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ENSURING FOOD SECURITY IN THE 21ST CENTURY WITH HYBRID RICE: ISSUES AND CHALLENGES

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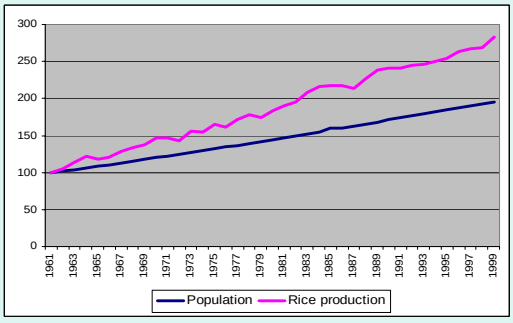
GENERAL CONTEXT

- The population consumed more wheat, rice, and maize as food than other crops.
- In 2004, the amount of energy (kcal) per capita supplied from rice was about 700 kcal (1 kcal=4.184 kJ) per day or more to about 3.23 billion persons.
- The implementation of the International Year of Rice – 2004 reconfirmed that rice will continue to be a global food crop and billions of people around the globe will continue to depend on rice for their energy and protein each day.

Consumption and production of rice, wheat and maize in 1997/99

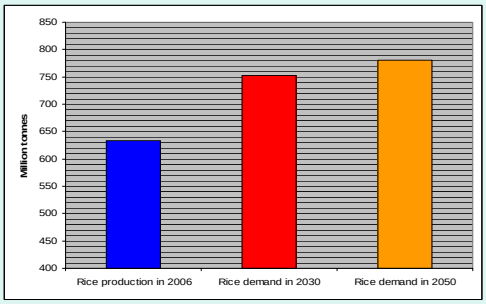
	Consumption as food (million tons)	Production (million tons)	Food/ production
Rice paddy	514.5	587.4	87.6%
Wheat	421	596.9	70.5%
Coarse grains	238.9	899.9	26.5%



Relative growth of the world population and that of the world rice production (1961=100), 1961 to 1999

Rice production, population and rice availability in 1961, 1999, 2002, and 2006 (* *Rice availability = per capita rice production*)

	Rice production (million tons)	Population (billion persons)	Rice availability (kilogram per person)*
1961	215.6	3.10	69.5
1999	610.6	5.99	101.8
2002	568.3	6.22	91.2
2006	634.6	6.58	96.4



Global rice production in 2006 and projected rice demand in 2030 and 2050

- **In order to meet the increased global demand, more rice should be produced in the future with less land and water resources, in addition to the uncertainty under the global climate change**
- **The lesson learned from the development and adoption of hybrid rice in China since 1976 and later in other countries shows that more rice could be produced even on less land with hybrid rice.**

This paper reviews the past experiences on hybrid rice adoption and discusses the issues and challenges of the adoption of hybrid rice for ensuring food security in the 21st century.

ENSURING FOOD SECURITY WITH HYBRID RICE – PAST EXPERIENCE

- **Utilization of hybrid vigor has been applied to increase the production of maize and other crops**
- **Unlike maize, rice is a self-pollinated crop and this had made the application of hybrid vigor in commercial rice production difficult.**
- **The discovery of wild rice plant with abortive pollen in 1970 by a team of Chinese rice scientists led by Prof. Yuan Longping opened the opportunity for the massive production of hybrid or F1 seed of rice, thus the utilization of hybrid vigor for increasing rice production**
- **In 1974: first series of hybrid rice combinations/varieties were developed in China. They were 3-line varieties**
- **1975: field trials in Hunan showed hybrid rice varieties yielded at least 20% more than high-yielding rice varieties**
- **1976: Commercial hybrid rice cultivation started in China**
- **1976 – 1990: Rapid expansion of area under hybrid rice cultivation in China.**

	Harvested area (million hectares)	Yield (kilogram per hectare)	Production (million tons)
1961	27.0	2,078	56.2
1965	30.5	2,967	90.7
1970	33.1	3,416	113.1
1975	36.4	3,528	128.7
1980	34.4	4,144	142.8
1985	32.6	5,250	171.3
1990	33.5	5,717	191.6

<u>In conclusion:</u> the wide adoption of hybrid rice had enabled China to ensure food security, at the same time save land and water resources for other production activities for poverty reduction and economic development

- **In 1990: the 17th Session of the International Rice Commission**
  - **Noting the success of the adoption of hybrid rice in China,**
  - **Noting there was no hybrid rice production outside China**
  - **Recommended FAO and member-countries to established programmes on hybrid rice development and use for food security**
- **1990-1992: FAO/IRC organized missions of hybrid rice experts to member countries outside China to discuss on the possibility of the development and use of hybrid rice for food security**
- **1992-2002: FAO/IRC formulated and implemented several field projects on hybrid rice development and use in Bangladesh (1 project), Egypt (1 project) , India (2 projects), Indonesia (1 project), Myanmar (1 project), Philippines (1 project), and Viet Nam (2 projects)**

- In 1998, the International Task-Force for Hybrid Rice was established by National Research Systems in Asia, IRRI, and China National Hybrid Rice Research and Development Centre, and FAO in order to promote collaboration in the development and use of hybrid rice for food security.
- 1998-2006: Asian Development Bank provided fund for Hybrid Rice Development and Use for Food Security in Asia
- In USA: Commercial hybrid rice has been expanding, especially in Texas and Arkansas
- In 2007: FAO provided funding support to the development and use of hybrid rice in: Indonesia ((completed) and Sri Lanka (on-going)

- Results of the FAO field projects confirmed that outside China, hybrid rice varieties also yielded at least 15% more than high-yielding rice varieties
- In 2004: there were at least 1.5 million hectares of hybrid rice in several Asian countries outside China
- In 2006: Commercial hybrid rice production began in Egypt
- In 2008: It is estimated that the total area planted to hybrid rice outside China was much larger than that in 2004. However, the total area under hybrid rice cultivation in countries outside China in 2008 occupies still a small fraction of the total rice production area.

- Therefore, there is good potential for adoption of hybrid rice to increase rice production, thus ensuring food security in the 21st century

ENSURING FOOD SECURITY IN THE 21ST CENTURY WITH HYBRID RICE: ISSUES AND CHALLENGES

- Low yield of F1 seed production
- Increase adoption of direct seeding for crop establishment
- Low economic return from hybrid rice production
- Increased concern for environmental degradation
- Climate Change
- Stagnation of rice yield in China

Low Yield of F1 Seed Production

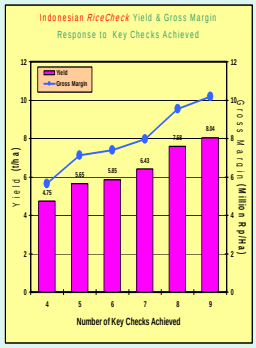
- Situation:
  - Farmers have to buy new F1 seed in cultivation of hybrid rice. This adds to rice production cost, which may not be the case of high-yielding varieties
  - Yields of F1 seed production are still low in many areas/countries (# 1 – 1.5 tonnes/ha)
  - Low yield of F1 seed production results in high prices of F1 seed, which is a major constraint for wide adoption of hybrid rice
- Opportunity/Response:
  - Improvements in F1 seed production have been made in China (> 2.5 tonnes/ha) , India (# 2 tonnes/ha) and other countries. Consequently technologies for high yield of F1 seed production are available for transferring to other locations/countries.
  - Higher yield of F1 seed production could be obtainable with the improvement of out-crossing rate of the parental lines, especially the CMS lines
  - Apomitic (hybrid) rice – Looking into the future

Increased Adoption of Direct Seeding

- Situation:
  - Due to cropping intensification (growing two or more crops in a year) and Labor shortage and high labor wages in rural areas because of migration from rural areas to urban centers, farmers in Asian countries have increasingly shifted from transplanting to direct seeding in rice production. Direct seeding normally requires a high seed rate
- Opportunity/Response:
  - Development of methods that require less labor and less seed for rice crop establishment.
  - For example seedling broadcasting method in Sri Lanka

Low Economic Return from Hybrid Rice Production

- Situation:
  - The low rate of adoption of hybrid rice in Asian countries outside China may probably be due to the low economic return from hybrid rice production?
- Opportunity/Responses:
  - Development of high-yielding hybrid rice varieties with good grain quality for high prices in the markets
  - Adoption of Rice Integrated Crop Management: Rice – ICM systems have proven to be effective in increasing yield and reducing production costs in irrigated rice production with high-yielding varieties, thus higher return from rice production. They could be modified for hybrid rice production



Rice yields in Grande do Sul, Brazil in 2003/04 season (Adapted from Pulver and Carmona, 2004).

	Yield (*tonnes/ha*)		
	District average	Rice- ICM	Increase
Fronteira Oeste Region – 7 sites	5.9	10	4.1
Campanha Region – 2 sites	5.5	10	4.5
Depressão Central Region – 5 sites).	5.6	9	3.4
Average of all regions – 14 sites	5.7	9.7	4

Concern for Resource and Environment Degradation

- **Situation:**
  - **There is increasing concern among the population with regard to pollution by pesticide and fertilizer residues used in rice production.**
  - **Also water resources are diminishing due to expansion of industry and urbanization.**
- **Opportunity/Responses:**
  - **Rice Integrated Crop Management (Rice – ICM) Systems have improved the efficiency of the application of inputs in the production of high-yielding rice, thus minimizing the negative effects of rice production on the environment and resources. Rice – ICM Systems could be modified for adoption in hybrid rice production.**

RICE INTEGRATED CROP MANAGEMENT VIET NAM

- ⌘ Uniform land leveling to reduce water consumption and costs of weed management
- ⌘ Use certify seeds and row seeding to decrease the seed rate in crop establishment
- ⌘ Undertake weed control measure to keep zero weed up to 45 days after seeding
- ⌘ Apply rotational irrigation to reduce water consumption
- ⌘ Apply balance fertilizers and use Leaf Color Chart for adjustment of N rate in top dressing
- ⌘ Reduce insecticide rate with IPM
- ⌘ Harvest at 95% maturity
- ⌘ Drying in dryers

+ Yield increase: 0.2-0.4 t/ha

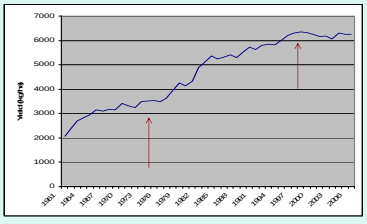
+ Cost reduce: US$ 30-50/ha

+ Benefit increase: US$ 80-100/ha

Climate Change

- **Situation: Climate change due to global warming is a fact and it could affect rice production in general through the following ways:**
  - **Increasing air temperature increase: Rice yields in tropical climate have been found to decrease with increasing air temperature**
  - **More variability in rainfall and its distribution, which would cause more frequent and severe drought and flood**
  - **Rising sea-level and water, which could expand the areas under influence of salinity/tidal water in major rivers' delta where rice is widely cultivated.**
- **Opportunity/Responses:**
  - **Development of new generation of hybrid rice varieties with better tolerant to high temperature, drought and flood, and salinity**

Stagnation of Rice Yield in China



- **Opportunity/Responses:**
  - **Study needs to be carried out to understand the real cause of the recent yield stagnation to find appropriate responses**

LESSON LEARNED AND CONCLUDING REMARKS

- Rice has been and will be the staple food for more than half of the world population.
- The world population is still growing, while land and water resources for rice production are limited.
- Wide adoption of hybrid rice is a viable technological option for increasing global rice production, thus ensuring food security in the 21st century.
- The successful development and wide adoption of hybrid rice have still a number of technical issues and challenges to overcome.
- The support and commitment of policy makers are essential for effective and wide adoption of hybrid rice for increasing rice production.
- Formulation of strategies and guidelines for effective and wide adoption of hybrid rice is important for obtaining support from policy makers. This will need the expertise and the participation of all stake-holders.

⌘ Farmers need more rice for more income
⌘ Population need more rice for food security

⌘ **Could hybrid rice meet both requirements ?**

THANK YOU