTION 5: SETTING UP THE CONSORTIUM | 379 |
| C ₄ rice: brainstorming from bioinformaticians <i>R. Bruskiewich and S. Wanchana</i> | 381 |
| Surveying the possible pathways to C ₄ rice <i>P.L. Mitchell and J.E. Sheehy</i> | 399 |
| INDEX | 413 |