IRRI's Strategy for Addressing Needs, Challenges and Opportunities 2007-15

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Rice Science for a Better World

IRRI's Mission

To reduce poverty and hunger, improve the health of rice farmers and consumers, and ensure environmental sustainability through collaborative research, partnerships, and strengthening of national agricultural research and extension systems.

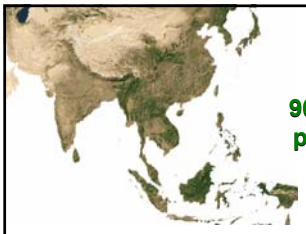
IRRI Board of Trustees, April 2006

IRRI's Response to a Changing World

Challenge: Relating IRRI's research agenda to the Millennium Development GOALS

Five Strategic Goals:

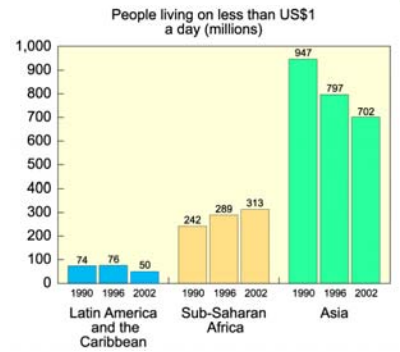
- **Poverty Alleviation**
- **Human Health and Nutrition**
- **Protecting the Environment,**
- **Access to Information**
- **Genetic Resources**

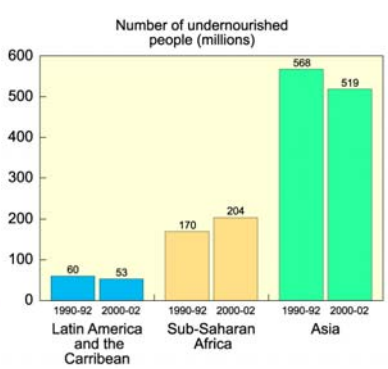


90% of the world's rice is produced and consumed in Asia.

~70% of the world's poor live in Asia.

…and nearly all of them eat rice two or three times a day!

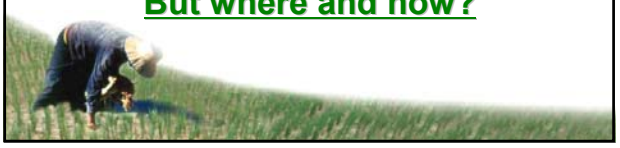


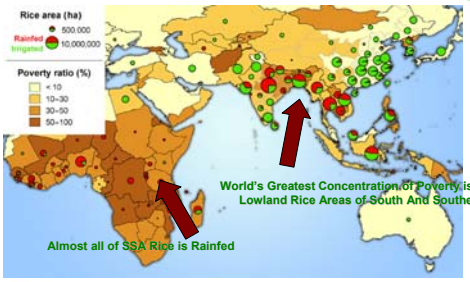


If we want to do something about poverty

It is clear that we must invest in rice

But where and how?





There is a clear relationship between the prevalence of rainfed rice and the level of poverty.

Rainfed Rice Characterized by Harsh Environments

- **Drought, prolonged submergence, and salinity create yield unreliability**
- **Discourage investments and market oriented diversification**

Rainfed rice farmers are trapped in a vicious circle.

IRRI's research can move them into a virtuous circle.

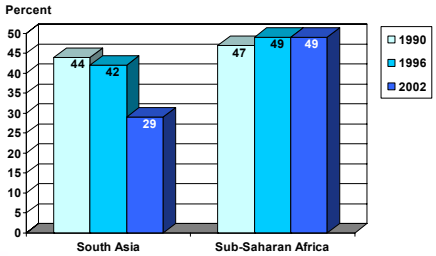
Reliably improving productivity in rainfed rice environments will give farmers options to diversify their income sources.

A clear entry point for poverty alleviation is to focus on rainfed rice systems.

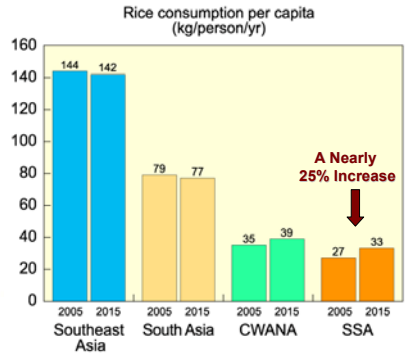
A Fundamental Change in IRRI's Approach

- **If we focus primarily on a larger pile of rice (food security), then we invest in the favorable intensive systems.**
- **If we focus on helping to lift the poor – especially the rural poor – out of poverty, then we invest in difficult rainfed environments.**

Trend in poverty (% of population) in South Asia and Africa



Sources of raw data:
No. of people living on less than US$1/day: World Bank. Attacking Poverty: World Development Report 2000-2001. United Nations Development Programme 2005.
Total population: Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2004 Revision; World Urbanization Prospects: The 2003 Revision, http://esa.un.org/unpp.



Sub-Saharan Africa: The Other Major Concentration of Poverty

This region is the world's fastest growing rice consumer and will also grow as a producer.

A Focus on Poverty and Its Consequences Drives IRRI to Africa

- **World's second largest concentration of poverty**
- **Rice is increasingly important**
  - Rural income source
  - Affordable and prized urban staple
- **Lessons from Asia can be applied**
  - Tools of molecular biology help unlock genetic potential
  - Relevant traits for rainfed systems
  - Renewed interest by private sector prompt investments in irrigation, land and water management

IRRI Will Begin Its Africa Program In Eastern Africa

East African Rice Farmers Are More Commercial

Advantages and Disadvantages

What Is Special About Mozambique ?

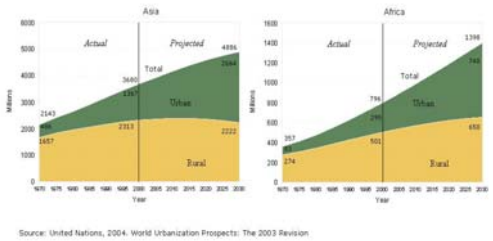
Major River Deltas

A History of Rice Cultivation & Market Orientation

Research Challenges in East Africa

- **Market orientation competes with Asia**
  - Price and grain quality
- **Seed availability and quality**
- **Rehabilitation of irrigation schemes**
- **National support capacity, research and extension**
- **Crop management and land preparation**
- **Water – borne diseases**
- **Transport for inputs and harvest**

Trends in urbanization, Asia and Africa, 1970-2030



Source: United Nations, 2004. World Urbanization Prospects: The 2003 Revision

Increasing urbanization means IRRI must assure affordable rice supplies for urban poor, as well.

Inexpensive rice for poor consumers versus a living wage for farmers is a constant tension.

Increased productivity and profitability in rainfed environments address rural poverty and inexpensive rice from irrigated lands addresses urban poverty.

GOAL: Reduce poverty in rice-dependent regions of endemic poverty through improved and diversified rice-based systems

- **Abiotic stress tolerance to stabilize and raise yields and permit diversification in rainfed systems.**
  - Progress in salt, drought, submergence, and phosphorus
- **Ensure adequate and affordable food supplies for poor rice consumers through further increases in productivity and profitability in irrigated rice systems.**
- **Improve food security and farmers' income in rice-growing countries in East and southern Africa through improved rice varieties and cropping systems.**
- **Understand high-value, quality rice.**

Malnutrition: A Consequence of Poverty

Hidden hunger: vitamin and mineral deficiencies from inadequate diets rob the poor of productive lives.

The number of affected poor in Asia dwarfs that of any other region of the world.

Irrigation water from tube wells polluted with arsenic can contaminate rice grains in the field.

Microbial toxins in poorly processed and stored rice and heavy metals, such as Cadmium, in contaminated soils can also threaten the health of rice farmers and consumers.

GOAL: Improved health and nutrition of poor rice consumers and farmers

- Nutrient-enriched rice.
  - Substantial capacity and progress in pro-vitamin A, Fe, and Zn…high throughput transformation; analytical capacity
- Healthy rice.
  - Differential uptake of As, Cd
  - Backstop NARES in postharvest storage
  - Digestibility…diabetes increasing
- Establish partnerships with rural health for waterborne diseases.

Rice–based systems in Asia are changing rapidly.

Maintain a long view of the environment for future generations.

In Asia, 80 percent of freshwater drawn is used in agriculture and nearly 80 percent of the water in agriculture is used in rice cultivation.

Competing demands from industry, urban areas, and higher value crops mean less water available for rice cultivation.

Impact of climate change likely to change water availability in rice – growing areas

Retaining productivity levels while using less water will be a major challenge confronting IRRI over the next decade.

Many dramatic changes will affect agriculture-environment interactions.

Crop establishment, water, nutrient and pest management...all will require from fundamental to applied research for sustainable systems at field and landscape levels.

But…the social dimension?

Labor is becoming a serious constraint.

A "feminization of agriculture" is occurring with continued urbanization and out-migration of men.

What technologies and practices must change to address this new reality?

Crop diversification should raise income, yet will also raise challenges for sustainability and environmental impact.

A switch from flooded to aerobic systems can have dramatic impact on green house gas emissions and nutrient leaching into ground and surface water.

Climate and Rice

- Global climate change is a reality and will affect rice farmers for decades to come.
- Rising temperatures can negatively affect yield.
- Extreme environmental events can increase frequency of drought, flooding, and sea water intrusion.
- Changing production practices will affect GHG emissions.

There is a clear and important role for developing rice varieties and cultural practices that can cope with climate change.

Rice and Climate Change Consortium[1]

- Minimize the impact of rice production on greenhouse gas emissions but also change the "balance" sheet such that productivity and environmental quality can be sustained.
- Decipher the mechanisms involved and to improve germplasm adaptation to expected future climatic conditions.
- To develop genetic and NRM technologies to mitigate the negative effects of agricultural activities on climate.

[1]Planning meeting written up in *Science*

GOAL: Ensure that rice production is sustainable and stable, has minimal negative environmental impact, and can cope with climate change

- Process-based research on indicators of sustainability in intensive systems.
  - Field to landscape-level research in rice dominated systems
  - GHG emissions expertise
- Resistance to temperature stress, flooding.
- Pest–disease complexes under Δ T° .
- Assess alternative water management.
- Backstop IPM and INM activities in NARES.
- Address critical social issues as rural economies undergo dramatic changes.

Research for Development

- **The challenges are great**

  Ten years ago tolerance in productive rice varieties to drought, submergence, and salt was considered to be practically impossible.

- **The opportunities are real**

  Advances in molecular biology and data analysis make yesterday's dream tomorrow's reality.

A Real World Example

Flooding and Prolonged Submergence Common in Asia and SSA: A Consequence of Climate Change

Long considered to be an intractable problem…

In late 1980s, submergence tolerant, but otherwise undesirable accessions identified in rice gene bank… extremely difficult trait to transfer

A Real World Example of Science for Development

Sub1A is an ethylene-response-factor-like gene that confers submergence tolerance to rice

(Nature, Vol. 442, 10 August 2006)

Kenong Xu[1], Xia Xu[c], Takeshi Fukao[2], Patrick Canlas[1], Reycel Maghirang-Rodriguez[3], Sigrid Heuer[3], Abdelbagi M. Ismail[3], Julia Bailey-Serres[2], Pamela C. Ronald[1] and David J. Mackill[3]

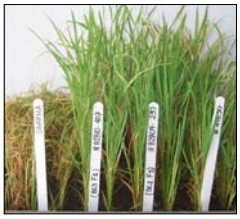
[1] Department of Plant Pathology, University of California, Davis, California 95616, USA

[2] Center for Plant Cell Biology, Department of Botany and Plant Sciences, University of California, Riverside, California 92521-0124, USA

[3] International Rice Research Institute, DAPO Box 7777, Metro Manila, The Philippines

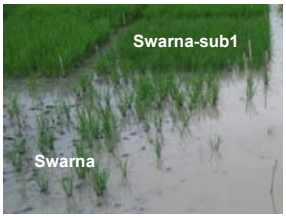
Sequence data from this article have been deposited with the EMBL/GenBank Data.

Libraries under accession nos. DQ011597-DQ011607 and DQ453964-DQ453966.



A mega variety for flood prone rainfed lowlands in South Asia converted to Sub1 tolerance by MAS

A deep understanding of genetics and mechanisms allows:



- Precise manipulation of traits
- Systematic screening of gene bank for variants of genes
- Differentiation among mechanisms conferring the same trait…stacking for resiliency
- Rapid development of varieties with high adoption probability

Precision Breeding

Frontier Projects: Major Challenges, High-Risk, But Massive Payoff

We must look beyond today's problems to find tomorrow's solutions to secure opportunities for future generations.

- IRRI's strategic frontier projects accentuate the Institute's commitment to challenges beyond MDGs
  - Novel and focused research on problems of strategic importance to the future rice production and the environment.
- Potential to make an impact at the level of the Green Revolution, or greater
  - Generate a sense of excitement
  - Position IRRI in the global scientific community

Frontier Projects

- Rice and climate change
- Drought-tolerant rice
- C_4 rice
- (Associative N-fixation in rice; apomixis)

Approach and feasibility to be determined by high-level scientific planning workshops

What About Rice Over the Longer Term?

- **Productivity must increase**
  - Available land will not increase significantly
  - Pressure for alternative uses of crops may grow (biofuels and replacement) and increase demands on remaining areas
- **Available water will decrease**
- **Temperatures will increase**
- **Societal tolerance for impact of N fertilizers will decrease**
  - Prices likely to increase

What do we do about it?

Take Some Tricks From the Other Grasses?

Genes?

Greater water use efficiency, greater N-Use efficiency, higher yield in maize due to C_4

Maize (C_4) **Recipe for success in rainfed systems?** **Rice (C_3) → (C_4)**

A New Photosynthesis System for Rice

- **Increase productivity for intensive systems**
- **Much greater efficiency in use of water and nitrogen**
- **Greater tolerance of rainfed conditions**

Addresses poverty, environmental, and productivity concerns

Drought and Productivity in Unfavorable Rice Environments

- **Drought tolerance trait is strongly influenced by genes with large effects.**
- **Detection, analysis and delivery for use in marker-aided breeding.**
- **Incorporating genes from rice and other species into widely grown or "mega" rice varieties.**
- **Broad and new partnerships will be necessary to take the genetic findings from the laboratory to farmers' fields in a wide variety of rainfed conditions.**

Why Do We Think Investments In Frontier Projects Makes Sense?

- **History tells us so**
  - From IR8 to *Sub1*
- **Not that there are no dangers**
  - Failure in some is assured
  - Financing horizon is very different

Compelling Convergence

- **Required traits for improving productivity in rainfed rice systems:**
  Drought, submergence, and salt tolerance
- **For African rice systems**
  Drought, submergence, and salt tolerance
- **For adaptation to climate change**
  Drought, submergence, and salt tolerance

A carefully defined research agenda can address a wide variety of globally important issues.

Gauging IRRI's Relevance

Millennium Development Goals

Rice is central to achieving the MDGs, particularly those aimed at poverty, human health and nutrition, and the environment.

This strategy positions rice research to address key global concerns and helps assure IRRI's continued relevance.

A Challenge to the Social Sciences

Priority research areas

- **Analysis of rice-based livelihood systems and pathways out of poverty in "poverty pockets" (Goals 1 and 2).**
- **Impact assessment, both ex-ante and ex-post focusing especially on NRM technologies. Institutionalization of ex-ante analysis for research planning and prioritization (Goals 1, 2, and 3).**

A Challenge to the Social Sciences

Priority research areas

- **Analysis of the nature and patterns of shifts in comparative advantages and areas of major cereals (rice, wheat, and maize) under likely future scenario of shifts in demand and supply factors including trade liberalization (Goals 1 and 2).**

A Challenge to the Social Sciences

Priority research areas

- **Ex-ante socioeconomic analysis of biotechnology products to address public perceptions, bio-safety considerations and potential impact (Goals 1, 2 and 3.**
- **Analysis of water pricing and policies, and opportunities and institutional reforms for increased adoption of water efficient technologies (Goals 1 and 2).**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