



**BIOTECHNOLOGIES AT WORK
FOR SMALLHOLDERS:
CASE STUDIES FROM
DEVELOPING COUNTRIES IN
CROPS, LIVESTOCK AND FISH**



OCCASIONAL PAPERS ON **INNOVATION IN FAMILY FARMING**

**BIOTECHNOLOGIES AT WORK
FOR SMALLHOLDERS:
CASE STUDIES FROM
DEVELOPING COUNTRIES IN
CROPS, LIVESTOCK AND FISH**

Edited by

J. Ruane, J.D. Dargie, C. Mba, P. Boettcher, H.P.S. Makkar, D.M. Bartley and A. Sonnino

Food and Agriculture Organization of the United Nations

2013

The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations (FAO) concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The mention of specific companies or products of manufacturers, whether or not these have been patented, does not imply that these have been endorsed or recommended by FAO in preference to others of a similar nature that are not mentioned.

The views expressed in this information product are those of the author(s) and do not necessarily reflect the views or policies of FAO.

ISBN 978-92-5-107877-8 (print)

E-ISBN 978-92-5-107878-5 (PDF)

© FAO, 2013

FAO encourages the use, reproduction and dissemination of material in this information product. Except where otherwise indicated, material may be copied, downloaded and printed for private study, research and teaching purposes, or for use in non-commercial products or services, provided that appropriate acknowledgement of FAO as the source and copyright holder is given and that FAO's endorsement of users' views, products or services is not implied in any way.

All requests for translation and adaptation rights, and for resale and other commercial use rights should be made via www.fao.org/contact-us/licencerequest or addressed to copyright@fao.org.

FAO information products are available on the FAO website (www.fao.org/publications) and can be purchased through publications-sales@fao.org.

Cover photo (from top to bottom):

@Zaijie Dong

@Manzoor Dar

@NARI/Chanda Nimbkar

CONTENTS

Acknowledgements	v
Abbreviations and Acronyms.....	vi
CHAPTER 1	
INTRODUCTION.....	1
<i>J.D. Dargie</i>	
CHAPTER 2	
CASE STUDIES IN THE CROP SECTOR.....	7
2.1 Use of Tissue Culture and Mutation Induction to Improve Banana Production for Smallholders in Sri Lanka.....	8
<i>P.J.L. Lagoda</i>	
2.2 Successful Marker-Assisted Selection for Disease Resistance and Drought Tolerance in Pearl Millet in India	18
<i>R. Yadav, C.T. Hash, C. Howarth, J.R. Witcombe and I.S. Khairwal</i>	
2.3 Clean Planting Materials Produced <i>in Vitro</i> to Improve Performance of Sweet Potato, Plantain and Bananas in Ghana	27
<i>M.D. Quain and B.M. Dzomeku</i>	
2.4 Molecular Markers and Tissue Culture: Technologies Transcending Continental Barriers to Add Value and Improve Productivity of Cassava in Africa	37
<i>E. Okogbenin, C. Egesi and M. Fregene</i>	
2.5 Somatic Embryogenesis for the Production of Plantain Planting Materials in Cuba	47
<i>J. López, N. Montano, D. Reinaldo, A. Rayas, V. Medero, A. Santos, D. Rodríguez, M. Basail, Y. Beovidez, A. Cantero and D. Montano</i>	
2.6 Use of Tissue Culture in Cassava for Rural Households in Colombia	56
<i>R.H. Escobar, J. Restrepo, J. Tohme and W.M. Roca</i>	
2.7 Transforming Rice Production in Flood-Affected Areas: Development of the Swarna-Sub1 Variety Using Marker-Assisted Backcrossing and its Deployment in India.....	63
<i>U.S. Singh, M.H. Dar, S. Singh and A.M. Ismail</i>	
CHAPTER 3	
CASE STUDIES IN THE LIVESTOCK SECTOR.....	71
3.1 Sustainable Improvement in Sheep Productivity in India Using the FecB (Booroola) Mutation	72
<i>C. Nimbkar</i>	
3.2 Saving the Endangered Namaqua Afrikaner Sheep Breed in South Africa through Conservation and Utilization	82
<i>E. van Marle-Koster, C. Visser, S.O. Qwabe and M.A. Snyman</i>	

3.3 Application of Artificial Insemination with Frozen Semen in an Angora Goat Breeding Project in Northern Patagonia, Argentina	90
<i>A. Gibbons, J. Arrigo, H. Taddeo, M. Abad and M. Cueto</i>	
3.4 Use of Artificial Insemination in a Community-Based Approach to Deliver Cattle Production-Related Veterinary Services in Four Dairy-Producing Areas of Bangladesh	98
<i>M.M.U. Bhuiyan, M.T. Islam and M. Shamsuddin</i>	
3.5 Intensive and Integrated Farm Systems using Fermentation of Swine Effluent in Brazil	109
<i>I. Bergier, E. Soriano, G. Wiedman and A. Kososki</i>	
3.6 Taking the Laboratory to the Field: Rapid Diagnosis of Peste des Petits Ruminants (PPR) in Cameroon	117
<i>A. Wade and A. Souley</i>	
3.7 Application of the Sterile Insect Technique in Zanzibar to Eradicate Tsetse Flies, the Vectors of Trypanosomosis	125
<i>U. Feldmann, F. Mramba, A.G. Parker, K.M. Saleh, V.A. Dyck and M.J.B. Vreysen</i>	
CHAPTER 4	
CASE STUDIES IN THE FISHERY SECTOR.....	133
4.1 Application of Probiotics as an Environmental Treatment and Feed Additive in the Production of Farmed Marine Shrimp in China	134
<i>Y. Xinhua</i>	
4.2 PCR-based Pathogen Detection in Shrimp Aquaculture in India.....	140
<i>P.C. Thakur, A.P. Padiyar, A.K. Sahoo, G. SubbaRao and D. Ramraj</i>	
4.3 Interspecific Hybrid Catfish in Thailand.....	149
<i>U. Na-Nakorn</i>	
4.4 Use of Within-Family Selection and Gynogenesis to Develop the Jian Carp (<i>Cyprinus carpio</i> var. jian) in China.....	156
<i>Z. Dong</i>	
4.5 Small-Scale Fish Fermentation and Processing in West Africa	161
<i>G.R. Akande</i>	
CHAPTER 5	
AGRICULTURAL BIOTECHNOLOGY CASE STUDIES: CHALLENGES, ACHIEVEMENTS AND LESSONS LEARNED	173
<i>J.D. Dargie</i>	

ACKNOWLEDGEMENTS

First and foremost, we gratefully acknowledge the contributions of the scientists and researchers worldwide who prepared this unique series of 19 case studies covering the crop, livestock and fisheries/aquaculture sectors where biotechnologies were used to serve the needs of smallholders in developing countries. Contributors had direct experience with the case studies and were therefore in a position to provide an insider's guide to the relevant background, achievements, obstacles, challenges and lessons learned. We also thank Charlotte Lietaer of FAO's Research and Extension Unit for all her administrative assistance.

We are also grateful for the Ministry of Agriculture of Canada's financial support to FAO's work on agricultural biotechnologies in 2012-2013 (through project GCP/GL0/453/CAN), which included the preparation of this publication.

ABBREVIATIONS AND ACRONYMS

ABDC-10	FAO international technical conference on Agricultural Biotechnologies in Developing Countries
ACIAR	Australian Centre for International Agricultural Research
AGE	Joint FAO/IAEA Programme for Nuclear Techniques in Food and Agriculture
AI	Artificial insemination
AICPMIP	All-India Coordinated Pearl Millet Improvement Project
AR4D	Agricultural research for development
AW-IPM	Area-wide integrated pest management
BBrMV	Banana bract mosaic virus
BBSRC	Biotechnology and Biological Sciences Research Council (in the United Kingdom)
BBTV	Banana bunchy top virus
BMP	Better management practice
BRAC	Bangladesh Rural Advancement Committee
CAI	Cervical artificial insemination
CCSHAU	Chaudhary Charan Singh Haryana Agricultural University (in India)
CDVF	Community-based Dairy Veterinary Foundation (in Bangladesh)
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Centre for Tropical Agriculture
CMD	Cassava mosaic disease
CMV	Cucumber mosaic virus
CNPq/REPENSA	National Research Networks in Agrobiodiversity and Agricultural Sustainability programme (in Brazil)
COOASGO	Cooperativa Agropecuária São Gabriel do Oeste Ltda (in Brazil)
CRRRI	Central Rice Research Institute (in India)
CS	Case study
CSIR-CRI	Council for Scientific and Industrial Research-Crops Research Institute (in Ghana)
DFID	Department for International Development (United Kingdom)
DM	Downy mildew
ELISA	Enzyme-linked immunosorbent assay
EMBRAPA	Brazilian Agricultural Research Corporation
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FHIA	Fundacion Hundurena de Investigacion Agricola
FIDAR	Fundación para la Investigación y Desarrollo Agrícola (in Colombia)
FSD	Frog skin disease
GIS	Geographic information systems

HPV	Hepatopancreatic parvovirus
IAEA	International Atomic Energy Agency
IBERS	Institute of Biological, Environmental and Rural Sciences (in United Kingdom)
ICAR	Indian Council of Agricultural Research
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDRC	International Development Research Centre (in Canada)
IFAD	International Fund for Agricultural Development
IITA	International Institute of Tropical Agriculture
INIVIT	Instituto de Investigaciones de Viandas Tropicales (in Cuba)
INTA	Instituto Nacional de Tecnología Agropecuaria (in Argentina)
IPR	Intellectual property rights
IRRI	International Rice Research Institute
LAI	Laparoscopic artificial insemination
LAMP	Loop-mediated isothermal amplification
LANAVET	Laboratoire National Veterinaire (in Cameroon)
MABC	Marker-assisted backcrossing
MAPA	Ministry of Agriculture, Livestock and Food Supply (in Brazil)
MAS	Marker-assisted selection
MBV	Monodon baculovirus
MCTI	Ministry of Science, Technology and Innovation (in Brazil)
MINEPIA	Ministry of Livestock, Fisheries and Animal Industries (in Cameroon)
MPEDA	Marine Products Export Development Authority (in India)
MrNV	Macrobrachium rosenbergii nodavirus
MTA	Material transfer agreement
NACA	Network of Aquaculture Centres in Asia-Pacific
NaCSA	National Center for Sustainable Aquaculture (in India)
NARES	National agricultural research and extension systems
NARI	Nimbkar Agricultural Research Institute (in India)
NARS	National agricultural research systems
NDUAT	Narendra Dev University of Agriculture and Technology (in India)
NGO	Non-governmental organization
NRCRI	National Root Crop Research Institute (in Nigeria)
OIE	World Organisation for Animal Health
PATTEC	Pan African Tsetse and Trypanosomiasis Eradication Campaign
PCR	Polymerase chain reaction
PL	Postlarvae

PPR	Peste des petits ruminants
PVS	Productivity veterinary service
QTL	Quantitative trait locus
R&D	Research and development
RFLP	Restriction fragment length polymorphism
RT-PCR	Reverse transcriptase PCR
SIT	Sterile insect technique
SPF	Specific pathogen-free
SPIA	CGIAR Standing Panel on Impact Assessment
SSA	Sub-Saharan Africa
SSR	Simple sequence repeat
STRASA	Stress-Tolerant Rice for Africa and South Asia
USAID	United States Agency for International Development
WS	Wet season
WSSV	White spot syndrome virus