Contents

Foreword		xii	
A	ckno	wledgments	xv
A	cron	yms and Abbreviations	xvi
E	xecut	ive Summary	1
	The	achievements and challenges of	
	а	gricultural water management	2
	The	changing global and national contexts for AWM	4
		future stresses and risks caused by rising food demand	
	a	nd intensification of irrigated agriculture	<i>6</i>
		cies, institutions, and investments to promote	
	a	gricultural water in development	7
	The	primary messages of the report: Toward an action plan	15
		script on Sub-Saharan Africa	
1		Diversity, Contributions, and Achievements of	
	Agr	icultural Water Management	18
	1.1		
		be recognized in any analysis of the sector	19
	1.2	Irrigated agriculture has been vital to meeting	
		fast-rising food demand.	22
	1.3	Agricultural water management has contributed	
		significantly to rural economic growth and	
		poverty reduction	30
2	The	Challenges Facing Agricultural Water Management	33
	2.1		
	2.2		
		increasingly constrained.	35

	2.3	The groundwater irrigation revolution has been achieved	
		at the price of the depletion of these resources	28
		in many regions.	,50
	2.4	Publicly managed irrigation schemes have	38
	۰.	generally performed poorly.	.00
	2.5	Water management for rainfed agriculture has been neglected.	4 1
	٠.	Technology is available, but often is not disseminated	
	2.6	and adopted	41
	2.7	The environmental impacts of agricultural water	• * *
	2.7	management have been neglected.	42
		management have been neglected.	•
3	The	Changing Global and National Contexts for	
3	Aori	icultural Water Management	.47
	3.1	Changes in the global development context are	
	J.1	affecting agricultural water management.	.47
	3.2	Changing water resources management priorities	
	0.2	are affecting AWM policies.	54
	3.3	Development approaches in agricultural water	
	0.0	management are evolving.	59
	3.4	The roles of the respective AWM stakeholders	
	0.1	are changing.	63
4	The	Future Contributions of Agricultural Water Management	
_		Potential Risks	67
	4.1	Matching future supply and demand for agricultural	
		products will continue to be a challenge for agricultural	
		water management.	67
	4.2	As demand for irrigated crops grows and water and land	
		resources are constrained, water productivity must increase.	72
	4.3	There is considerable scope for improved water	
		management for rainfed agriculture.	82
	4.4	Limited expansion of the irrigated area can take place	84
	4.5	Resulting increases in water withdrawals for irrigation	
		may strain the water resource base	86
	4.6	Changes in agricultural water management of the	
		required magnitude will create risks for the	
		environment and society	91
5	Pol	icy and Institutional Options to Promote Agricultural	~~
		ter Management's Contribution to Development	93
	5.1	Global and regional policies for	00
		agricultural water management	93

	5.2	National policies for agricultural water management	105
	5.3	Agricultural policy and agricultural water management	
	5.4	Fiscal policy, incentives, and agricultural water	
		management	123
	5.5	The need for major institutional changes:	
		The roles of government, users, and the private sector	136
	5.6	Women are agricultural water managers, too	
	5.7	Irrigation and agricultural water management	
		interventions should be targeted more at poverty reduction.	148
	5.8	Agricultural water management and the environment	
6	Inve	estment Options to Promote Agricultural	
	Wat	er Management	157
	6.1	The range of investments in irrigation and	
		agricultural water management	157
	6.2	The evolving investment options in agricultural	
		water management	181
	6.3	Financing investment in agricultural	
		water management	190
	6.4	Strengthening the poverty-reduction focus of	
		agricultural water management investments	194
N	otes	•••••••••••••••••••••••••••••••••••••••	199
Bi	iblio	graphy	201
Īn	ıdex.		210
Fi	gure		
	1.1	Total Cereals Demand and Per Capita Consumption	
	1.2	Per Capita Cereals Consumption by Region, 1997–9	25
	1.3	Production Indices for Mainly Irrigated and Mainly	
		Rainfed Crops, 1997–9	26
	1.4	Increases in Production and Yields for Fruits and	
		Vegetables in Developing Countries, 1961–3 to 2002–4	27
	1.5	Sources of Growth in Crop Production, 1961–99	
	1.6	Daily Per Capita Food Consumption	29
	1.7	Incidence of Undernourishment in Developing Countries	
	2.1	The Decline of Water Availability in Developing Countries	37
	3.1	Rates of Return on Investment by Stage of Development	
		of Water Infrastructure	60
	4.1	Anticipated Sources of Growth in Crop Production,	
		1997–2030	70

4.2	Projected Increases in Production and Yields for
1.2	Prodominantly Irrigated Crops in Developing Countries/1
4.3	I in a line Efficiencies 1997–9 and 2030
4.4	Detertion Efficiency of Alternative Irrigation Systems
4.5	Irrigated Cropping Intensities, 1997–9 and 2000
4.6	Chara of Irrigated and Rainfed in Cereal Production
4.0	T
4.7	Water Resources Infrastructure in Ethiopia85
4.8	Duningted Irrigated I and Expansion by Region,
4.0	1007 0 to 2020
4.9	Currend Averton With drawals in Developing Countries,
4.7	100E and 7075
4.10	TAKAN drawale as Percentage of Renewable Resources III
4.10	V Pasing 1005 and 2025
5.1	Rainfall Variation and GDP Growth
5.2	CDP Growth in Ethiopia under Conditions of
5.2	77
5.3	The Amount of Water Head to Grow Food
5.3 5.4	Trade Flows between Developing and Developed Countries121
5. 4 5.5	Descript Headcount in Irrigated and Kainfed Areas ¹⁴⁵
6.1	Sprinkler and Drin Irrigation in Selected Countries
6.2	Estimated Water Reflows, 2000
6.3	Water Treatment Gaps
0.3	Water Heathleste Superior
Tables	
1.1	Irrigated Land Expansion by Region of the Developing
1.1	Wald 1961_2000
1.2	Features of Publicly and Privately Managed
1.2	Imigration Systems
1.3	Twinted and Poinfod Crops in the Developing Countries23
1.4	Careals Self-Sufficiency by Region (1997–9)24
2.1	In displayed Appulal Investment in Water Services for
2.1	Daveloning Countries
2.2	Vintual Water Content of Diets
2.3	Virtual Water Content for Selected Products
2.4	n
2.3	Requirements in Developing Countries
2.5	Clobal Distribution of Cropland and Of the Percentage
2.0	of Land Drained
2.6	Major Production Basins Affected by Land Degradation
2.0	Due to Solinity
3.1	Became Programs and Projects of CGIAK Institutes
0.1	Relevant to Agricultural Water Management

3.2	Possible Climatic Changes in the 21st Century and Their
	Likely Impacts on Water Resources and Agriculture57
3.3	Regional Impacts of Climate Change58
4.1	Summary of Selected Variables in FAO and IFPRI/IWMI
	Supply and Demand Projections for Developing Country
	Irrigated and Rainfed Crop Production69
4.2	Annual Percentage Rates of Increase in Crop Production
	Projected by Region of the Developing World, 1969-203069
4.3	Projected Changes in the Commodity Composition of
	Food Consumption for 93 Developing Countries72
4.4	More from Less: Water Productivity Gains from Shifting
	to Drip from Conventional Surface Irrigation in India76
4.5	Share of Rainfed and Irrigated Production in Total Crop
•	Production in Developing Countries82
4.6	Annual Renewable Water Resources and Irrigation Water
	Requirements in Developing Countries, 1997–9 to 203088
4.7	Projected Increases in World Water Consumption,
	Total and Irrigation89
5.1	Selected Elements for a Research Agenda in AWM97
5.2	Environmentally Harmful Consequences of
	Irrigation Subsidies
6.1	Coverage of Sprinkler and Drip Irrigation164
6.2	Current and Likely Future Investment Patterns in
	Agricultural Water Management182
6.3	Financing Irrigation and Agricultural Water Management189
6.4	Types of Management in Irrigation191
6.5	Typical Areas for Public Financing and Interventions in
	Agricultural Water Management193
6.6	How Agricultural Water Management Interventions
	Contribute to Poverty Reduction196
Boxes	
1.1	Multifunctionality in Paddy Cultivation
	in Monsoon Asia
2.1	Spotlight on Large-Scale Irrigation Management40
2.2	Irrigation Water Quality and Health in Egypt45
3.1	The Challenge Program on Water for Food50
3.2	World Bank Safeguard Policies63
3.3	Private Investment in Irrigation in Latin America66
4 .1	Defining Irrigation Efficiency, Crop Water
	Productivity, and Evapotranspiration
4.2	The China Tarim Basin II Project
4.3	Developing Less-Water-Intensive Rice Production Systems79

4.4	Fertigation—Fertilization and Irrigation Working Together	80
4.5	Participation Aids Innovation in Rainted Systems	84
4.6	The Risk of Water Pollution from Agricultural Sources	92
5.1	Hot Spots for Irrigation and Riparian Issues	94
5.2	Affordable Drip Irrigation	98
5.3	Morocco—The Dilemma of an Irrigated Agriculture	
	Constrained by Lack of Market Opportunity	104
5.4	Using Temporary Subsidies to Improve AWM—Mexico	105
5.5	Local Groundwater Management	110
5.6	Saving Groundwater through Demand Management	112
5.7	Accelerating Local Regulation through Participatory	
•••	Hydrological Monitoring	113
5.8	Formalization of Water Rights in Peru	115
5.9	Market Links Drive Smallholder Irrigation Investment	
0.,,	and Production in Zambia.	118
5.10	Nigeria—National Fadama Development Project	119
5.11	China—Struggling with Food Self-Sufficiency Goals as	
	Water Shortages Grow	122
5.12	Hoing Block Tariffs to Conserve Water and Improve	
	Environmental Quality	128
5.13	Automoted Irrigation Charge Collection System	
	in Shandong, China	129
5.14	(1) ye give Principles for Sustainable	
	Cost Recovery in Irrigation	130
5 15	Nonprice Instruments to Promote Water Use Efficiency	131
5.16	Using a Mix of Incentives in the Jordan Valley	133
5.17	Poduction and Targeting of Irrigation Subsidies	
0.1.	in Harvana India	134
5.18	Traignation Efficiency Stinstates Stow Adoption of	
0.120	Drip Technology	136
5.19	An Irrigation Farmer's Perspective	141
5.20	The Beneficial Impact of Irrigation on Women and Girls	
	in Bangladesh	146
5.21	Problems Faced by Women in Irrigation in Nepal	147
5.22	Poverty-Reduction Benefits of Irrigation in India	150
5.23	Reasons for Difference in Antipoverty Impacts	
	of Irrigation Improvement in Sri Lanka and Pakistan	152
5.24	Better Fertilizer Use in China	155
5.25	Environmental Flows and the Living Murray Initiative	156
6.1	Contrasting Experiences of Modernization	15
6.2	Large-Scale Irrigation Modernization in Victoria, Australia	135
6.3	Niger Private Irrigation Promotion Projects 1 and 2	164
6.4	Rapid Adoption of Drip Irrigation Technology in Jordan	16

х

CONTENTS xi

The Positive Economics of Drainage: Evidence from	
Egypt and Pakistan167	7
Social and Economic Benefits of Reclaiming	
Salt-Affected Soils	3
DRAINFRAME169)
The Treatment of Wastewater Issues in the	
Yemen Sana'a Basin Water Management Project176	5
Succeeding in New Irrigation Development in	
the Brazilian Semi-Arid Region179)
Investments in Water Diversion and	
Irrigation Completion in Iran)
Experiences of Public-Private Financing in	
Large-Scale Irrigation in Morocco	5
Public Investment Leads the Way for the Private Sector:	
Irrigation Development in the Brazilian Semi-Arid Region187	7
A Checklist for Improving the Pro-Poor Impact	
of Irrigation Projects197	7
	Egypt and Pakistan