REPORT OF THE
INTERNATIONAL RICE COMMISSION
Twenty-First Session

Chiclayo, Peru

3–5 May 2006

CONTENTS

EXECUTIVE SUMMARY

The FAO Conference, at its Fourth Session in 1948, established the International Rice Commission (IRC), with the objective of promoting national and international action in matters relating to the production, conservation, distribution and consumption of rice. The Commission's Constitution went into force in 1949. Its member countries have grown from 15 in 1949 to 61 at present. Every 4 years, the IRC organizes a session to review the emerging issues and recent achievements in scientific, technical and socio-economic matters relating to sustainable rice production. Furthermore, it assists member countries in orienting strategies for their national rice development programmes while encouraging extensive interaction among national, regional and international institutions.

The Twentieth Session of the IRC was convened in Bangkok, Thailand, in 2002. The Twenty-First Session of the IRC was convened at the Gran Chiclayo Hotel, Chiclayo, Peru, from 3 to 5 May 2006 by the Ministry of Agriculture of Peru and FAO. The main theme was "Rice is Life – Bringing the Implementation of IYR to Farmers' Fields". It was attended by 90 delegates and participants from member countries and partner institutions. There were five sub-sessions, a poster session and a field visit.

MAIN OBSERVATIONS

The Commission *noted* the following:

1. In December 2002, the United Nations General Assembly (UNGA) at its 57th Session, noting that rice is the staple food of more than half of the world's population and reaffirming the need to focus world attention on the role that rice can play in providing food security and eradicating poverty, declared 2004 the International Year of Rice.
2. The Second Committee of the 60th Session of the United Nations General Assembly in November 2005 recognized the success and the contribution of the implementation of the International Year of Rice in 2004 in effectively raising awareness of the role that rice plays in reducing hunger and poverty and the support of all stakeholders for sustainable rice production.
3. Rice supplies consumers with more calories than other staple crops, particularly in the diets of very poor people whose food purchases account for more than half of all expenditures. Women and children in sub-Saharan Africa, South and Southeast Asia, and Latin America and the Caribbean are especially susceptible to deficiencies in micronutrients, in particular vitamin A, iron and zinc.
4. For the third consecutive year, global paddy production experienced a brisk expansion in 2005, which lifted total production to an all-time high of 629 million tonnes. However, the increase in global production in 2005-06 will be only just sufficient to cover utilization.
5. Rice production in sub-Saharan Africa continues to be outpaced by consumption, while food insecurity and poverty are extensive in rainfed rice ecosystems in Asia where the demand for food has been growing fast.
6. The world population continues to increase steadily, while land and water resources for rice production are diminishing due to competition from other sectors of the economy and the growing population. Moreover, the environment and natural resource bases of rice production are being degraded due to pesticide and nutrient contamination.
7. The increased temperature, rising seas and erratic rainfall distribution under global climate change have potentially large negative impacts on the productivity of rice farming.
8. Pilot tests conducted by FAO, member countries and partner institutions have demonstrated the effectiveness of rice integrated crop management (RICM) systems in closing the rice yield gap (i.e. the difference between the yield potential of existing varieties and the yields which are actually obtained by farmers), increasing farmers' profits and minimizing damage to the environment.
9. After the development of high-yielding varieties, hybrid rice and NERICA rice are the two major achievements in the field of rice breeding. In 2004, about 1.5 million ha of hybrid rice were planted in a number of Asian countries, in addition to about 15 million ha of hybrid rice in China. In sub-Saharan Africa, NERICA rice is being adopted by farmers.

MAIN RECOMMENDATIONS

The Commission *recommended* the following:

1. Member countries, funding donors, FAO, partner institutions and all stakeholders should increase collaborative efforts and funding support to activities aimed at full implementation of the Commission's recommendations for the sustainable increase in rice production to reduce hunger and poverty.
2. The partnership in rice research and development between national and international institutions, as well as NGOs (non-governmental organizations) and the private sector, should be strengthened and broadened for effective contribution to the sustainable increase in rice production in member countries.
3. Rice production systems should be viewed in an integrated way, from seed selection to food on the table, taking into account the interaction and relationships among rice plants and other organisms in the rice ecosystems, in order to maximize income and nutrition enhancement and to conserve natural resources for future production.
4. Strategies and policies for sustainable rice production should aim to build the capacity of rice farmers in precision management in order to: improve the efficiency of resource utilization (especially water), reduce environmental damage and enhance the economic competitiveness of rice production systems. Guidelines and criteria for monitoring the sustainability of rice production systems should therefore be developed for each of the rice agro-ecologies in order to facilitate farmer training.
5. Efforts to improve human nutrition should include initiatives to: promote the development, dissemination and adoption of rice varieties with a high content of iron, zinc and vitamin A; raise consumer awareness; and obtain support from industry.
6. Variety development should focus not only on high yield, but also on increased nutritional value and improved tolerance to salinity, high temperature, drought and flood stress.
7. Small and medium-size enterprises that harness technologies for transforming the whole rice grain – including milled rice, rice bran and rice husks – into value-added products should be promoted in order to increase the returns from rice production and to open up employment opportunities.
8. The Secretariat of the Commission should organize a Global Expert Consultation, between the Twenty-First (2006) and Twenty-Second (2010) Sessions, in order to review progress and identify suitable strategies for upscaling the transfer of rice integrated crop management systems for closing the yield gap, increasing profit and reducing environmental degradation in rice production under different agrosocio-economic set-ups.

MAIN REPORT

The FAO Conference, at its Fourth Session in 1948, established the International Rice Commission (IRC), with the objective of promoting national and international action in matters relating to the production, conservation, distribution and consumption of rice. The Commission's Constitution went into force in 1949. Its member countries have grown from 15 in 1949 to 61 at present. Every 4 years, the IRC organizes a session to review the emerging issues and recent achievements in scientific, technical and socio-economic matters relating to sustainable rice production. Furthermore, it assists member countries in orienting strategies for their national rice development programmes while encouraging extensive interaction among national, regional and international institutions.

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1. OPENING SESSION

The Provisional Agenda (Appendix A) was unanimously approved by the 74 delegates from member countries and 19 participants from international institutions (Appendix B). The Session elected the Minister of Agriculture of Peru, Mr Manuel Manrique Ugarte, as the Chairperson of the Commission; Mr Jorge Burneo from Ecuador as the First Vice-Chairperson; and Mr El Tantawy Badawi Hassan from Egypt as the Second Vice-Chairperson (Appendix B).

The regional welcome address was delivered by the Governor of Lambayeque Region, Mr Yehude Simons Munaro (Appendix C), the national welcome address by the Minister of Agriculture of Peru, Mr Manuel Manrique Urgante (Appendix D) and the FAO Statement by the FAO Assistant Director-General for Latin America and the Caribbean, Mr Jose Graziano Da Silva, on behalf of the Director-General of FAO (Appendix E).

1.1 Keynote Address

The Keynote Address was given by the Chief of the Crop and Grassland Service, FAO, Mr E.A. Kueneman (Appendix F).

The Commission *noted* the following:

1.1.1 In December 2002, the United Nations General Assembly, noting that rice is the staple food of more than half of the world's population and reaffirming the need to focus world attention on the role that rice can play in providing food security and eradicating poverty, declared 2004 the International Year of Rice.

1.1.2 In 2002, world rice production began to recover, following three consecutive years of declining production.

1.1.3 Rice production in sub-Saharan Africa continues to be outpaced by consumption.

1.1.4 Land and water resources for rice production are diminishing and environmental degradation due to pesticide and nutrient contamination, methane emission and ammonia volatilization are a few of the adverse affects of rice production requiring urgent attention.

1.1.5 Case studies from several countries in Asia, Latin America and Madagascar have demonstrated that high yields of irrigated rice are readily obtainable with improved crop management practices utilizing current varieties.

1.1.6 Seeds of NERICA varieties in Africa are increasingly available and can assist upland rice farmers to increase yield and income.

1.1.7 In areas where significant yield increases have been obtained due to improved crop management, programmes with strong breeding and seed production capabilities should consider hybrid rice to further increase yield potential. Hybrid rice offers additional potential – provided seed production problems (low yield of F1 seed and high labour costs) can be overcome.

1.1.8 In order to improve management, farmers must be exposed to new crop management technologies. The transfer of improved agronomic practices is distinct from seed-based technology and requires adequate resources for extension activities, such as demonstration plots, technical bulletins and extensive farmer training.

1.2 Report on the implementation of the Commission's Twentieth Session recommendations

The report was presented by Mr Nguu Van Nguyen, Executive Secretary of the Commission (Appendix G).

The Commission *noted* the following:

1.2.1 As recommended by the Twentieth Session, the International Year of Rice in 2004 was successfully implemented by FAO through the IRC Secretariat, its technical units, member countries and partner institutions, such as IRRI (International Rice Research Institute), CIAT (International Centre for Tropical Agriculture) and WARDA (Africa Rice Center), non-governmental organizations (NGOs), the private sector and other civil society bodies worldwide.

1.2.2 The Twentieth Session made a series of recommendations to its member countries, CGIAR (Consultative Group on International Agricultural Research) centres, FAO and others concerned with enhancing sustainable rice production. Limited resources meant that choices had to be made and FAO gave priority to the implementation of the recommendation concerning the development and dissemination of rice integrated crop management (RICM) with the aim of closing the yield gap in irrigated rice production.

1.2.3 Pilot tests and extensive on-farm demonstration plots have reported yields of 10 tonnes/ha or more, indicating that it is feasible to bridge the yield gap between actual farmer yields and the yield potential of current varieties. The results illustrate that significant increases in farmer yield can be obtained without additional costs, through the application of RICM systems.

1.3 Rice market situation in 2005 and outlook for 2006

The Commission *noted* the following:

1.3.1 For the third consecutive year, global paddy production experienced a brisk expansion in 2005, lifting total production to an all-time high of 629 million tonnes, equivalent to approximately 420 million tonnes of milled rice. However, tight domestic supplies in a number of countries and production shortfalls in 2004 resulted in an 8.6 percent increase in global imports in 2005, reaching a record volume of 29.0 million tonnes.

1.3.2 In the 2005/06 marketing year, milled rice consumption – mostly as food – is estimated at about 420 million tonnes (6 million tonnes more than in the previous year). On average, per caput rice food intake could rise slightly to 57.0 kg/year. Therefore, despite sizeable gains in 2005, global production would be only just sufficient to cover utilization, with the result that global rice inventories at the end of the season would remain unchanged at around 99 million tonnes.

1.3.3 International rice prices in 2005 hovered around the relatively high levels of the previous year, with the FAO rice price index (1998-2000 = 100) averaging 103 (compared with 104 in the previous year).

1.3.4 It is estimated that global paddy production in 2006 could rise to 634 million tonnes, while world rice trade in 2006 may fall by 4.1 percent to 27.8 million tonnes due to anticipated production shortfalls in traditional exporting countries, such as Australia and the United States of America.

1.4 RECOMMENDATIONS

The Commission *recommended* the following:

1.4.1 In recognition of the increasing population and of the fact that rice production in 2006 will only match utilization, member countries, FAO, partner institutions and all stakeholders should increase collaborative efforts to bring the implementation of IYR to farmers' fields in order to promote sustainable rice production and continue to match utilization.

1.4.2 Given that rice is a strategic commodity in many countries, subject to considerable policy interactions, governments should minimize as far as possible interventions that could destabilize the world rice market and they must act in accordance with their international obligations.

1.4.3 Given its declining resources, the Commission should limit the number of recommendations and focus on areas where intervention could lead to an effective increase in rice production, enhancing human nutrition and environmental conservation.

1.4.4 Noting the global importance of rice – confirmed by the UN Declaration of the International Year of Rice in 2004 – and noting that FAO has only one rice officer to cover the Secretariat functions of the IRC and provide all technical assistance globally for FAO rice production agronomy, it is recommended that member countries and donors increase funding support to enable full implementation of the Commission's recommendations with regard to the sustainable increase of rice production for food security and poverty reduction.

1.4.5 Given that pilot tests conducted by FAO, member countries and partner institutions have demonstrated the potential of the rice integrated crop management system for economically increasing rice yield while minimizing environmental degradation, the Secretariat of the Commission should organize an expert consultation, between the Twenty-First and Twenty-Second Sessions, to review progress and identify strategies for upscaling the transfer of rice integrated crop management systems.

1.4.6 On the basis of the success of the improved crop management programmes which allow breeders to develop varieties and hybrids with increased yield potential and stress tolerance, while maintaining or improving grain quality to respond to the increased demand for higher quality rice, rice breeding should continue to receive support in major producing countries.

2. SESSION ON RICE GENETIC IMPROVEMENT FOR *RICE IS LIFE* IN FARMERS' FIELDS

2.1 Impacts and achievements for the improvement of human nutrition

The Commission *noted* the following:

2.1.1 Micronutrient malnutrition affects more than half the world population. Women and children in sub-Saharan Africa, South and Southeast Asia, and Latin America and the Caribbean (LAC) are especially susceptible to deficiencies in micronutrients, particularly vitamin A, iron and zinc.

2.1.2 The goal of the Biofortification Challenge Program (BCP), HarvestPlus of the CGIAR, is to improve the health of the poor by breeding staple foods that are rich in iron, zinc and vitamin A for poor consumers.

2.1.3 Rice has become the most important food grain in LAC, supplying consumers with more calories than any other staple crop. Rice has become particularly important in the diets of very poor people, who comprise about 40 percent of the total population of LAC. Food purchases account for more than half of all expenditure by the poor, and rice in turn accounts for about 15 percent of their food purchases.

2.1.4 Preliminary data obtained at CIAT indicate that on average 59 percent of the iron and 26 percent of the zinc present in brown rice is lost after milling. Among the eleven genotypes tested, there were significant differences in iron and zinc levels after milling. Similar findings have been reported by IRRI.

2.1.5 A transgenic approach is being used by a number of stakeholders, including IRRI, to increase the level of provitamin A in rice, while at the same time germplasm banks are being screened for mineral content to identify potential varieties or donors for immediate use.

2.2 Breeding varieties for rainfed rice ecosystems in Asia: progress and impact

The Commission *noted* the following:

2.2.1 Improved varieties are widely used in Asia and improved crop management is beginning to narrow the gap between actual yields and potential yield. There has been, however, more technological progress in rice production in the irrigated ecosystem than in rainfed systems.

2.2.2 Rainfed ecosystems – sloping and plateau uplands, medium to deeply flooded monsoon-dependent lowlands, and salt-affected coastal areas – still account for about 45 percent of total rice lands in Asia and are, therefore, a potential source for sustaining future growth in rice production, although some of these ecologies are better suited to other crops or production systems, for example rice-fish in rainfed lowland.

2.2.3 Progress has been made with the development of varieties for upland ecosystems, but most farmers continue to grow traditional varieties. Substantial efforts have also been made to improve varieties for the flood-prone ecosystem by changing the plant's capacity to elongate with rising floodwaters and developing "kneeing" ability when the water recedes and the plants lodge. However, farm-level data from Thailand show limited adoption of the improved deepwater rice varieties due to marginal effects on yield. Many farmers in the flood-prone ecosystem have invested in drainage infrastructure and abandoned deepwater rice in favour of shorter-duration high-yielding rice varieties, often raising two rice crops in the same year thereby substantially increasing rice production and income.

2.2.4 Progress has been relatively slow in the development of varieties for the rainfed lowlands. However, data on the effect of adoption show that rice yield remains low because farmers do not use adequate inputs due to the risk of crop failure as a result of drought and submergence.

2.2.5 Recent efforts to incorporate drought and submergence tolerance into popularly grown modern varieties may contribute to a substantial increase in rice production in this ecosystem.

2.3 Achievements and impact of NERICA on sustainable rice production in sub-Saharan Africa

The Commission *noted* the following:

2.3.1 The interspecific varieties of New Rice for Africa (NERICA) are being adopted by farmers in sub-Saharan Africa in upland ecosystems.

2.3.2 Sixty NERICA varieties for rainfed lowland and irrigated ecologies have recently been named by the Africa Rice Center (WARDA) and are ready for further testing and adoption by member countries.

2.3.3 Upland NERICAs have short growth duration (around 100 days). Resistance and tolerance to some of the major African pests and diseases (e.g. stem borer, nematodes and rice blast) and abiotic stresses (e.g. iron toxicity and drought) have been observed. Some NERICAs also compete well with weeds.

2.3.4 At present, the availability of seed is the most important constraint to expanding the use of NERICA varieties by farmers in sub-Saharan Africa.

2.4 Rice research at the International Cooperation Centre of Agricultural Research for Development (CIRAD)

The Commission *noted* the following:

2.4.1 Rice scientists at CIRAD are working in developing countries in Africa, Asia and Latin America, in partnership with national and international institutions, NGOs (non-governmental organizations) and the private sector. They also participate in global research initiatives, such as the Generation Challenge Program.

2.4.2 CIRAD's work focuses on specific problems for development, for example: new improved varieties showing yield stability and potential; grain quality; and crop management practices.

2.4.3 The main challenge for the coming years is to spread knowledge of the achievements to a larger number of potential users.

2.5 Recommendations

The Commission *recommended* the following:

2.5.1 Given that different disciplines need to be combined for the development of strategies to reduce micronutrient malnutrition throughout the world, it is recommended that member countries and institutions concerned promote technologies, increase consumer awareness and obtain support from industry in order to improve human nutrition.

2.5.2 Given the extent of food insecurity and poverty in rainfed rice ecosystems in Asia and taking account of the rapidly growing demand for food, alternative production and livelihood strategies should be found for these marginal rice-based systems.

2.5.3 As the interspecific varieties of New Rice for Africa (NERICA) developed by WARDA are being adopted by farmers, complementary technologies should be developed in order to enhance performance and quality. Prerequisites for technologies such as NERICA to raise food security in the sub-Saharan region should include the development of a seed sector, improved farmer access to seeds and information, and policies that support the marketing of locally produced rice.

2.5.4 Noting that the partnership between CIRAD and other national and international rice research institutions, as well as with NGOs and the private sector, is commendable, efforts to broaden partnerships in rice research and development should be strengthened for the sustainable increase of rice production and quality.

3. SESSION ON INTEGRATED MANAGEMENT FOR RICE IS LIFE IN FARMERS' FIELDS

3.1 The concept and implementation of precision farming and the integrated rice management system for sustainable production in the twenty-first century

The Commission *noted* the following:

3.1.1 The precision farming system (PFS) is based on the recognition of the spatial and temporal variability in crop production and on the subsequent application of the understanding of variability to improve farm management for increased productivity and reduced environmental risks.

3.1.2 In developed countries, PFS technologies accompanied by advanced information technology and full agricultural mechanization are being tested and modified as a means of responding to variation attributes occurring over space and time.

3.1.3 In most of the developing world, the concept of PFS is known also in agricultural research and education. However, the costs of the technologies and tools used in precision farming systems in industrialized countries are beyond the reach of resource-poor farmers in developing countries. Rice integrated crop management (RICM) systems were recently developed as a suitable approach to help small farmers better understand management options in order to apply inputs in the right amounts at the right time, reducing production costs per tonne.

3.2 Progress towards more competitive irrigated rice production in Latin America: transfer of improved crop management practices

The Commission *noted* the following:

3.2.1 Deficiencies in crop management and technology transfer were identified as primary causes of the large yield gap, resulting in non-competitive production in the irrigated rice sector in nearly all Latin American countries.

3.2.2 Results of the technology transfer programmes implemented by the Latin American Fund for Irrigated Rice (FLAR) with support from the Common Fund for Commodities (CFC) demonstrate that high yields without significant cost increases are possible through the use of simple technology when applied in an integrated form and with precision. The technology functions across a wide range of environments when properly adjusted to local conditions.

3.2.3 The technological interventions promoted by FLAR are based on precision management, defined as making a decision, implementing a practice or applying an input in the exact quantity at the right moment and under appropriate conditions to enhance yield and production efficiency. The precision management programme is based upon six crop management practices that, when applied in an integrated manner and with precision, result in large yield increases and reduced production costs.

3.2.4 Farmers are the primary force for change, and when farmers are directly responsible for making crop management practice decisions, adoption is generally rapid. Technology transfer is more difficult when technical assistants are involved in the decision-making process. Farmer involvement is essential for effective and efficient technology transfer programmes.

3.2.5 There are no fixed recipes for technology transfer strategies, and methodologies and local programmes must be compatible with local needs, available resources and existing institutional structures.

3.3 Weedy rice problems and solutions for its management

The Commission *noted* the following:

3.3.1 Weedy rice, which is a product of the natural hybridization between cultivated varieties and wild rice relatives, has become a serious problem due to wider adoption of direct seeding as a result of the labour shortages and high costs in several countries.

3.3.2 Weedy rice is not easy to control since it is a weed which has the same genome as cultivated rice. Normally the best way to combat weedy rice is through the use of clean rice seeds and pre-planting treatment – for example, stale seed bed preparation, removing the germinated weedy rice mechanically or using a suitable herbicide before rice planting.

3.3.3 The parasitic weed, *Rhamphicarpa fistulosa*, is becoming a serious constraint to upland rice in parts of sub-Saharan Africa and crop rotation is an effective means of reducing yield losses. More attention is required to identify rice varieties which are tolerant/resistant to the parasitic weed.

3.4 Issues on weed management in United States rice production

The Commission *noted* the following:

3.4.1 The top two major weed species in the United States of America are *Echinochloa* spp and weedy *Oryza*. The rice crop establishment system (dry seeding vs water seeding) impacts weed spectrum and weed management strategies. However, chemical weed control is still the backbone of weed management programmes.

3.4.2 The major issues related to weed management are:
- resistance to herbicides/species shifts;
- mitigation of gene flow from cultivated rice with enhanced traits to weedy rice;
- herbicide drift;
- water scarcity (the most serious issue);
- emerging aquatic weed complex including invasive species; and
- input costs.

3.5 Impact of integrated nutrient management on sustainable rice production

The Commission *noted* the following:

3.5.1 Inadequate crop nutrition is one of the prime reasons for yield gaps. Integrated nutrient management (INM) ensures maintenance and possible enhancement of soil fertility through the balanced and judicious use of mineral fertilizers combined with organic and biological sources. The results are seen in terms of improved nutrient efficiency, increased crop productivity and minimized nutrient losses to the environment.

3.5.2 Rice requires large amounts of nitrogen and potassium. Nitrogen management is critical for high yield; low efficiency due to poor management results in increased costs and environmental contamination.

3.5.3 Nutrient balance studies provide information that enables farmers to manage nutrients more efficiently, especially in rice rotation systems (rice-wheat, rice-legume etc.).

3.6 Aquatic biodiversity in rice-based systems for food and nutrition

The Commission *noted* the following:

3.6.1 In many countries, particularly in Asia, the consumption and marketing of aquatic organisms obtained from rice-based systems are particularly important for food security; they often are the most readily available, most reliable and cheapest source of animal protein, fatty acids and other nutrients for both farming households and the landless.

3.6.2 Global advancement of integrated pest management practices and progress in fish seed production of local species provide opportunities for the enhancement and culture of aquatic organisms in rice-based systems.

3.6.3 The potential of rice-fish farming as a distinct and viable farming system requires promotion. The identification of suitable areas for rice-fish systems should receive priority. Rice-fish farming should be reflected in national rice policies and strategies and should become an integral component of national agricultural extension systems.

3.7 Impacts of diversification of rice-based systems for enhanced human nutrition

The Commission *noted* the following:

3.7.1 Diversity is a fundamental principle of good nutrition and the basis of dietary guidelines for individuals and populations.

3.7.2 Diversification for enhancing human nutrition takes several important forms when dealing with rice-based systems: dietary diversification among rice-eating urban populations; diversity of foods for rural populations within a rice-based ecosystem; biodiversity of rice genetic resources; and diversification in processing and preparation of raw materials.

3.7.3 Rice accounts for 20 percent of the world's dietary energy supply (DES), 25 percent of the DES for all developing countries, and 30 percent of the DES for Asian developing countries. The nutrient content of different rice species and varieties is related to the genetic resources, while the diversity of processing and preparation methods offers further options for improving and compromising the nutrient intake of rice-consuming populations.

3.7.4 Wholegrain rice provides a superior nutrient profile compared to milled/polished white rice.

3.7.5 The rice ecosystem also provides many options for improved nutrition for rural populations and the ecosystem approach to improved nutrition has been gaining more attention recently.

3.8 Using wholegrain rice to promote small and medium enterprises (SMEs)

The Commission *noted* the following:

3.8.1 Prices of milled rice – the primary product obtained from rough rice – have tended to fall in real terms in recent years, thus affecting the socio-economic development of rice-producing countries.

3.8.2 Technologies are available for transforming wholegrain rice, including milled rice, rice bran and rice husks, into value-added products for increasing the returns from rice production and opening up employment opportunities.

3.9 Recommendations

The Commission *recommended* the following:

3.9.1 Rice production systems should be viewed in an integrated way from seed selection to food on the table, taking account of interactions and relationships among rice plants and other organisms in the rice ecosystems, and of the conservation of resources for future rice production. Guidelines or criteria should be developed for evaluating and monitoring the performance of rice production systems with respect to economic competitiveness, income and employment generation, human nutrition and environment conservation.

3.9.2 Increased funding support must be provided and greater efforts should be made to transfer precise crop management systems in order to increase farmer capacity to apply inputs in a precise and timely manner and adopt integrated crop management practices.

3.9.3 FAO and other interested organizations should increase efforts to develop appropriate technology transfer strategies and methods best suited to the various conditions in developing countries.

3.9.4 Given that variability of field conditions – both within a field and between fields – is a major cause of inefficient crop management in rice production, member countries should promote the application of information technology to improve the understanding of spatial variability and guide precision management.

3.9.5 Integrated and diversified strategies for weed management should be urgently developed for sustainable rice production under the changing environment of high labour costs, increased adoption of direct seeding in crop establishment and water scarcity.

3.9.6 Nutrient balance charts for rice crops under different ecosystems should be developed in order to assist farmers to understand and adopt precision nutrient input management.

3.9.7 Member countries should promote, where appropriate, the development and transfer of rice-fish systems to enhance the economic competitiveness of rice-based production systems, human nutrition, rural incomes and employment opportunities. While high rice yields are impossible in the monsoon season due to low solar radiation, new agro-enterprises (e.g. aquaculture) may lead to improved income and food diversity. An expert consultation is therefore recommended to explore options and guide pilot development.

3.9.8 The evaluation of the composition and consumption of rice cultivars should continue for the development of food biodiversity indicators to guide agrobiodiversity conservation and human nutrition. Wholegrain and moderately milled rice and rice products should be made available and their use promoted in order to obtain human nutrition benefits, particularly those related to micronutrients.

3.9.9 Small and medium-sized enterprises that harness the technologies for transforming rice, including milled rice, rice bran and rice husks, into value-added products should be promoted to increase the returns from rice production and open up employment opportunities.

3.9.10 New paradigms for sustainable rice research and development must be explored; FLAR provides a good model, encouraging farmer support and the pooling of resources to research common problems. New partnerships in technology transfer are also recommended.

4. SESSION ON REGIONAL STRATEGIES FOR *RICE IS LIFE* IN FARMERS' FIELDS

4.1 Rice production in Latin America at a critical crossroads

The Commission *noted* the following:

4.1.1 Rice is a major dietary staple in Latin America and the Caribbean (LAC) and it is especially important in the diet of the low income strata. There is a deficit between rice production and consumption in Central America and the Caribbean subregion, while a surplus is recorded in the Southern Cone region.

4.1.2 Rice production in LAC is affected by ongoing negotiations in the World Trade Organization (WTO) and declining funding support from the public sector. However, the increasing intervention and support from rice growers, especially in the area of crop management through FLAR, holds promise for significant yield increases in the region.

4.1.3 Twenty-six countries are rice producers in LAC and 60 percent of production is derived from the high potential irrigated ecosystem. Plant breeding programmes have been very dynamic, releasing over 300 new rice varieties during the last three decades. Improved varieties that led to the Green Revolution resulted in significant yield increases and reduced rice prices to both farmers and consumers. However, the incidence of pests and diseases (blast, mite complex and white leaf virus) are continuing challenges for the rice sector, requiring an integrated approach using conventional and advanced breeding technology and improved crop management practices.

4.2 Latin American Fund for Irrigated Rice (FLAR): a new form of public-private association for the development of the rice sector in Latin America

The Commission *noted* the following:

4.2.1 FLAR has created a dynamic new paradigm of partnerships in rice research and development where producer associations and rice-related private enterprises provide the main funding for applied research and technology transfer. FLAR has integrated the interest of 14 countries in LAC, representing both public and private entities. FLAR also receives support from the Common Fund for Commodities to assist member countries in crop management and technology transfer. CIAT has provided infrastructure to FLAR and financial resources for administration.

4.2.2 To date, the major achievements of FLAR include: the identification of genetic material suited to tropical and semi-tropical conditions for possible use by institutional and national partners to develop commercial varieties; and the development of the "farmer-to-farmer" method for transferring precise management technology in rice production which gives yield increase without additional cost.

4.2.3 FLAR has been a driving force to consolidate local institutions essential for an impact in the rice sector.

4.3 African smallholder farmers: rice production and sustainable livelihoods in sub-Saharan Africa

The Commission *noted* the following:

4.3.1 The demand for rice as a staple food in many sub-Saharan African countries has dramatically increased in recent years and forms the basis of the diet of millions of people in Africa. However, in spite of a notable increase in regional production, the region spends about US$1 billion a year on importing rice to ensure food security.

4.3.2 The majority of rice farmers are smallholders and resource-poor farmers in upland ecosystems where yields generally remain very low. The region has considerable wetland areas that should be harnessed for rice production, but major improvements in infrastructure are required.

4.3.3 Technologies such as NERICA (New Rice for Africa) varieties for rainfed upland ecologies and rice integrated crop management systems, such as IPM (integrated pest management), have been developed by international (WARDA, CIRAD etc.) and national research systems to enhance the productivity of rice production in different ecosystems. However, many technologies have not been widely adopted due to poor technology transfer and support infrastructures, including seed production and distribution, transportation, marketing of inputs and outputs, and post-harvest processing.

4.3.4 Countries supported by development partners have begun to engage in multi-stakeholder consolidation to find solutions to constraints affecting rice production and consumption in Africa.

4.4 Regional strategies for sustainable rice-based production systems in Asia and the Pacific: challenges and opportunities

The Commission *noted* the following:

4.4.1 Rice is the most important source of calories for the region's population and rice-based systems are central to livelihoods, providing part-time employment to some 300 million men, women and children. Diminishing land and water resources and poor economic return from rice production are serious constraints to food security and poverty reduction in the region.

4.4.2 By 2025, it is expected that 2 million ha of irrigated dry-season rice and 13 million ha of irrigated wet-season rice in the region will experience physical water scarcity. The productivity and sustainability of rice lands are threatened, not only by the degradation of the natural resource base, but also by the increase in temperature, salinity and erratic distribution of rainfall anticipated under global climate changes.

4.4.3 The landholdings of rice farmers in the region are becoming smaller as a consequence of subdivision (for inheritance, sale, leasing and state redistribution), with the result that farm incomes are inadequate and the livelihoods of resource-poor farmers are threatened.

4.4.4 A wide range of political, economic and social measures are required to harness the benefits of technologies for enhancing food security and alleviating poverty in rice-based livelihood systems.

4.4.5 In irrigated ecosystems, technologies such as hybrid rice and the recently developed rice integrated crop management (RICM) systems have been effective in increasing yield and profits from rice production. However, while both hybrid rice and RICM systems are increasingly adopted, they still cover only a relatively small rice area in the region.

4.5 Challenges and opportunities for sustainable increase of rice production in the Near East region

The Commission *noted* the following:

4.5.1 Rice is the third largest crop (after wheat and cotton) in the Near East region in terms of area sown and it plays a significant role in the strategy to overcome food shortages. The region's small irrigated agro-ecology is favourable for very high yields. However, there is high variability in rice yields among different countries due to differences in socio-economic factors and biophysical conditions.

4.5.2 The stagnation in the expansion of rice harvested area in most countries – observed since 1990 – suggests that substantial and sustainable increase in rice production in the region will depend greatly on the increase in the productivity of rice production systems through the adoption of improved varieties and precision crop management.

4.5.3 The utilization of rice biomass is poorly handled and further study is required on converting crop residues into usable products of economic value.

4.5.4 Low efficiency of water use and inefficient drainage systems result in raised soil salinity in several countries.

4.6 Sustainable rice production in Europe

The Commission *noted* the following:

4.6.1 Though rice is not a staple food crop in Europe, its consumption continues to increase and imports remain high. The consumption of long-grain *indica* rice has surpassed the consumption of round- to medium-grain *japonica* rice, which is traditionally produced and consumed in the region. In recent years, the rice cultivated area in the European Union has remained stable, while it has continued to decline in southeast Europe and the central Asian subregion. Rice production has increased in Turkey and the downward trend in the Russian Federation and Ukraine has been overcome.

4.6.2 The relatively high operation costs for rice production and the increasing environmental concerns over pesticide use and methane gas emissions from irrigated rice fields are major socio-economic constraints; low temperature and water scarcity are the main physical constraints of rice production in Europe.

4.7 Recommendations

The Commission *recommended* the following:

4.7.1 Strategies and policies in all regions should aim to build up rice farmers' capacity in precision management to improve the efficiency of resource utilization (especially water) and reduce environmental damage while enhancing the economic competitiveness of rice production systems. Guidelines and criteria should be developed for monitoring the sustainability of rice production for each agro-ecology in each region in order to facilitate farmer training.

4.7.2 In the light of the progress made in closing the yield gap through the application of precision crop management and given the potential effects of global climate change, continued efforts in variety development are required. New generations of rice varieties should be high-yielding, with improved nutritional value and more tolerance to salinity, high temperature, drought and flood stress.

4.7.3 The efforts of FLAR to mobilize the partnership among stakeholders in Latin America and the Caribbean for sustainable rice production are commendable and its regional representation should be extended to include the few rice-producing countries that are not yet members. The promotion of partnerships among stakeholders along the lines of the FLAR model should be encouraged in other regions.

4.7.4 **Africa:** Member countries should establish strategies and policies to: enhance rural infrastructure; increase access to credit and inputs; improve crop production and post-harvest technologies; strengthen farmers' organizations; and facilitate the marketing of locally produced rice. In this regard, subregional and regional economic organizations in Africa should develop policies to facilitate rice marketing across national borders. It is also recommended to promote seed production and distribution of NERICA rice, and demonstrations of SRI (System of Rice Intensification) and IPM.

4.7.5 **Asia and the Pacific:** In addition to intensification through adoption of hybrid rice and RICM systems, member countries should formulate strategies for the diversification and intensification of rice-based cropping systems (e.g. inclusion of economically important crops in rotation, rice-fish farming systems) and the efficient use of locally available resources for cost-effective production, with the main objective of enhancing food security and improving the livelihood of resource-poor farmers.

4.7.6 **Latin America and the Caribbean:** Member countries should strengthen technology transfer activities and develop a new generation of rice varieties with higher yield potential.

4.7.7 **Near East:** Member countries should give priority to the development and transfer of improved production technologies resulting in higher yield and more efficient water and nutrient utilization.

4.7.8 **Europe:** Priority should be given to reducing production costs and decreasing the adverse environmental consequences of rice production.

5. SESSION ON COUNTRY REPORTS AND STATEMENTS

5.1 Argentina

Rice production is competitive at international level. Natural resources (soil and water) are in abundance, ecological conditions are favourable, there is good germplasm availability and an acceptable level of technology. There are, therefore, good prospects for production increase. However, domestic consumption is stagnant and so rice production must look towards rice exports and, if possible, new markets. To this end, varieties with improved grain quality should be adopted but without compromising the productivity of currently used varieties.

5.2 Bolivia

At present, rice production in Bolivia guarantees national demand and has the growth potential to match increases in domestic demand. The demand for different varieties has been met by following recommendations concerning the agronomic management of the different production systems. The International Centre for Tropical Agriculture (CIAT, Cochabamba), with international cooperation, has aimed to improve, first, national food security and then farmers' incomes (especially small farmers). There are numerous challenges, including:

- Improvement of production using high-yielding varieties with resistance to the principle pests and diseases, in particular Piricularia.
- Improvement of grain quality, taking into account national and international demand.
- Coordination to achieve a consensus on protection policies for national production.

Efforts are required in several other areas in order to support technological development and achieve competitive production:

- Legal mechanisms must be established for the marketing of raw materials in order to guarantee equitable distribution of benefits among farmers, processing mills, wholesalers and middlemen.
- Technical staff and rice growers must be given access to FAO projects (for training and genetic material exchange) in order to consolidate a germplasm bank with a database so as to provide a better service and facilitate germplasm exchange.
- A sustainable relationship should be built with plant breeding and crop agronomy research centres, and the results obtained made available both within and outside the country.

5.3 Brazil

Rice production in Brazil is about 11 million tonnes per year. Upland rice production (rainfed) is decreasing (mainly due to area reduction); irrigated rice production has increased. Most of the rice production in Brazil comes from irrigated farms. The states of Santa Catarina (SC) and Río Grande do Sul (RS) are the main irrigated rice production states in Brazil, accounting for 40 percent of the cultivated area and almost 73 percent of the rice harvested in the country. Upland rice covers more than half of the rice planted area and accounts for less than 25 percent of total production. The varieties and management technologies available for the south of the country can be applied to achieve more competitive production. Mean productivity in SC is about 7.5 tonnes/ha, while in RS it is about 6.5 tonnes/ha on more than 1 million ha of planted area.

The Rice Institute of Río Grande (IRGA), the Agricultural Research and Rural Extension Enterprise (EPAGRI) and the Brazilian Agricultural Research Corporation (EMBRAPA) are the main public institutions working with rice in Brazil. IRGA and EPAGRI are concerned exclusively with irrigated rice for the states of Río Grande and Santa Catarina, respectively. Both institutions have research as well as extension services. EMBRAPA operates throughout the national territory and works with both upland (rainfed) and irrigated rice; however, it does not have a specific extension service. The institutions all have plant breeding and broad crop management programmes.

The main constraint to increasing productivity in south Brazil is technology transfer. IRGA, together with rice growers in RS, developed a technology transfer programme, “Project 10”, with partial funding from CFC-FAO-FLAR for technology transfer in part of the state area. The results reveal than some farmers can produce more than 10, 11 and even 13 tonnes/ha. The state average, over more than 1 million ha, has already increased from under 5.5 tonnes/ha to 6.5 tonnes/ha.

5.4 Colombia

In coming years, the Colombian rice sector is due to face imports from the United States of America resulting in lower price levels. Efforts made during recent years to increase yield and to decrease production costs per tonne will not be sufficient: greater reduction in production costs is urgently needed in order to be competitive and face the new foreseen prices.

The different lines of support promised by the government must aim to maintain farmer incomes, rewarding those who make a serious effort to decrease production costs. Research must concentrate on specific areas, such as crop fertilization, disease and pest control, farm rental, harvest and transport.

5.5 Costa Rica

Farmers currently rely on varieties adapted to both rainfed and irrigated conditions. SENUMISA (Semilla del Nuevo Milenio SA) is in the final stages of a process of releasing more varieties to improve supply. The Management for High Productivity Programme is spreading and is currently in the consolidation stage with a partnership between SENUMISA and CONARROZ (National Rice Corporation). This partnership provides the rice sector with the opportunity to increase yields, reduce costs and improve profitability. The consolidation of the Technology Transfer National Programme, with the support of CONARROZ, offers the whole sector the opportunity to optimize variety potential and improve crop management. Through the release of high-yielding varieties, the Clearfield Production System provides the national rice sector with a great opportunity to recover and sow rice in a cost-effective way in fields contaminated with red rice and off-type varieties. It is also necessary to introduce other conventional breeding systems while being open to alternative breeding and biotechnological development forms. In rainfed production systems, irrigation projects need to allow farmers to plan sowings around those dates with higher solar radiation; where irrigation is available, it is necessary to identify varieties that still offer the farmer good profitability when sown during periods with less solar radiation.

5.6 Ecuador

Rice cropping takes place mostly in the coastal zone with 331 460 ha planted by 70 515 farmers. The average holding per farmer is only 4.7 ha, but 32 percent of farmers have between 50 and 200 ha. Productivity is 3.62 tonnes/ha and a mere 8 percent of farmers use certified seeds. The best sowing date for rice is in December, because luminosity increases during February, March and April.

Some private enterprises are beginning to adopt a technical approach to rice crop development. PRONACA is planting 8 382 ha, and participating farmers receive technical advice, certified seeds and inputs. This will lead to the attainment of an estimated productivity of 4.8 tonnes/ha for 2006.

Ecuador will soon sign a free trade agreement with the United States of America, and it will have to face the consequences of this treaty. Farmers will use certified seeds of the highest possible quality and map those areas with best production, while developing technological packages to reduce production costs and enable them to participate in the international market.

5.7 Egypt

Rice is one of the most important crops in Egypt and its production plays a significant role in the strategy to overcome food shortages and improve self-sufficiency for local consumption and export. It occupies annually approximately 0.64 million ha. Given the limited land available for cultivation in Egypt, the Rice Research Program (RRP) has aimed to increase production and yield since the 1980s by cultivating high-yielding short- and long-grain varieties. The average yield in 1984 was 5.71 tonnes/ha and reached

9.8 tonnes/ha in 2004 with an increment of 4.1 tonnes/ha (i.e. 72 percent), placing Egypt first among the main rice-producing countries of the world.

These achievements were due to the well-organized multidisciplinary Rice Research Program, its technology transfer component and the efficiency of the National Rice Campaign. Recently, researchers have managed to cultivate new short-duration varieties (120-135 days from seed to seed), which are harvested 30 to 45 days earlier than the traditional long-duration varieties and yield 13.0 tonnes/ha. The yield per day of the short-duration varieties is higher than that of the long-duration traditional varieties; this translates into a saving of 3.5 billion m^3 of irrigation water which represents about 30 percent of rice water consumption. RRP aims to reduce the gap between potential rice yield using the conventional breeding method (13 tonnes/ha) and the national average (9.8 tonnes/ha), by adopting a strategy of sustainability, including:

- government policy to support sustainability;
- improved technologies (genetic technology; crop, soil, nutrient, water and pest management; agricultural machinery; and technology to improve the productivity of saline areas [150 000 ha]);
- external support (marketing input and output, institution credit, extension and ownership);
- farmer participation (attention to farmers' goals, income and preferences, taking into account resource constraints [land, labour, capital, organization]); and
- dissemination of new Egyptian hybrid rice to cover most of the rice area in Egypt.

5.8 Guatemala

Two rice-planting systems are used in Guatemala: rainfed (10 000 ha) and irrigated (2 000 ha). While rainfed rice clearly dominates, there are zones – such as the Polochic river banks – where up to 25 000 ha can be sowed with irrigated rice. Guatemala rice production is destined in part (40 percent) to local consumption and in part (60 percent) to imports, and in total is the equivalent of 69 000 tonnes of paddy rice. The average field yield is 3.5 tonnes/ha and per caput rice consumption is the lowest of all Latin America at 5.5 kg.

The Guatemalan Rice Association (ARROZGUA) is an NGO devoted to the management, research and marketing of rice in Guatemala. Its mission is to organize, train, promote and enhance the rice sector, through specialization of its stakeholders and by means of strategies and programmes benefiting the sector. The technical area of ARROZGUA provides assistance to the country's rice farmers in several areas:

- Plant breeding to obtain new varieties.
- Technological package management (e.g. agronomic research, reduction of production costs, training, new crop practices, technology transfer).
- Administration and marketing of the national harvest (purchase agreements for a guaranteed price product delivered to the industry established on a grain quality basis stipulated by the quality control laboratory).
- Strategic partnerships with national and international institutions involved in rice.

5.9 Madagascar

The working group on the System for Rice Intensification (SRI) was established in 1990. It was based on the concept of the Jesuit Priest, Henri de Laulanié. SRI is neither a theme nor a mere package of technologies: it is a system of rice production, an excellent system of rice cultivation. In Madagascar, there are three irrigated rice production systems, namely:

- Traditional system – practised for centuries, rice yields have stagnated at 2.5 to 3.5 tonnes/ha; characterized by random hill transplanting using a large number of old (3 months or more) seedlings per hill.
- Improved system – yields ranging from 3.5 to 6 tonnes/ha, characterized by transplanting two to four 20- to 30-day-old seedlings per hill.
- System for Rice Intensification – yields reaching 10 tonnes/ha (or more in some cases), characterized by transplanting one very young (2-leaf stage) seedling per hill and with minimum irrigation.

The Ministry of Agriculture, Livestock and Fisheries has organized during the last 3 years numerous contests for best farmers at regional and national level; the three winners in each of 22 regions and the three best national farmers in the contest were all farmers practising the System for Rice Intensification.

5.10 Mexico

Until 1988, Mexico was self-sufficient in rice production. Since then, the commercial opening of the country – with adhesion to GATT, admission to WTO and finally the signing of NAFTA – has seriously affected national production, due to the accelerated liberalization of imports and the accelerated deduction of custom duties, adopted without taking account of the enormous competitive differences between farmers of exporting countries. Initially, large imports of white polished rice from Asia brought about a drastic fall in Mexican production and the signing of NAFTA then caused Asian rice to be displaced by imports of American paddy rice. It was thus possible to avoid the closure of the few surviving rice mills which were purchasing ever-decreasing amounts of the national harvest. The situation of the rice crop is characterized by:

- drastic reduction in sowing area and production;
- bankruptcy of mill industries and loss of direct and indirect employment;
- accelerated growth of imports and loss of food self-sufficiency; and
- disarticulation of the rice production chain (farmer–mill–packing–wholesaler).

Various factors affect the competitiveness of the Mexican rice farmers: fall in international prices and overestimation of the currency, poor agricultural infrastructure, excessive fragmentation of agricultural fields, limited access to private bank financing, high domestic freights, high financing costs and high cost of agricultural inputs. At present, the predominating variety in 90 percent of rice fields in Mexico is IR8 (Philippine Miracle), introduced in the early 1970s; it has low milling quality with polished white whole rice yields of between 32 and 42 percent, compared with long-grain American varieties that yield 55 percent. For many years, INIFAP (National Institute of Forestry, Agriculture and Livestock Research), the government organization responsible for rice research, conducted trials which did not relate to the demands of industry and consumers. As a result, it is not currently possible to reduce imports, as there are no modern and more competitive long-grain varieties available to replace IR8.

5.11 Nicaragua

Rice is one of the most important crops in national agriculture and one of the main staples in the Nicaraguan diet. Each year, rice activity generates US$80 million at national level and creates about 75 000 jobs. Demand is rising due to the increase in per caput consumption, which currently stands at 40 kg/person. Recent studies reveal that for the most resource-poor sector of the population, nearly 60 percent of food expenditure is on rice.

The average national yield of irrigated rice in Nicaragua is only 4.4 tonnes/ha. Progressive rice farmers beginning to implement improved crop management obtain in the dry season mean yields of 7.1 tonnes/ha (i.e. approximately 2.6 tonnes/ha more than the national average). With improved crop management, yields reach more than 9.7 tonnes/ha during the season of greater solar radiation (summer), i.e. just over double the national mean yield. Demonstrative plots in farms confirm that these yields are easily attainable, without significant increases in production costs per unit of area, which in turn is translated into an important reduction in the cost per unit of rice. These achievements aim to increase the production competitiveness of Nicaragua. It is feasible to produce irrigated rice in Nicaragua at a cost of US$110 per tonne, which is competitive with United States production or with any other rice-exporting country in the world.

5.12 Panama

Rice is a staple food crop for the population of Panama. Despite the achievements of the last 30 years, problems of limited production, high costs and environmental degradation persist. Integrated crop management is the key to their solution and rice chain-monitoring is important as a basis for decision-making. It is essential that the rice subsector maintain its competitiveness through a strong research and innovation project focusing on integrated crop management and dealing with emerging phytosanitary problems, with enough resources to satisfy the agricultural technological demand necessary for the sustainability of the activity in the global market. It is necessary to change technology transfer methods for more suitable ones, such as integrated knowledge management and field schools, so that the new technologies generated and validated by research/innovation interdisciplinary teams may be immediately adopted by the users. Panama's challenge is to enlarge cropping areas with irrigation and a high technological profile so that rice growers may remain competitive in spite of globalization.

5.13 Peru

Rice has the largest cropping area in the country, with a record 352 000 ha planted in 2005. About 100 000 farmers are dedicated to this crop, most of whom (85 percent) deal with under 5 ha. The most common planting system is transplanting, which employs between 80 and 100 day-wages per hectare, giving rice remarkable economic and social significance in those zones where it is cultivated. Rice consumption is 52 kg per person per year, the country consumes 1 440 444 tonnes of white rice annually and national production meets the country's needs. The crop uses between 10 000 and 18 000 m^3 of water per hectare per season. Rice production ecologies include the Coast, High Selva and Low Selva:

Coast: Coastal areas provide about 41 percent of national rice area with a mean yield of 8.3 tonnes/ha. In Arequipa, yield can reach 15 tonnes/ha. About 90 percent of coastal rice areas are planted to IR43. Salinity problems and low temperatures starting in April affect late sowings and the major pests are *Hydrellia* sp. (Diptera) and *Chironomus xanthus.*

High Selva: About 42 percent of national rice area is found in this ecology. The prevailing cultivar is Capirona, which produces an average 6.8 tonnes/ha. The main pests and diseases are *Pyricularia oryzae* and white leaf virus transmitted by the *Tagosodes orizicolus* vector.

Low Selva: About 17 percent of national rice area is found in this ecology. Seeds of old varieties, often mixed, are broadcasted onto the mud of rivers when flow is low. No fertilizers or agricultural chemicals are applied. Average yield is 2.8 tonnes/ha. The main pest is *Diatraea saccharalis* and the most common diseases are *Pyricularia oryzae* and *Helminthosporium oryzae*.

The Rice Project of the National Institute for Agricultural Research and Extension (INIEA) is in charge of research; the main experimental stations are located in Vista Florida (Coast), El Porvenir de Tarapoto (High Selva) and San Roque de Iquitos (Low Selva). The Rice Project has just released the variety, La Conquista, for the High Selva zone, obtained by the individual genealogical selection method – starting from PNA 2349, crossing with Huallaga-INIA and Uquihua – carried out at the Vista Florida Experimental Station in 1995.

5.14 Spain

The rice area is approximately 120 000 ha – 22 percent of the rice area of the European Union; mean yield is 8 tonnes/ha (8.5 tonnes/ha in the south). Farmers' main concern is loss of profitability as a result of the disappearance of the guarantee prize and the gradual reduction of subsidies by the European Union. Water scarcity for irrigation, especially in the south (Andalucía), is another pressing problem. About 90 percent of the national rice area is under integrated management, with a significant decrease in inputs (seeds, nitrogen, water and insecticides). There is now a desire among farmers to increase their (to date) low participation in the processing and marketing of white rice.

5.15 Thailand

Rice is more than a staple food: it is the culture and the way of life of the Thai people. Rice lands in Thailand cover about 10.64 million ha (9.2 million ha in the wet season and 1.44 million ha in the dry season). In 2004, Thailand exported about 10 million tonnes from a total production of 27.3 million tonnes of paddy rice or 17.2 million tonnes of white or milled rice. Exported rice includes aromatic rice, good quality white rice, parboiled rice, glutinous rice and rice products, such as rice flour and noodles. However, the average rice yield is quite low (about 2.5 tonnes/ha). Moreover, rice farmers are still poor compared to other crop growers. These problems are well recognized by the government. A roadmap for rice development during 2006-08 has been drawn up to upgrade rice yield, in terms of both quantity and quality, and to improve the well-being of Thai farmers. The roadmap indicates the following five strategies to be implemented:

- Research and development

- Farmer development
- Rice production
- Value creation
- Rice marketing promotion

Furthermore, the Department of Rice (DOR) was established by combining all rice activities of the Ministry of Agriculture and Cooperatives (MOAC) into a single department. DOR comprises six offices:

- Rice Policy and Strategy
- Rice Research and Development
- Rice Extension
- Rice Seed
- Rice Products Development
- Administration

The goal of DOR is to improve rice crop management for higher productivity and quality of Thai rice, in order to maintain Thailand's competitiveness and its status as the world's first rice exporter. Rice quality will be guaranteed by incorporating a certification system and a traceability system along the rice supply chain. Good Agricultural Practices (GAP) and Good Management Practices (GMP) certificates will be issued to those who meet the requirements for each standard, and the Q-Mark can be placed on rice products. There has been much improvement in terms of GAP, thanks to the technical assistance provided by FAO under the Thai RiceCheck System Project – TCP/THA/0167 (T) Training on Integrated Crop Management Technologies for Production of Good Quality Rice Seeds – funded by FAO during 2002-04. It was successfully implemented in farmers' fields using the Thai RiceCheck system for integrated rice crop management.

5.16 Uruguay

During the last few years, rice has been planted to about 180 000 ha. Average yield has increased, from 6 tonnes/ha to over 6.5 tonnes/ha. Slightly fewer than 600 farmers plant rice. Large-grain varieties of both the *indica* and the tropical *japonica* (American quality) genetic base are being cultivated. The locally obtained varieties, El Paso 144, INIA Tacuarí and INIA Olimar, cover more than 95 percent of the cultivated area and 85 percent of the seed is certified – its quality and purity generate a uniform product and help to control red rice. The crop is sowed mechanically in rows or broadcast in surface-drained dry soil during the months of October and November. Rice crops share the soil with livestock production. The livestock sector utilizes the majority of the natural resources during the rotation period. After sowing rice for 2 or 3 consecutive years, improved pastures (grasses and legumes) are sowed by plane without any soil tillage for 3 to 5 years. Research is carried out by the National Institute for Agricultural Research (INIA); the results are transferred mainly by private professionals, who then transfer them to the farmers.

5.17 Venezuela

High-yielding varieties, adapted to most regions where irrigated rice is cultivated in Venezuela, will soon be available. Crop management technologies which allow varieties to express their maximum potential have been identified and are being transferred to farmers. However, there are numerous deficiencies in farmer organizations which prevent the transfer of improved production technologies and include the following:

- Lack of appropriate financing to allow farmers to begin sowing activities on time.
- Insufficient fertilizer acquisition (in particular urea), resulting in late and ineffective application.
- Lack of coordination between administrative and technical departments within local farmer associations creating a negative impact on technology transfer.
- Work overload for technology transfer coordinators, reducing their effectiveness and causing great damage because the use of pesticides, continuous sowing and permanent rice production result in damage by rodents.

6. CLOSING SESSION

The Closing Session was co-chaired by Mr Manuel Manrique Ugarte, Minister of Agriculture of Peru and Mr E.A. Kueneman, Chief of the FAO Crop and Grassland Service, on behalf of the Director-

General of FAO. Mr Kueneman expressed sincere thanks to the Government and people of Peru for their kind offer to host the Twenty-First Session of the IRC. In his closing remarks, the Minister of Agriculture of Peru congratulated all the staff involved in the preparation and organization of the successful Twenty-First Session. He praised the delegates and participants for their laudable contributions towards the success of the Session.

6.1 Adoption of the Report

The Commission unanimously adopted the Report of the meeting.

6.2 Other matters

6.2.1 The Commission *recognized* the importance of rice for world food security and poverty alleviation and *confirmed* its support to the work of the FAO Secretariat of the International Rice Commission.

6.2.2 The following FAO member countries expressed interest in becoming members of the Commission: Argentina, Bolivia, Costa Rica, Honduras and Spain.

6.3 Date and place of the next session

The Commission expressed appreciation for the invitation extended by the delegation of France to host the Twenty-Second Session in 2010. The final decision as to the exact date and place shall be made by the Director-General of FAO, in consultation with the Government of the member country concerned.

APPENDIX A
PROVISIONAL AGENDA

Theme: "Rice is Life – Bringing the Implementation of IYR to Farmers' Fields"

1. Election of Chairperson and Vice-Chairpersons
2. Adoption of Agenda
3. Welcome Address from Host Country
4. FAO Statement
5. Keynote Address
6. Report of the Executive Secretary
7. Rice market situation in 2005 and outlook for 2006
8. Rice genetic improvement for *Rice Is Life* in farmers' fields
9. Rice integrated management for *Rice Is Life* in farmers' fields
10. Regional strategies for *Rice Is Life* in farmers' fields
11. National reports and perspectives
12. Other matters
13. Date and place of the next session
14. Adoption of the Report
15. Closing Session

APPENDIX B
LIST OF DELEGATES AND PARTICIPANTS

Chairperson:	Mr Manuel Manrique Ugarte (Peru)
First Vice-Chairperson:	Mr Jorge Burneo (Ecuador)
Second Vice-Chairperson:	Mr. Abdel El Azim El Tantawy B. Hassan (Egypt)
Executive Secretary:	Mr Nguu Van Nguyen (FAO/Rome)

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APPENDIX C
WELCOME ADDRESS

Mr Yehude Simons Munaro
Governor of Lambayeque

Mr Chairman,
Excellencies,
Distinguished Delegates,
Ladies and Gentlemen,

As President of the Regional Government of Lambayeque, I welcome you to our Region, known as the "Region of Friendship and Culture". It is our sincere hope that these three days may be of learning for you and for ourselves.

The slogan for this Twenty-First Session is *Rice Is Life* and Peruvians certainly understand that *Rice Is Life*. In a world where hunger still affects 850 million people, where 200 million children suffer the consequences of hunger, *Rice* – the most nutritional cereal – is indeed *Life*. In Peru, rice is a huge source of employment: approximately 40 million working days to satisfy the average Peruvian consumption of 50 kg of milled rice per person per year. Peru is a high rice-consumption country.

Lambayeque is the region with the highest rate of rice consumption in the whole country. This Session will touch upon numerous areas: the significance of rice as food, rice varieties, cultivation techniques, scientific advances and government policies. The presence today of the Minister of Agriculture is a guarantee of Peru's commitment to rice. Furthermore, this Session provides an opportunity for FAO Representatives to foster collaboration between the region of Lambayeque and this specialist organization of the United Nations.

Lambayeque is a desert. Nevertheless, it is the "rice region" with between 60 000 and 70 000 ha of rice planted every year. Water scarcity and salinity, however, are becoming major constraints to rice production in this region. Peru is therefore keen to make the necessary efforts to diversify rice-based production systems in this region to generate income and reduce poverty, and to increase rice area and production in the Amazon region where water resources are more abundant. Peru requests that FAO collaborate in the diversification of rice-based production systems in the coming months and years.

In the name of Señor de Sipán, it must be said that here in Peru we are not just Incas, we are also pre-Incas and we are very proud of our culture, the culture of Señor de Sipán. It is my sincere hope that our guests will visit our museums during their stay, so that they may understand the great meaning of the Mochica culture in Peru.

Thank you.

APPENDIX D
WELCOME ADDRESS OF THE MINISTER OF AGRICULTURE OF PERU

Mr Chairman,
Excellencies,
Distinguished Delegates,
Ladies and Gentlemen,

Rice is the staple food of 17 countries in Asia and the Pacific, eight countries in Africa, seven in Latin America and the Caribbean and one in the Near East. The crop was introduced to Peru by the Spaniards in the second half of the sixteenth century in the coastal valleys of the south of the country, and it now occupies much of the northern valleys and forest borders and forest. Rice occupies 350 000 ha and is the source of 40 million working-days from sowing to harvest, accounting for 10 percent of the gross value of agricultural production.

Rice is a cereal of great importance in the Peruvian diet. *Rice Is Life* for the major populations of the world and it is deeply related to the cultural heritage of numerous societies. In Asia alone, more than 2 000 million people obtain 60 to 70 percent of their dietary energy from rice. It is the fastest-growing food source in Africa and it is of vital importance for food security. Production systems based on rice and the corresponding post-harvest handling provide employment to almost 1 000 million people in rural zones of undeveloped countries. Small-scale farmers in low-income countries cultivate approximately four-fifths of the world's rice.

Rice production faces serious constraints, including yield stagnation, labour shortage, gender-based conflicts, institutional limitations and environmental contamination. Given the diversity of regions, people and resources associated with rice-based systems in the world, coordinated participation at local and international level is needed for the successful global development of rice. On the other hand, the biodiversity of rice-based systems offers an excellent opportunity for improved nutrition in rural communities and for the enhancement of farmers' incomes.

The noble land of Chiclayo was home to ancient pre-Columbian cultures, such as Lambayeque, Mochica and Cimú, and once housed the great Mochica priest, "the Lord of Sipan", who dazzles us with his majesty. Chiclayo today is a modern and booming city in the Lambayeque region, a region that produces more than 350 000 tonnes of paddy rice per year, representing almost 15 percent of national production, in an area of approximately 40 000 ha. The Lambayeque region is the main rice-producing zone on the Peruvian coast, surpassed only by the San Martín region on the forest border when drought problems are present on the northern coast of Peru.

In Peru, milled rice consumption is greater than in other countries of Latin America and it is estimated that annual per caput consumption is over 50 kg. Rice is a staple in the Peruvian diet and it is used to make a wide variety of delicious dishes.

In this world meeting, organized by the Ministry of Agriculture of Peru and FAO, there will be discussion about how to promote international action dealing with production, storage, distribution and consumption of rice in the framework of the theme "Rice is Life – Bringing the Implementation of the International Year of Rice to Farmers' Fields". It is essential that our efforts in this Twenty-First Session of the International Rice Commission centre on issues such as plant breeding, integrated management for sustainable production and regional strategies for rice production.

This Session provides the opportunity to gather the experiences of international experts and FAO representatives of member countries in the framework of an authentic synergy of ideas for use in the design and execution of reliable and responsible agricultural public policies aimed at consolidating world food security and mitigating poverty in the field.

Peru and the noble city of Chiclayo welcome you and your ideas and proposals for which we will be eternally grateful. I declare the Twenty-First Session of the International Rice Commission open.

Thank you.

APPENDIX E
FAO STATEMENT

Mr Jose Graziano da Silva
FAO Assistant Director-General for Latin America and the Caribbean

Honourable Minister of Agriculture,
Mr Chairman,
Distinguished Delegates,
Ladies and Gentlemen,

On behalf of the Director-General of the Food and Agriculture Organization of the United Nations, I wish to welcome all of you to the Twenty-First Session of the International Rice Commission.

First of all, I would like to take this opportunity to express my sincere thanks to the Government of Peru for generously hosting this Twenty-First Session.

I also wish to reiterate the organizational structure and mission of the Commission, of which – as members – most of you are well aware. The International Rice Commission, which works within the framework of FAO, came into force on 15 January 1949; its mission was to promote national and international action in matters relating to the production, conservation, distribution and consumption of rice. The present membership is 61 and represents all rice-growing regions. The Commission meets once every 4 years to review the global status of rice development with respect to production and demand and to draw up strategies to meet future challenges. The Twentieth Session of the IRC took place in Bangkok, Thailand in 2002.

As you are aware, rice is the staple food of more than half of the world's population. Rice constitutes over 20 percent of the total food energy intake of the world population. Nearly 2 billion people in Asia alone derive between 60 and 70 percent of their daily dietary energy from rice and its products. Therefore, rice has a major influence on human nutrition and food security all over the world. Recently, rice has been increasingly perceived as a healthy food in a number of countries in Africa, Latin America and the Caribbean, and in other regions where rice is not traditionally a major food crop. In particular, rice production in sub-Saharan Africa has not been able to meet the demand of the population and governments in the subcontinent are spending about US$1 billion per year for rice importation in order to achieve food security. In addition, there are still about 850 million people suffering from hunger and malnutrition; of these, 250 million are children.

In the twentieth century, per caput consumption of rice in Latin America and the Caribbean increased from 10 to 30 kg; rice now supplies more calories to the diet than wheat, maize, cassava or potatoes and is especially important in the diet of the poor.

Overcoming hunger, poverty and malnutrition is a major challenge for many countries in the face of numerous constraints: land scarcity, depleted water resources and growing population. For this reason, the 57th Session of the United Nations General Assembly (UNGA) recognized the importance of rice as a staple food and affirmed the need to heighten awareness of the role that rice can play in providing food security and eradicating poverty in the attainment of the internationally agreed development goals, including those contained in the United Nations Millennium Declaration in 2000. On 16 December 2002, UNGA adopted Resolution 57/162 on the International Year of Rice, submitted by the Government of the Philippines and co-sponsored by 43 member countries, and declared 2004 the International Year of Rice (IYR).

The dedication of an International Year to rice, a single crop, is unique in the history of the United Nations. This unprecedented declaration presents a unique opportunity to coordinate efforts in a fight against world poverty and hunger. UNGA invited FAO to facilitate the implementation of the International Year of Rice, in collaboration with governments, the United Nations Development Programme (UNDP), the Consultative Group on International Agricultural Research (CGIAR), other relevant organizations of the UN System and non-governmental organizations (NGOs). The preparation and implementation were coordinated by the Informal International Working Group (IIWG) for IYR, made up of representatives of 17 rice-producing and consuming countries as well as six UN agencies, five CGIAR centres, NGOs and the private sector, in order to provide guidance in the planning of and preparation for IYR implementation. *Rice Is Life* was selected as the theme for IYR, whose mission was to promote improved production of and access to this vital food crop. Guided by the IIWG and the IYR Organizing Committee (FAO), the IRC Secretariat was strengthened in March 2003 in order to prepare for and implement IYR.

IYR 2004 was officially launched on 30 October 2003. For this occasion, the FAO Director-General addressed the Economic and Social Committee of the United Nations (ECOSOC) in New York, highlighting the need to increase rice production while decreasing pressure on the diminishing land and water resources – complicated tasks that he said could only be achieved if the global community worked together.

By 2004, governmental and public institutions, intergovernmental bodies and institutions, non-governmental organizations, private and youth sectors and farmers' associations worldwide had established their own IYR organizing committees. Initial compilation of information conducted by IRC showed that, globally, more than 800 activities were being implemented in 68 countries on five continents to celebrate IYR 2004. Celebratory activities included: festivals and cultural events; conferences and seminars; exhibitions; competitions (photographic, scientific, painting, cookery, rice planting); youth and school activities; IYR stamp production; and rice development projects.

The implementation of IYR in 2004 was reported to the Second Committee on Poverty Eradication during the 60th Session of UNGA in November 2005. In its Resolution, the Second Committee on Poverty Eradication of UNGA recognized:

> *the important contribution that the observance of the International Year of Rice, 2004, has made in drawing world attention to the role that rice can play in providing food security and eradicating poverty in the attainment of the internationally agreed development goals, including the Millennium Development Goals.*

The Executive Secretary of the International Rice Commission will provide you with more detailed information on the implementation and achievements of IYR worldwide.

On behalf of the Director-General of FAO, I would like to thank the member countries of the Commission and partner institutions, especially the members of the International Informal Working Group for IYR.

The implementation of the International Year of Rice will be deemed successful only when more rice is accessible and affordable to the poor and when impact is felt in both urban centres and rural areas, while ensuring an adequate return for rice farmers. The lessons learned from the Green Revolution in the 1970s and 1980s and, recently, in a number of countries, especially China and Viet Nam, demonstrate that global rice production can meet the demand of the increasing population, provided that it receives the commitment and support of all stakeholders: government policy-makers, researchers and scientists, extension officers, farmers and civil societies. Therefore, there is an urgent need for member countries to integrate rice production into their national economic development programmes.

Much work lies ahead beyond the International Year of Rice 2004. The period following the Green Revolution has seen the food security of many developing countries reinforced; however, there is concern with regard to a number of issues: environmental impact, productivity decline, biodiversity losses and possible links to increased rural poverty and malnutrition. According to FAO projections, rice demand in the year 2030 is forecast to reach approximately 803 million tonnes of paddy rice, that is 38 percent more than the annual quantity produced between 1997 and 1999. Rice production faces serious constraints, in particular, rice farmer poverty, globalization trends, WTO agreements and environmental impact.

Most rice farmers in developing countries are small-scale and resource-poor. The increase in rice yield and production during the Green Revolution initially increased returns from rice production and incomes of rice farmers, affording the poor in both rural and urban centres better access to food. However, farmer incomes have been negatively affected by the recent decline in rice prices worldwide. Furthermore, poverty usually occurs in rainfed rice production ecologies, remote areas and disaster-prone regions, where rice-holdings are small. Rainfed rice production (rainfed lowland, upland, deepwater and tidal wetland) occupies about 45 percent of the world's harvested area, but accounts for only one-fifth of production. The average yield ranges from under 1 tonne/ha to 3 tonnes/ha. A suitable developmental strategy and appropriate technologies to reduce these risks would help improve farmers' incomes in this ecology.

With globalization and the establishment of WTO agreements, developing countries are confronted with the challenge of keeping abreast of the trade liberalization momentum to reap the benefits of a more efficient allocation of resources, while providing alleviation to the plight of small producers, especially those who find it difficult to move to other sectors of the economy during the transition. Some developed countries, however, face the dilemma of opening their borders to rice from low-cost producers, while at the same time preserving the cultural heritage and environmental benefits associated with their own rice production systems.

Demographic pressure and the subsequent intensification of rice production have harmed the environment. Excessive use of pesticides leads to water pollution and health hazards. Intensive irrigation can cause salinization in semi-arid and arid zones and waterlogging in humid zones – leading to greatly reduced soil fertility – and years of high yields have caused the soil to become depleted of nutrients. Also of concern are the warming effects of rice production on the global climate, caused by methane emission from wetland rice and nitrous oxide emission from the use of nitrogen-based fertilizers. Protecting the environment is increasingly important.

Fortunately, technological options for sustainable increased rice production are available. A wide yield gap is still found in rice production and its narrowing could lead to substantial increase in production and farmers' incomes. Further yield increases could be achieved with the new generation of rice varieties, hybrid rice, super rice and, recently, NERICA (New Rice for Africa).

Twenty-six countries in Latin America and the Caribbean region (LAC) grow rice and the total production in 2004 was estimated at 25.8 million tonnes of paddy. This means that LAC contributes about 4.2 percent of world production (estimated at 605 million tonnes of paddy). Production in LAC is increasing: in 2000-03, average annual production was 22 million tonnes. During this period, yields increased from an average of 3.5 to over 4.0 tonnes/ha. The area under production decreased during 2001-03, mainly due to low world prices. In 2004, as prices recovered, the area under production increased to the same area as in 2000. This indicates that rice production in LAC is sensitive to world rice prices. Rice is a versatile crop and is grown in a wide range of climates and soils, and under diverse moisture conditions. About 55 percent of the crop (3.6 million ha) is grown under irrigation or in wetlands. About 45 percent (3.0 million ha) is grown under rainfed conditions in Latin America and the Caribbean.

The concept of precision farming has emerged in different forms in many countries since the early 1990s, taking advantage of advanced technologies (e.g. information technologies and farm mechanization) for better management of farm inputs on a smaller scale. Site-specific management helps improve productivity and efficiency and reduce environmental impact. In developing countries, farmers have used the integrated crop management system to narrow the yield gap as well as to reduce rural poverty. This system is an integrated production tool, helping small farmers to apply farm inputs in the right quantities and at the right time, improving profits, and reducing production costs and environmental risks.

In addition, biotechnology offers potential to increase yield and nutritional quality and to reduce needed inputs. Recently, Golden Rice – a rice with high levels of pro-vitamin A – has been successful in trials. The most important achievement in rice biotechnology is the sequencing and mapping of the rice genome that was completed in 2002 by the International Rice Genome Sequencing Project (IRGSP) and other public and private institutions. Knowledge of the rice genome could effectively assist the breeding of new rice varieties, including the transfer of genes from other crops and organisms to rice.

Rice production has been quite dynamic in Latin America and the Caribbean region. Since the late 1960s, over 300 new varieties have been released, production has tripled; high yields explain 80 percent of this increase. The main beneficiaries of the process have been consumers, with real rice prices dropping by over 40 percent during this period. An important reason for this trend is the impact of conventional and biotechnology-supported rice breeding programmes.

These programmes vary greatly in terms of capacity: from developing and testing their own crosses to evaluating a limited number of fixed lines. In order for smaller programmes to be effective, they must be associated with organizations developing fixed lines. Two such networks, Fondo Latinoamericano para

Arroz de Riego (FLAR) and the Working Group on Advanced Rice Breeding (GRUMEGA), currently support activities in irrigated and upland rice. Rice programmes in both the public and the private sector are facing more open markets; they are collaborating closely and understand the need for this trend to continue.

In his statement on the official launch of the International Year of Rice at the United Nations in New York in 2003, the Director-General of FAO said:

It's time to capitalize on rice-based production systems. They can help us achieve the goals of the Millennium Declaration and the World Food Summit: Five Years Later. It's time for the global community to work together to increase rice production in a sustainable way that will benefit farmers, women, children and especially the poor. Together we can manage these improvements so that their benefits help to increase global equity and peace.

There is an uphill task ahead. No doubt this body will deliberate in depth during the course of the next 3 days and appropriate recommendations will be formulated on how best to meet the above challenges.

On behalf of the Director-General of FAO, I wish you a successful Session.

APPENDIX F
KEYNOTE ADDRESS

IMPROVED RICE PRODUCTION IN A CHANGING ENVIRONMENT: FROM CONCEPT TO PRACTICE

Mr E.A. Kueneman, Chief, Crop and Grassland Service, FAO

I INTRODUCTION

The rice subsector has experienced three striking events since the last meeting of the International Rice Commission, held in 2002 in Bangkok, Thailand. First, the United Nations General Assembly adopted Resolution 57/162, declaring 2004 the International Year of Rice; it was the first time the UN had dedicated this honour to a single commodity. Second, in 2002 world rice production began to increase once again, following three consecutive years of declining production: world production in 2005 stood at around 614 million tonnes of paddy rice (FAOSTAT, 2005). Third, world average yield in 2005 is projected to break the 4 tonnes/ha barrier. An average yield of 4 tonnes/ha may not appear to be a major accomplishment, but considering that rice is grown on over 150 million ha under a wide variety of conditions from irrigated to dryland to floating, an average yield of 4 tonnes/ha is indeed a significant achievement.

There are, however, also negative factors that plague the rice sector. Rice production in sub-Saharan Africa continues to be outpaced by consumption; imported rice now accounts for over 50 percent of sub-Saharan Africa's rice requirement. Rice is rapidly becoming a food staple in the African diet, and low and stagnant rice production accentuates the food security problem confronting much of sub-Saharan Africa. Food shortage in Africa is becoming synonymous with rice deficit. Excessive water usage, environmental degradation due to pesticide and nutrient contamination, methane emission and ammonia volatilization are a few of the adverse affects of rice production requiring urgent attention. Land and water resources for rice production are diminishing and global climate changes may have a major effect on rice production. There are, however, a wide range of technologies available for reducing the adverse consequences of rice production, but the majority have not been extended to the rice grower. Technology adaptation and adoption remain opportunities and challenges.

In consideration of the entire spectrum of events, the Twenty-First Session of the International Rice Commission (IRC) is being held in a much more positive environment than most recent sessions. Several of the advances in rice production have emerged from recommendations made at recent IRC sessions, in particular the promotion of improved crop management technologies. The Twentieth Session in Thailand, as well as the Nineteenth Session in Egypt, made important recommendations for improving yield and bridging the yield gap in irrigated rice. The Expert Consultation on Yield Gap and Productivity Decline in Rice Production in September 2000 in Italy also identified that improved crop management and technology transfer are the principal mechanisms for enhanced yield. FAO and its partners took immediate action on the Commission's recommendations and made major progress in this important area, that has the potential to enhance the productivity and efficiency of farmers' crop management as well as to help meet global food security requirements. This article gives primary attention to these advances and also reviews other developments that may have important effects on the global rice industry in the near future.

II THE CHANGING ENVIRONMENT OF RICE PRODUCTION

Global rice production has met consumption demand during recent decades. However, this situation cannot necessarily be maintained without appropriate action in the near future. The global rice production environment is undergoing substantial changes in numerous areas that require adjustments in rice research and development to support sustainable production.

II.1 Increasing rice demand and declining resources for rice production

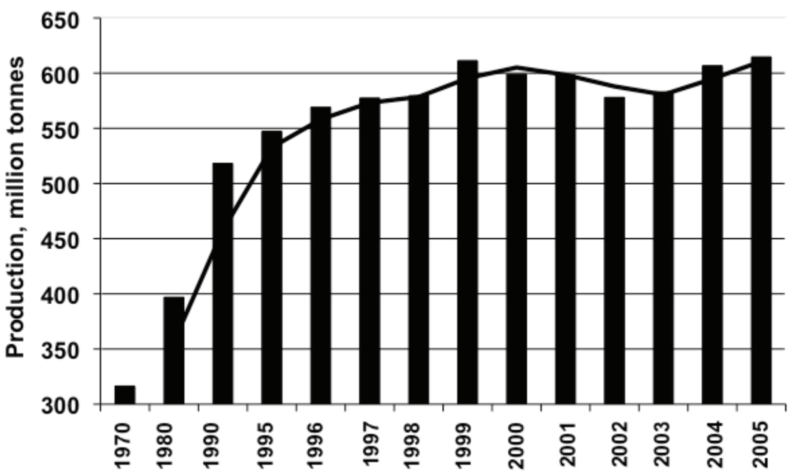
Worldwide, rice provides 27 percent of dietary energy supply and 20 percent of dietary protein. Rice production nearly doubled during the period from 1970 (316 million tonnes) to 2001 (592.8 million tonnes). The world's rice production, after reaching a peak in 1999, declined during the 2000-02 period and has been increasing again since 2002 (Figure 1), closing the gap between consumption and production. However, there are still 852 million people suffering from hunger and malnutrition and, due to the steady population increase, rice demand is projected to increase from 571.9 million tonnes in 2001 to 771.1 million tonnes in 2030 (FAO, 2003a).

The world rice harvested area grew from 133 million ha in 1970 to 157 million ha in 1999 (FAOSTAT, 2005), mainly as a result of the increase in cropping intensification. In tropical climate areas with favourable temperature regimes, two or more rice crops can be grown on the same land in a year. Rice-rice and rice-other-crop-rice systems are very popular with farmers in Bangladesh, southern China, southern India, Indonesia, Myanmar, the Philippines and Viet Nam. Rice-rice systems are also widely practised in many irrigated lands in sub-Saharan Africa. Continuous rice production systems are also common in much of tropical Latin America.

In 2005, the global rice harvested area was 153.5 million ha, i.e. a decline of 3.4 million ha since 1999 (FAOSTAT, 2005). In the near future, the possibility for expanding area under rice-based systems will be limited due to increased competition for land and water from the urban and industrial sectors in the major rice-producing countries in Asia. Outside Asia, inadequate water supply limits rice cultivation in Spain, Portugal, Egypt and Australia (Nguyen and Ferrero, 2005). The Egyptian Government plans to limit the area under rice production due to the limited water supply. In a number of countries in sub-Saharan Africa and Latin America, there is still considerable land area suited to rice production. High development costs are a deterrent to expanding irrigated rice in Africa. Lack of capital and stable economic policies restrict long-term investment in irrigated rice in Latin America, despite the availability of vast land and water resources.

The accumulation of greenhouse gases in the atmosphere is warming the planet, resulting in changes in the global climate (IPCC, 2001). In 1992, Downing reported that the core agricultural zone in Zimbabwe would be reduced by 67 percent with a 2°C temperature increase (Downing, 1992). A later report also suggested that agricultural land in the low latitude tropical climate regions may be hardest hit by temperature increases (Rosenzweig and Iglesias, 1994). Recently, Darwin *et al*. (2005) estimated that the amount of land classified as "land class 6", which is the primary land class for rice, maize, sugar cane and rubber in tropical areas, would decline by 18 to 51 percent in the next century as a result of global warming.

FIGURE 1.
World rice production in 1970, 1980, 1990 and 1995-2005
Source: FAOSTAT. 2005.



Increasing the productivity of the rice systems has proven an effective means of conserving water and of decreasing greenhouse gases in wetland rice systems by reducing the area under production. The large-scale adoption of hybrid rice (about 50 percent of total rice area) permitted China to increase production from 128 million tonnes in 1975 to 191 million tonnes in 1990, while reducing the rice harvested area from 36 million ha in 1975 to 33 million ha in 1990 (Nguyen, 2004). Increase in productivity has translated into a substantial reduction in the total amount of water consumed in rice production. The practice of intermittent irrigation is also expanding as a potential alternative to the relatively high rate of water consumption in fully flooded irrigated rice.

II.2 Changing policy, trade and market agreements

Historically, rice trade has accounted for only a small amount of world rice production; until recently, it was considered relatively unimportant. Rice is generally thought of as the "most protected" crop since governments have historically intervened in pricing, inputs supplies, procurement and trade. However, trade in rice has grown into a major international business with global rice trade amounting to over 26 million tonnes (milled) in 2004 and it is projected to continue to grow (Calpe, 2005). The rice protection policies in both developing and developed countries are frequently becoming contested issues in world trade negotiations. The trade liberalization policies resulting from the Uruguay Round of the GATT conference in the late 1990s are often considered to be the driving force behind the rapid increase in rice trade. Likewise, failure to reach an agreement at the WTO-Cancun meeting was precipitated by agriculture, and rice trade was a major issue. Market access and export subsidies are major issues still to be resolved. Domestic price support is also an important issue that appears to be difficult to negotiate due to the historical importance of rice as a food and source of income in many major rice-producing countries. Although international rice trade is still relatively small and accounts for only 7 percent of world production, trade has been shown to assist in reducing large fluctuations in national rice price and has had a calming effect on world prices.

National rice policies are in a continuous state of evolution, and more changes are anticipated as world production and consumption equalize and other sectors of the economy become increasingly important in the major rice-producing countries. Consequently, rice is no longer viewed as just a subsistence crop in the world market but increasingly as a tradable commodity. Recent studies reported that complete trade liberalization would increase rice trade by between 7 and 73 percent (depending on grain type), increase export prices by 2 to 91 percent, but decrease consumer prices by 18 to 27 percent. Total economic gain from complete liberalization would amount to US$7.4 billion annually with over two-thirds of the gains going to importing countries or rice consumers (Wailes, 2004). This illustrates the potential economic gains and losses involved in rice trade agreements. Although it has not been quantified, similar reductions in government subsidies in the United States of America and Europe would have major impacts on world trade and rice prices.

II.3 Diminishing labour supply and increased concern for environmental conservation

Rice cultivation in many countries is labour-intensive. Labour shortages are being experienced in many rice-producing areas, especially those near urban centres, as farmers migrate to seek more lucrative employment in other sectors of the economy. The labour supply for rice production is diminishing in a number of Asian countries (Pingali, Hossain and Garpacio, 1997). Farm mechanization will be required to sustain rice production as migration from rural to urban areas increases with industrial development. There is a need to foster sustainable mechanization, which is environmentally friendly, ecologically sound and less resource demanding. Direct seeding is growing in popularity in Asia due to labour shortages for transplanting. Direct seeding requires rice varieties with thicker stems and which are less susceptible to lodging, as well as better land levelling and preparation to ensure adequate plant establishment.

Environmental considerations play an increasingly important role in rice production. Contamination from pesticides and fertilizers is under close scrutiny; programmes such as integrated pest management and integrated nutrient management offer viable alternatives. Reduced subsidies for fertilizers will require greater efficiency; this in turn will change cultural practices. In general, the major rice-producing countries have low N-use efficiency. Technology for higher N-use efficiency is available, but has not been adopted by most rice producers. New paradigms in technology transfer are required to expand the use of proven technologies in pest management, fertilizer usage and water management.

II.4 Shifting consumer preference and malnutrition in rice-consuming populations

Nutritional value is normally not considered a qualitative factor. The nutritional contributions of rice were reviewed extensively in the 2002 IRC Session (Kennedy, Burlingame and Nguyen, 2003). Essentially, rice in developing countries is an important source of carbohydrates, accounting for between 27 and 50 percent of the dietary energy supply, a major source of protein, supplying 20 to 50 percent of the dietary protein requirements, and a significant source of fat, supplying 3 to 27 percent of the dietary requirements. The variation in meeting dietary requirements is explained by the wide range in rice consumption. In countries such as China and India, rice supplies approximately 9 to 17 percent of the recommended nutrient intake (RNI) of calcium, foliate and iron and nearly 20 percent of the RNI of zinc. In general, rice contains adequate levels of B vitamins (thiamine, riboflavin and niacin) but contains little vitamin C, D or beta-carotene (vitamin A). The bran contains the highest level of dietary fibre, minerals such as Ca, K, Fe, Zn and P, as well as most of the B vitamins. Consequently, rice processing (milling and polishing) significantly reduces the nutritional quality of rice. Most high-yielding varieties contain less than 1.5 mg iron/100 g, but germplasm has been identified containing twice this quantity (Graham *et al*., 1999; Juliano, 2003). However, iron nutrition is complex and a major problem is the low bioavailability (often only about 18 percent). In addition, there are numerous inhibitors of iron absorption, including phytic acid, polyphenols, vegetable proteins and calcium, as well as enhancers of absorption that include ascorbic acid, organic acids and animal tissues, i.e. meat, fish and poultry.

Extensive research is underway to improve the nutritional quality of rice, using both conventional breeding methods and biotechnology. Variation within the species permits the use of conventional breeding methods to improve nutritional characters thereby avoiding the difficulties with genetically modified organisms (GMOs) (Graham *et al*., 1999; Kennedy, Burlingame and Nguyen, 2003). Data in Table 1 show a wide range of protein content in rice varieties around the globe. Similarly, Senadhira, Gregorio and Graham (1998) reported large variations in the zinc and iron content between grains of different rice varieties. Attempts to improve beta-carotene content led to the "Golden Rice" phenomenon in the mid-1990s, but the difficulties encountered in engineering led to delays in its commercial development. Many of these difficulties may now have been resolved and new research is promising, pointing to higher levels of beta-carotene (Beyer *et al*., 2002). Efforts are also underway to increase iron content via several methods including genetic modification using the ferritin gene from the common bean (Lucca *et al*., 2000). Although much of this work is at an advanced stage, a major limitation remains consumer acceptance of GMO rice.

TABLE 1: Protein content in grains of rice planted around the globe

Source	Sample number	Range of protein content (%)
Oryza sativa L	2 674	4–14
• Asia	1 626	4–14
• Australia	24	5–10
• North America	190	4–13
• South America	301	5–13
• Europe	233	5–13
• Africa	300	5–11
Oryza glaberrima Steud	195	9–14

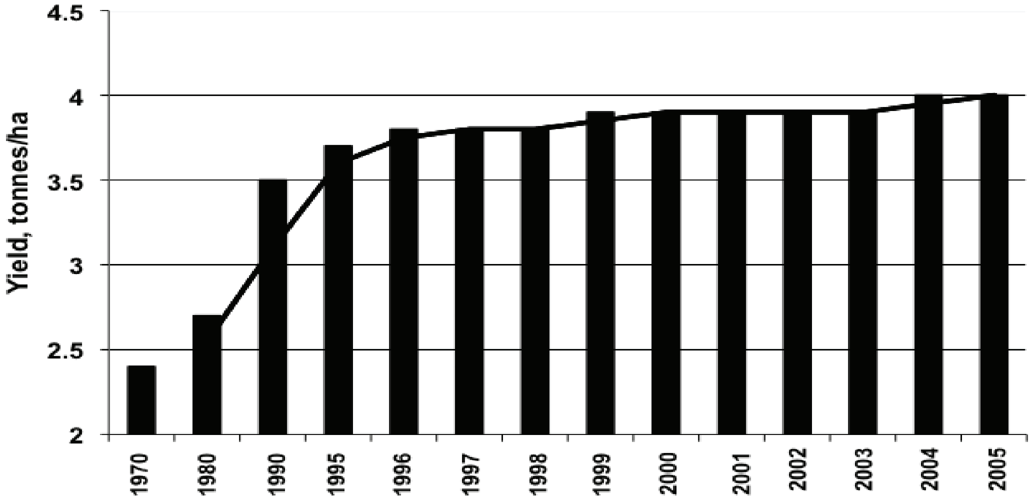
Source: Juliano and Villareal, 1993 (adapted).

Higher incomes as a result of developments in the manufacturing sector are leading to greater demand for higher quality rice. The price of aromatic rice such as Basmati and Khao Daw Mali is much higher than that of HYVs (high-yielding varieties) and the demand for aromatic, soft and long-grain rice continues to increase with improvements in the income of rice-consuming populations, especially in many European countries (Ferrero and Nguyen, 2004). Currently, high quality rice accounts for 75 percent of international rice trade (Calpe, 2005). Rice breeders will have to be more stringent on grain quality characteristics to meet the requirements of sophisticated consumers.

II.5 Emerging partnerships in research and development

The contribution to rice producers and consumers from research conducted at the international research centres under the CG (Consultative Group [on International Agricultural Research]) system is large and unquestionable. Both the consumer and the producer have benefited tremendously from the advances

FIGURE 2.
Trend in world rice yield, 1970-2005
Source: FAOSTAT, 2005.



made in research. Further refinements in pest and disease resistance breeding and improved grain quality have added further value to the high-yielding plant types that drove the Green Revolution in the 1960s and 1970s. The worldwide benefits of the Green Revolution were seen in the yield increase of 1.7 tonnes/ha (Figure 2). Although not readily apparent, agronomic research conducted following the Green Revolution is the primary factor fuelling current yield increases.

The CG centres have fostered closer collaborations with national programmes and non-traditional partners, partly as a result of the reduction in resources. The participatory approach to research has helped the centres focus more sharply their research activities. Furthermore, centre-wide initiatives were introduced to reduce duplication of efforts and more cost-effective research programmes. The CG centres have historically been the source of new technologies; current research from these centres and elsewhere will contribute to the continuing effort to further increase rice production that is less resource demanding and less damaging to the environment.

Public sector research and extension programmes have traditionally assumed responsibility for national enhancement of rice production in many countries. In Latin America, however, the demise of the public sector efforts during the 1990s due to structural readjustments resulted in the surfacing of a national growers association as a primary conduit for rice research and development. Currently, the private sector accounts for nearly 80 percent of all expenditures on rice research and development in Latin America. A similar retraction in public sector support to rice has occurred in much of Asia, but the private sector has not often assumed a stronger role in rice development. Little funding is available for laboratory-level or on-farm research activities.

The private sector is an untapped resource for rice development. Private seed companies, fertilizer suppliers, pesticide companies etc. depend on an economically successful farmer to be successful themselves. The advancement of technologies that increase farmer profits also produces increased sales of essential inputs. Recently, non-governmental organizations and the private sector have begun to actively invest in rice research, especially in the field of rice biotechnology (Brookes and Barfoot, 2003).

Policy-makers as well as researchers and extension personnel, therefore, need to examine alternative means of support for vital rice research and development. State and district governments are assuming more of a role in several countries, NGOs are operating in all areas of development, input suppliers have a vested interest in the advancement of rice, and millers require paddy to operate. Establishing partnership linkages within the rice chain to pool revenue for research and development is feasible, since all sectors have a vested interest in the success of the crop. Promoting research and development through growers associations is an attractive alternative. For example, FLAR (Latin American Fund for Irrigation Rice) not only derives funds for rice research and development from producers and millers but it has established agreements with commercial seed and chemical companies. Expanding and widening partnerships among the public sector, NGOs and the private sector will be a central challenge for rice research throughout the world. The FLAR model should be examined by other countries.

III FROM CONCEPT TO PRACTICE: CASE STUDIES ON CLOSING THE YIELD GAP IN IRRIGATED RICE PRODUCTION

The Nineteenth Session of the International Rice Commission in 1998 directed special attention to the yield gap in irrigated rice and noted that bridging the yield gap was the most appropriate means of increasing yield and profitability in the highly productive irrigated sector. Subsequently, FAO (Rome) organized in 2000 in Italy an Expert Consultation on Bridging the Yield Gap that provided a forum for analysing the extent of the yield gap in the major rice-producing regions and developing action plans for addressing the problem. These two events combined with the Twentieth Session of the IRC provided the basis for formulating the concept of rice integrated crop management to enhance productivity in irrigated rice, which was then articulated by the Secretariat of the International Rice Commission (Nguyen, 2002; Clampett, Nguyen and Tran, 2003). After the Nineteenth Session of the Commission, FLAR with assistance from the Common Fund for Commodities (CFC) commenced efforts to close the yield gap in several Latin American countries, while FAO has assisted Indonesia, the Philippines, Thailand and Viet Nam in initiating activities in integrated crop management and technology transfer. The International Rice Research Institute (IRRI) in collaboration with Indian institutions has also undertaken activities to address the yield gap problem. Finally, a new “compost-based” concept for smallholders emerged from Madagascar and is referred to as the System of Rice Intensification (SRI). While the activities are being pursued by different organizations, often with distinct methods, they all have the common objective of increasing on-farm yields through the use of improved crop management.

III.1 Asian case studies

Improved crop management programmes are also being implemented in several Asian countries, including the Philippines, Indonesia, Viet Nam and India. The programmes are being implemented by several institutions using different technologies and methods of technology transfer. Results from several of the countries are presented in the 2005 issue of the International Rice Commission Newsletter (Vol. 54).

Indonesia. Much research, development and assessment of integrated crop management (ICM) has been carried out by numerous national institutions in Indonesia during the last 5 years (Abdulrachman, Las and Yuliardi, 2005). The programme has evolved from a discipline-oriented on-farm research programme into an active integrated extension programme that utilizes ICM as a methodology with a set of principles for guiding farmers in managing the rice crop with emphasis on the following areas: (1) selection of rice variety for high yield and use of quality seed; (2) planting of young and healthy seedlings; (3) incorporation of organic manure and basal fertilizer prior to transplanting and use of the leaf colour chart for predicting the need for nitrogen top-dressing; (4) use of intermittent irrigation; (5) frequent mechanical weeding; and (6) control of pests and diseases based on regular field observations. The rice ICM system was first evaluated in Grobogan District, Central Java in the wet season (Nov.-Feb.) of the 2000/01 cropping season. In the 2001 dry season, the assessment became part of the National Integrated Crop Management Network of the Indonesian Agency for Agricultural Research and Development (IAARD) and was conducted in seven provinces. In 2002, the Integrated Rice Development Project (P3T) was initiated and developed in 31 districts, located in 14 provinces. The assessment of the impact of the application of rice ICM system during 2001/02 showed that the application of ICM methodology positively increased yield in 25 villages (out of the 26 villages assessed), with yields increasing by more than 20 percent in 13 villages (Table 2). The programme found that new varieties, seed treatment and rodent control were the preferred features of the ICM programme. In contrast, use of the leaf colour chart, organic fertilizer and soil analysis to predict P and K requirements were least accepted by growers.

Philippines. The Philippine Rice Research Institute is implementing a rice integrated crop management system, referred to as PalayCheck (Cruz *et al*., 2005; Olvida, 2005; Publico, 2005). The programme is based upon the application of key checks similar to the Australian RiceCheck programme. Technological interventions consist of eight checks, namely: use of high quality seed; land levelling;

reduced density and early transplanting; use of leaf colour chart for monitoring N nutrition; monitoring of panicle size and density; water management; control of pests, diseases, insects and weeds; and harvest at early maturity. A large number of on-farm demonstration plots show that full compliance with the checks results in yields of over 8 tonnes/ha compared to an average of 4.5 tonnes/ha with conventional crop management (Figure 3). Yield is highly related to adoption of the key checks and ranges from about 4 tonnes/ha from farmers who achieved three key checks to over 8 tonnes/ha from farmers who achieved all key checks. Similarly, gross profit margins nearly doubled from US$421/ha to US$828/ha due mainly to increased yield. Although some farmers reported high yields, especially during the dry season, the overall impact was limited because the checks were only partially adopted; only 20 percent of the farmer-cooperators followed all eight recommendations. Farmers seldom adopt technologies as "packages"; they normally select component practices that they view as more important. Adoption of several practices (in this case, eight) requires time and much effort. Therefore, during the initial phase of introducing the technologies, it may be necessary to reduce the number of technological interventions resulting in a simpler technical message.

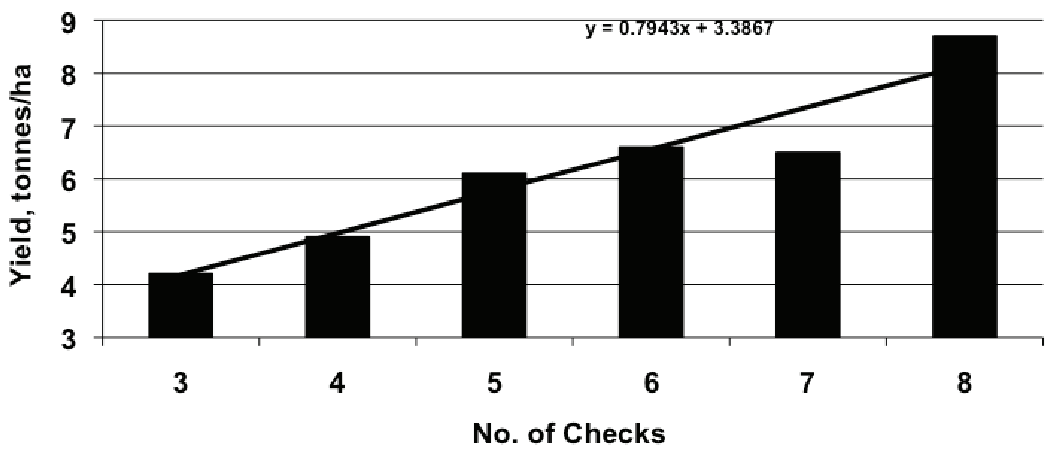
TABLE 2: Range of yield changes due to application of ICM methodology in 26 villages in Indonesia during three cropping seasons, 2001–02

Range (%) of yield change due to application of ICM	Number of villages
Increase of > 30% to < 50%	6
Increase of > 20% to < 30%	7
Increase of > 10% to < 20%	8
No increase	4
Decrease of > 3%	1
Total number of villages under observation	26

Viet Nam. Viet Nam is employing an integrated crop management programme called "3 Increases, 3 Reductions" (Pham, Trinh and Tran, 2005). The application of this programme follows a participatory approach in which the technology is introduced, tested and subsequently modified based on farmer experience. The programme has not to date resulted in substantial increases in rice yield. Yield increases ranged from 1.7 to 6.3 percent in three cropping seasons in two districts during 2002-04. However, the programme reduced production costs as a result of the decrease in the quantities of fertilizers, pesticides and seed; there were also improvements in grain quality. Rice produced with the "3 Increases, 3 Reductions" programme was cleaner as a result of the lower incidence of disease infection resulting in higher whole grain yield from milling. As a result, profits increased from US$44 to US$64/ha/season (Pham, Trinh and Tran, 2005).

India. Collaboration between IRRI and Indian scientists led to the development of an ICM programme incorporating technologies from various sources. The ICM programme is built upon five management factors: early transplanting (4-leaf stage); one seedling per hill; square transplanting (0.225 × 0.225); early and frequent mechanical weeding; and intermittent irrigation (Balasubramanian *et al.*, 2005). Yield

FIGURE 3:
Yield increase in the Philippines during wet season related to adoption of various improved management practices (checks)
Source: Cruz *et al.*, 2005 (adapted).



increase on research farms using the five management factors ranged from 35 to 48 percent. Removal of a single component caused the following yield depressions: 19 percent due to late weeding; 16 percent due to transplanting older seedlings; 14 percent due to transplanting more than one seedling per hill; and 10 percent due to infrequent irrigation. On-farm demonstration plots reported yield of 6.6 tonnes/ha with ICM and 4.4 tonnes/ha with conventional management, or a 50 percent yield increase. Profits increased more than threefold from US$105/ha to US$369/ha due to improvements in crop management. The programme is currently developing procedures for widespread dissemination of the ICM technologies.

III.2 Latin American case studies

Following the recommendations that emerged from the Nineteenth Session in 1998 and the Expert Consultation on Bridging the Yield Gap (FAO, Rome) in 2000, FLAR obtained assistance from the Common Fund for Commodities (CFC) to initiate efforts to bridge the yield gap in several Latin American countries. The following is a summary of the results of this effort in southern Brazil, Venezuela, Costa Rica and Nicaragua.

Rio Grande do Sul, Brazil. Average irrigated rice yield in the State of Rio Grande do Sul in southern Brazil stagnated at 5.2 tonnes/ha in the last 15 years. In 2003/04, FLAR, in collaboration with the state rice growers association, Instituto Rio Grandense do Arroz (IRGA), initiated activities to improve yield through the introduction and promotion of improved crop management (Pulver and Carmona, 2004). The salient features of the technical intervention focus on six strategic management practices: planting date to expose the crop to high solar radiation during the reproductive period; reduced seeding density to produce healthy plants that are less susceptible to lodging with less incidence of foliar diseases; improved pest management based upon insecticide treated seed; balanced nutrition in sufficient quantities for high yield; early weed control; and appropriate irrigation water management. The six practices must be applied in an integrated manner and with precision. Simply adopting one or two of the improved practices and omitting others does not result in the anticipated increase in yield. Likewise, applying the practices but at an inopportune time or under an inappropriate condition does not produce the desired results.

In the first year of the project (2003/04), demonstration plots were established at 17 sites. Farmers who applied all the practices with precision obtained an average yield of 9.7 tonnes/ha, which is 4 tonnes/ha greater than the regional average and 3.5 tonnes/ha greater than the adjacent commercial fields of the participating farmer (Table 3). From the demonstration plots, established at two sites of commercial size, yields of 12 tonnes/ha were recorded. These are the highest yields that have ever been reported in the state and clearly show that very high yields are feasible even with currently available varieties when accompanied by improved crop management.

In the second year, the programme expanded to cover 52 sites. The mean yield of demonstration plots comprising over 8 000 ha was 9.1 tonnes/ha (2.3 tonnes/ha greater than commercial fields on the same farm) (Table 4). Growers who adopted all the practices but not in the degree required had an average yield of 7.8 tonnes/ha (1.6 tonnes/ha greater than the regional average during the same season). These farmers generally did not reduce the seeding density to the required level. Growers who partially adopted the improved practices obtained a yield of 7.1 tonnes/ha (1.0 tonnes/ha greater than the regional average). Finally, growers who attended only one or two field events and attempted to use the technology but in an imprecise manner reported an average yield of 6.5 tonnes/ha, representing a yield increase of only 0.8 tonnes/ha above the regional average. The varying level of success, depending upon the degree of adoption of the technology, is similar to the yield responses experienced with the adoption of “production checks”, popularized by the Australian RiceCheck programme.

TABLE 3: Summary of yields obtained with the most appropriate technology in demonstration plots established on farms with farmer leaders

Region	Yield (tonnes/ha)			
	District average	Farmer yield	Improved crop management	Yield increase over district average
Fronteira Oeste Region - 7 sites	5.9	6.7	10.0	4.1
Campanha Region - 2 sites	5.5	5.5	10.0	4.5
Depressão Central Region - 5 sites	5.6	5.8	9.0	3.4
Average of all regions - 14 sites	5.7	6.2	9.7	4.0

Source: Pulver and Carmona, 2004 (adapted).

TABLE 4: A summary of farmer participation, adoption of improved practices and the resulting impact on yield, production and income for the 2004/05 cropping season

All Regions 2004/05 season	No. farmers	Area (*ha*)	Yield (*tonnes/ha*)	Yield increase (*tonnes/ha*)	Production increase (*tonnes*)
Farmer Leaders	52	8 467	9.1	2.3	19 124
Farmers with assistance	115	25 805	7.8	1.6	42 291
Farmers without assistance	268	52 107	7.1	1.0	53 154
Indirect participants	1 171	114 209	6.5	0.8	92 247
Total	1 606	200 588			206 816
Value of increased production @ US$150/tonne					31 022 400
Increased income/farmer					US$19 317

Source: Pulver and Carmona, 2005 (adapted).

In just two growing seasons, the programme incorporated 1 600 farmers over an area of approximately 200 000 ha into the improved crop management programme. The large number of participants and the rapid adoption of the technology are principally due to the extension methodology employed, that is, the “farmer-to-farmer” method. This system is based on farmer-to-farmer exchange, resulting in the autonomous diffusion of technologies. In addition, the use of large-scale demonstration plots provides convincing evidence that the technology being transferred is relevant, easily adjusted to different conditions and simple to adopt.

Venezuela. During the last two decades, the mean rice yield in Venezuela has remained stagnant at 4 to 4.5 tonnes/ha. In the 2003 season, the CFC/FLAR project commenced, providing assistance to the national rice growers association (FUNDARROZ) with the objective of developing a coordinated technology transfer system (Pulver and Rodriguez, 2004 and 2005). The project collaborates with eight organizations, accounting for approximately 115 700 ha of irrigated rice (nearly 80 percent of the total rice area in the country). During the 2003/04 dry season, demonstration plots with improved management technology gave excellent yields, often exceeding 9 tonnes/ha. The agronomic practices that resulted in improved yields were based on four concepts: date of planting that permits the crop to receive maximum solar radiation during the reproductive phases; N fertilizer management resulting in high N efficiency; early weed control; and improved irrigation water management. In the second year of the project, two additional practices were added: the use of insecticide-treated seeds to control insect outbreaks during crop establishment; and lower planting density to reduce foliar disease and cost of treated seeds.

National yields in Venezuela are increasing at a faster rate than in any other Latin American country (FAOSTAT, 2005). The current national yield of 5.2 tonnes/ha is approximately 0.5 tonnes/ha greater than the national average prior to the CFC project. Numerous demonstration plots as well as commercial fields have demonstrated that yields of 6 to 7 tonnes/ha are readily feasible during the rainy season and yields of 8 to 10 tonnes/ha are obtainable during the dry season when solar radiation is abundant.

Costa Rica. Mean irrigated rice yields in Costa Rica have stagnated at about 4 to 4.5 tonnes/ha over the last 15 years. In the 2003/04 season, demonstration plots were established using the six strategic management practices developed for Venezuela, but modified to suit local conditions. On two cooperating farms on a semi-commercial area, yields of 7.5 tonnes/ha (approximately 3.5 tonnes/ha greater than the national average yield under irrigation) were obtained (Oviedas, 2005). In the 2004/05 season, the improved practices were extended to six commercial farms and 1 500 ha were planted using the six strategic practices, resulting in an average yield of 6.5 tonnes/ha (2.3 tonnes/ha greater than the national average). In the same season, demonstration plots planted on the same farms using “best management practices” gave an average yield of 7.6 tonnes/ha over an area of 360 ha (3.4 tonnes/ha greater than the national average) (Figure 4). The “best management practices” are essentially further modifications of the six strategic practices for Costa Rican conditions.

Nicaragua. Yields in the irrigated production system were approximately 4 tonnes/ha during the last decade. During the last two seasons, the FLAR/CFC project in collaboration with the national rice growers association (Asociación Nicaragüense de Arroceros - ANAR) introduced improved crop management practices. The technology consisted of the same six strategic management practices described for Brazil and Venezuela, but adjusted to the conditions of Nicaragua. In the 2003/04 season, the technology was introduced on one commercial farm. Yield with improved management was 9.7 tonnes/ha (5.3 tonnes/ha

FIGURE 4.
Summary of yields in Costa Rica with improved crop management (2004/05) compared to historic yields

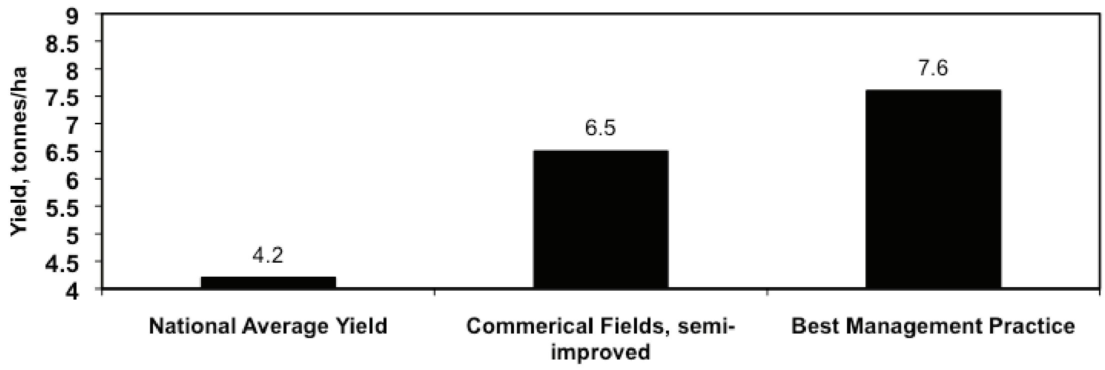
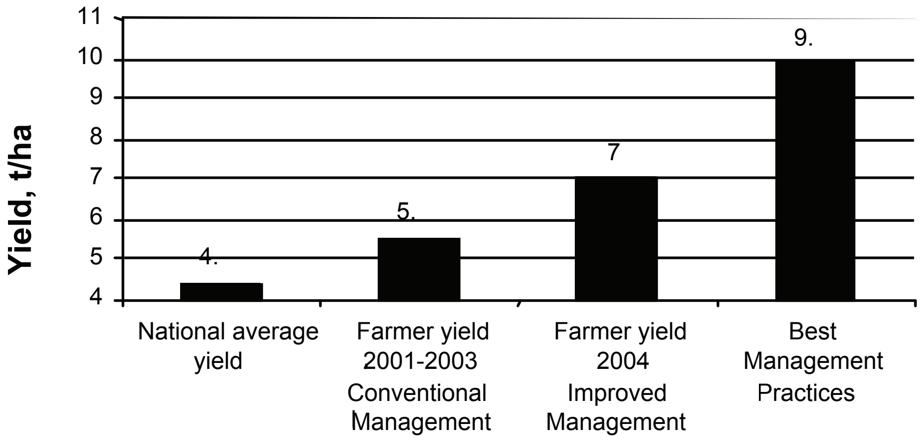


FIGURE 5.
Yield of irrigated rice in Nicaragua under various levels of crop management



greater than the national average under irrigated conditions). In the second season, the same technology was extended to four commercial farms. The average yield of the "best management practice" farms was 9.9 tonnes/ha (Pulver, Bejarano and Mendez, 2005). Participating farmers also began utilizing the technology and reported an average yield of 7.4 tonnes/ha. These yields are 3 to 5.5 tonnes/ha greater than the national average (Figure 5).

III.3 African case study

The system of rice intensification (SRI) was developed in Madagascar in 1986 and has recently been spreading to Asia (Stoop, Uphoff and Kassan, 2002 and 2004; Stoop, 2003; Uphoff, 2005). SRI is based upon early transplanting of clean seedlings, careful attention to transplanting to avoid root injury, transplanting at pre-determined spacing (0.25 × 0.25 m in unfertile soil and up to 0.50 × 0.50 m in fertile soil), frequent hand weeding before canopy closes, use of large amounts of compost or organic amendments, and intermittent irrigation to maintain the soil constantly moist during the vegetative stage followed by flooded conditions during reproduction. The SRI system has been called unconventional even though the technology employed has been well known for decades (Doberman, 2003; Sinclair, 1993; Sheehy *et al*., 2004). Use of high quality seed is known to provide a yield advantage of 10 to 15 percent; transplanting before the 4-leaf stage increases yield by approximately 16 percent (Balasubramanian *et al*., 2005); a weed-free environment is essential for high yields; and numerous sources of organic matter contain sufficient nutrients for high yields if applied in sufficient quantity.

Intermittent irrigation is feasible if weeds can be controlled manually. Intermittent irrigation has been practised for decades in the Tolima area of Colombia and high yields are the norm, often exceeding 10 tonnes/ha. However, weed control costs often reach US$400/ha due to dependence on chemical weed control and the need for repeated applications in the absence of flooded conditions to provide residual weed control. This does not appear to be a limitation for small farms, which are the focus of the SRI programme and where frequent hand weeding is feasible. Management of inorganic N fertilizer (urea) is a major problem without the water control provided by flooded conditions. Ammonia volatilization is a huge problem with surface applications of urea; it can be significantly reduced by applying urea on the dry soil surface followed by establishing a permanent flood to prevent nitrification/denitrification. In contrast, nutrients derived from the degradation of organic compost are essentially “slow release” with minimum losses. Some composted materials contain high levels of nutrients (e.g. chicken manure), and if applied in sufficient quantity they provide adequate nutrients to support high yields. However, not all compost is rich in nutrients, especially N. Given the wide variation in nutrient content of diverse compost, the SRI programme requires a more precise definition of suitable organic compost.

III.4 Summary of case studies

The case studies from several countries in Asia, Latin America and Madagascar implemented under distinct socio-economic settings, employing different technologies and methods of transfer have several features in common:

1. High yields of irrigated rice are readily obtainable with improved crop practices utilizing current varieties. Yields in on-farm demonstration plots and commercial area in southern Brazil routinely surpass 10 tonnes/ha and yields as high as 12.3 tonnes/ha have been obtained. Yields in Venezuela in the dry season often surpass 10 tonnes/ha in large areas. In Nicaragua, yields of over 12 tonnes/ha have been recorded in on-farm demonstration plots. In the Philippines, a yield of 11 tonnes/ha was recorded in demonstration plots using the PalayCheck technologies. Similarly, high yields often exceeding 8 tonnes/ha have been reported in lowland rainfed rice in Indonesia when grown under improved management. The SRI programme has also reported exceptionally high yields. An eminent rice scientist stated that the yield increases due to improved crop management are comparable to the yield advances experienced during the Green Revolution and referred to the advances occurring in crop management as the “Agronomic Revolution” in rice (Jennings, 2004).

2. Observations from Asia and Latin American countries indicate that varieties are not the only limitation to improved yield. Currently available varieties are capable of yielding over 10 tonnes/ha and farmers are exploiting less than 50 percent of the yield potential of available genetic material. The yield gap – the difference between yield potential and actual yield – is due to lack of application of improved crop management practices. New genetic material will only be beneficial if accompanied by improvements in crop management; otherwise, yield expression will be limited by deficiencies in crop management, as has been the case since the Green Revolution. On the other hand, improved crop management offers the opportunity for plant breeders to develop genetic material with higher yield potential. For example, FLAR breeders, recognizing the yield limit of current varieties, have adjusted their breeding programme to focus on identifying genetic material with higher yield potential to link to improved crop management.

3. High yields are more feasible in more favoured ecologies. Irrigated areas are easier to impact than less favoured ecologies; albeit, advances have also been reported in the lowland rainfed ecology. Within the irrigated sector, high yields are dependent upon adequate solar radiation. Yield advances are more frequently recorded during the dry season in the tropics or in temperate environments, where solar radiation is not a yield-limiting factor. Yield during the wet season in the tropics is limited, most probably due to low levels of solar radiation. All high-yielding environments, such as California, Australia, Egypt, coastal Peru and the southern cone of South America, also exhibit high levels of solar radiation. Under tropical conditions, adjusting the planting date to encounter high solar radiation during the critical phase of panicle initiation to flowering is one of the primary factors resulting in high yields reported in the case studies in Latin America.

4. Focusing production during the dry season and under irrigation presents opportunities for alternative uses of land resources during the wet season and in less productive ecologies. At current rice prices, production during the low-yielding wet season and in stressed ecologies may often not be economically viable. Rice prices have been declining for decades and as production and consumption equalize, there will be more pressure for lower paddy prices (Dawe, 2004). The low level of return on labour in rice production often confines farmers to poverty. Use of simple water harvesting techniques permits production during the high solar radiation dry season. Also alternative land use and income-generating practices are required. Fish production may provide more income than rice during the wet season. Livestock rotated with rice is an attractive alternative in many areas and is already widely practised in the temperate regions of Latin America. In Asia, traditional thinking encourages rice production during the monsoon season since rice can tolerant excessive water. However, further yield improvement during the wet season may be limited due to the low level of solar radiation. More thought is required to identify alternatives to rice farming during the solar-radiation-limiting wet season and other less favoured ecologies.

5. To date, the efforts in integrated crop management have been carried out mainly by FAO and some government institutions in four Asian countries, by IRRI and institutions in India, and by FLAR in Latin America (as well as growers associations in a number of countries). The transfer of SRI was carried out by conservation groups and NGOs. Traditionally, technological developments in rice were derived primarily from research activities at the CGIAR centres. The CG system may have over-emphasized variety development at the expense of crop management following the success of the Green Revolution resulting in a missed opportunity and decades of yield stagnation, especially in the high-yield-potential irrigated system (Jennings, 2004).

Variety improvement merits sustained attention in order to address the yield potential barriers. Varieties with higher yield potential will be essential for a sustainable increase in rice production under conditions of diminishing land and water resources and taking into account the potential impacts of climate changes such as high temperature regimes and increased area under tidal influence due to the rising sea level. The achievement of mapping the rice genome in 2002 creates new opportunities for the application of genetic resources in rice variety improvement by allowing scientists to identify and functionally characterize the genes and biochemical pathways that are responsible for agronomic performance, resistance to biotic and abiotic stress and consumer quality (Khush, 2004).

III.5 Outstanding issues in extension of crop management practices

Efficient and effective technology transfer programmes. The case studies provide convincing evidence that there are major differences between the transfer of improved crop management practices and simply introducing new varieties. Seed-based technologies are relatively easy to introduce and expand due to farmer-to-farmer exchange of seed. In contrast, improved crop management is “knowledge-based” and considerable effort is required to educate growers. Farmer-to-farmer exchange is often important but must be accompanied by a continuing educational process. Agronomic practices are not “fixed” like genetic traits and must be modified for different environments and frequently refined for distinct conditions within a particular farm. This requires in-depth knowledge of crop management by the farmer. How to teach millions of farmers with varying degrees of education remains a major challenge facing the rice sector.

Attention and resources have been directed towards the spread of high-yielding varieties. International germplasm testing programmes have been operative for decades. In contrast, there has been little attention to crop management and the identification of effective and efficient technology transfer programmes. The rice sector has limited knowledge of the farmer decision-making process, methods of educating growers, and means of sustaining extension activities, with the result that there is much “trial and error” in technology transfer. There are several examples of successful technology transfer programmes that are suitable for particular socio-economic settings, but it would be naïve to assume that systems developed in one particular country will function similarly in other countries with distinct socio-economic conditions. However, even with these limitations there are concepts that may be applicable to successful technology transfer programmes. These universal concepts need to be more clearly identified, adjusted to particular socio-economic conditions and assembled into a structured extension service. It is recommended that the International Rice Commission and its partners take a lead role in defining more efficient and effective technology transfer programmes to extend the use of improved crop management practices.

Improved N management. N fertilizer is an essential ingredient for high yields in rice production. Increased costs for N-based fertilizer present a serious problem for advocating adequate N rates for high yields, and the environmental consequences of inefficient use are also a major concern The problems associated with low N efficiency were highlighted at the Twentieth Session of the Commission. In Asia, FAO, IRRI and some member countries have promoted the use of the leaf colour chart for N top-dressing. Programmes in Latin America have incorporated practices to enhance high N fertilizer efficiency in the technology transfer efforts. SRI also places emphasis on more efficient N management through the use of organic compost. Technologies for N efficiency are available and need to be a component of all technology transfer programmes. In many African countries, high fertilizer prices make highly efficient management practices essential in order to compete with imported rice.

Research in crop management. Research in agronomy has not received the attention required; there is an imbalance in resource allocation which favours genetic improvement. This appears to be a consequence of the success of the Green Revolution, but the substantial decline in the growth rate of rice yield indicates that factors other than varieties are limiting yield. A host of factors require further research, for example, nutrient management for high yield, the role of climatic factors, date of planting, irrigation water management, and pest and disease control. Research on identifying improved crop management practices is out of date or lacking at both international and national level. Agronomic constraints to improved production are often erroneously thought to be "site specific", precluding a concerted research effort at the international research centres. However, recent efforts show that the major constraints to improved crop management are widespread and it is inefficient to address the factors on a country-by-country basis without networking and sharing experiences.

IV TECHNICAL OPPORTUNITIES FOR SUSTAINABLE RICE PRODUCTION IN THE MEDIUM TERM (2006-2010)

The current challenge is to find ways to continue increasing yields without putting pressure on the environment. Farmers who adopted high-yielding rice varieties obtained a major increase in yield but it was a one-time event; that is, once the new varieties were adopted there was no subsequent yield increase. The spread of rice cultivation into new areas, such as sub-Saharan Africa, presents yet another challenge to the scientific community. Even with the increased amount of land dedicated to rice, production has not kept pace with demand. This is further complicated by the low-input production systems in sub-Saharan Africa. Low-input results in low yield and subsequently high-cost-per-unit output. With this scenario it is difficult for small, poor farmers to compete in the market place against cheaper imported rice. Some low-lying areas in Asian countries with monsoon rainfall patterns are not suited for growing anything but rice in the rainy season. Trends certainly indicate that the demand for rice will continue to grow, but the issue is how to maintain small farmers in rice production if yields are so low that they cannot compete in an open market situation.

Improved field management can result in significant yield increases, comparable to the advances witnessed during the Green Revolution. However, in order to improve management, farmers must be exposed to the new crop management technology and this implies considerable resources for extension and farmer training. In addition to the closing of the yield gap with efficient transfer of improved crop management practices, as discussed above, there are also readily available technical options for assisting rice farmers. The most prominent are described below.

IV.1 Hybrid rice

Hybrid rice was first cultivated commercially in China in 1976 and yielded approximately 15 percent more than high-yielding varieties. Most recently, "super hybrids" have been developed that further increase yield by 20 percent. Hybrid rice increased annual production in China from about 128 million tonnes in 1975 to 191 million tonnes in 1990 (i.e. an increase of more than 60 million tonnes), while during the same period, the rice harvested area was reduced from 36 to 33 million ha. In 2004, more than 15 million ha in China and 1.5 million ha in other areas of Asia were planted with hybrid varieties. The area planted to hybrid rice in Asian countries outside China, however, represents only a small fraction of the total rice area (Table 5), indicating the major potential for adoption of hybrid rice to increase rice production. Outside Asia, hybrid rice varieties have also been successfully developed and used in the

TABLE 5: General situation of the commercial hybrid rice cultivation in Asian countries outside China, 2002-04

	Hybrid rice area (ha)			National rice area in 2004 (million ha)	% national area covered by hybrid in 2004
	2002	2003	2004		
Viet Nam	500 000	600 000	650 000	7.40	8.8
India	200 000	290 000	560 000	42.50	1.3
Philippines	27 943	-	192 000	4.00	4.8
Myanmar	1 294	54 656	54 656	6.00	0.9
Bangladesh	-	-	40 000	11.00	0.4
Indonesia	-	-	875	11.70	n.a.
Sri Lanka	-	-	15	0.75	n.a.
Total	-	-	1 497 546		

Source: Nguyen, 2005.

United States of America (Way, 2004). Recently, hybrid rice varieties suitable for a subtropical climate have been successfully developed in Egypt (FAO, 2003b). However, the high price of F1 seeds due to limited production remains a serious limitation to the widespread use of hybrids. Genetic uniformity and vulnerability remain a concern with current hybrids due to a common source of cytoplasmic male sterility.

IV.2 New Rice for Africa (NERICA)

NERICA rice was developed by plant breeders at The Africa Rice Center (WARDA), combining African rice varieties already adapted to the local environment with Asian varieties that have high yield potential. NERICA is drought-tolerant and can increase yield by 30 percent over traditional African varieties (Jones and Wopereis-Pura, 2001; Defoer *et al*., 2004). Its short growing season (approximately 15 days shorter than that of other varieties) is especially important in sub-Saharan Africa where farmers can schedule their planting and harvesting to take advantage of the short rainy season in drought-prone areas. This also allows farmers to grow a second crop (e.g. legumes) that, when alternated with rice, helps maintain soil fertility. Although developed mainly for the rainfed uplands, researchers hope to develop other varieties of NERICA for irrigated and lowland systems. West and Central Africa boast some 20 million ha of inland valley swamps which are well suited for rice production, but less than 20 percent is used at present. With the initial support of the United Nations Development Programme (UNDP), WARDA and FAO, the governments in sub-Saharan Africa established the Africa Rice Initiative (ARI) in 2002 to promote the dissemination of NERICA rice. Recently the African Bank of Development approved a US$35 million multinational project for NERICA dissemination in sub-Saharan Africa (Akintayo, 2005). Also, the Government of Japan has approved funding support for the FAO projects on the dissemination of NERICA and improved rice technologies in Ghana, Sierra Leone and Uganda.

IV.3 Progress in advanced breeding and rice biotechnology

Advances in rice research and biotechnology are crucial for raising the yield potential of rice. The development of new plant type (NPT) and C-4 rice aims to increase the yield potential of tropical rice to about 12 to 13 tonnes/ha. Recent efforts have resulted in only limited success (Khush, 2004). FLAR breeders are now also developing new plant types with higher yield potential to respond to the advances in agronomy. These new types are based upon large panicles. Wide crosses involving wild relatives of *Oryza* offer promise for incorporating traits not found in *Oryza sativa* and perhaps increased yield potential (Khush, 2004). Recurrent selection strategies have also been used by a number of countries in Latin America and the Caribbean for improving traits such as cold tolerance, grain quality, disease resistance and yield potential. More than 20 broad genetic base populations with different characteristics have been created by the national programmes; in 2002 Brazil released the first irrigated rice variety (SCSBRS 113-Tio Taka) out of a population breeding strategy, and in 2005 Bolivia released the second one. Breeding programmes in France and China already have population improvement as part of their breeding portfolio (Guimaraes, 2005).

The entire genome of rice has been sequenced and this has allowed the identification of thousands of DNA markers that are simple-sequence repeat (SSR), best known as microsatellite markers. Since the introduction of the modern high-yielding varieties, many breeding programmes have employed a genetically narrow gene pool. There are SSR markers available for many other traits, and there are numerous research programmes working to discover the function of rice genes. This type of information will allow the widespread development of Single Nucleotide Polymorphisms (SNPs), which are highly specific markers that are amenable to very high-throughput analysis.

Marker aided selection (MAS) is amenable to high-throughput analysis and sufficient polymorphism can be found for the parents of most crosses, enabling breeding to expand the genetic base (Coffman, McCouch and Herdt, 2004). Several molecular markers for disease and pest resistance are available including markers for both major and minor resistance genes for rice blast, rice bacterial blight (*Xanthamonas oryzae*) and planthopper. Rice hoja blanca is an important disease in LAC and is costly to screen in the field. Already one potential marker has been identified for resistance to this disease. The MAS technologies are being used in only a few advanced laboratories. As more information on resistance to biotic and abiotic stresses as well as on important agronomic characteristics emerges, the use of MAS will become more compelling. The question is not will MAS become an important standard activity in rice breeding programmes, but when will it be economical to employ the technology in high-volume rice breeding programmes.

Rice does not normally produce vitamin A and Golden Rice was developed to alleviate vitamin-A deficiency. It was developed by inserting two daffodil genes and one bacterial gene into the rice genome. This allows the production of beta-carotene in rice grain. The resulting plants are normal except that their grain is a golden-yellow colour due to the presence of provitamin-A (Potrykus, 2003). Rice hoja blanca virus (RHBV) is a major viral disease of economic importance affecting rice in northern South America, Central America and the Caribbean. Transgenic plants with the RHBV nucleoprotein viral gene are available and have been crossed with the commercial variety, Fedearroz 50 (Lentini *et al*., 2003). Field evaluations indicated that six fixed, transgenic lines were more resistant than Fedearroz 2000, the most RHBV-resistant commercial variety. The transgenic lines express low levels of RNA, which is detectable only by RT-PCR, and the RHBV nucleoprotein is not expressed in these plants, thus suggesting a very low risk, if any, for environmental and food safety concerns.

While the deployment of transgenic rice varieties for commercial production is still limited, there are many field experiments throughout the world. Herbicide resistance and stem borer resistance (Bt) are widely deployed in commercial cotton, maize and soybean. Herbicide resistance using mutants, which are not transgenic, is currently used on a wide scale in southern Brazil, the United States of America and parts of Colombia and Costa Rica. Mutant-herbicide resistance offers the opportunity to effectively control red rice, a major problem throughout LAC. New herbicide resistance based upon transgenic technology will soon be available, but commercialization remains a question. Resistance to abiotic and biotic stresses using genetic transformations continues to be pursued by several laboratories.

Commercial use of the new technology is complicated by intellectual property rights issues, public acceptance of GMOs and difficulties involving trade of transgenic material. The technology is much more advanced than is public acceptance and perception. Advanced breeding and biotechnology methods are available. However, the results of an FAO study show the need for urgent capacity building in developing countries in order to take full advantage of the new technologies.

V THE WAY FORWARD

The advances in crop management and corresponding large yield increases reported by various organizations in different countries and continents present new opportunities, especially in the irrigated sector. Technological factors and methods *per se* do not appear to be the primary factor limiting production increases but deficiencies in application of technology transfer hinder the spread of known technologies to large numbers of farmers. There are diverse methods of technology transfer. Several programmes are operative using different methodologies and strategies and involving a range of institutions/agencies. New partnerships are evolving that offer unique opportunities. Development of appropriate technology transfer systems for distinct socio-economic settings involving a range of actors represents the next challenge in the rice sector.

Higher yields and lower production costs with minimum harmful effects on the environment are imperative for more competitive production in a global market that is increasingly environmentally sensitive. Improved crop management can result in significant yield and production increases on less land and water, which offers the opportunity for diversification of the rice-based systems, for example, rotation of rice with fish, rice with livestock, rice with a range of other crops in order to spread risk but also to increase income and to improve human nutrition. New paradigms are emerging that require innovative ideas in technology transfer, more efficient use of resources and alliances with new partners.

As the yield gap in rice production is narrowing with improved crop management, a new generation of rice varieties will be needed for sustainable rice production. The progress in plant breeding and rice biotechnology should be harnessed for generating rice varieties with not only high yield potential but also good taste, eating quality and added nutrients. This will require a broad and strengthened partnership among the international institutions, public institutions, private sector and non-governmental organizations.

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APPENDIX G
REPORT OF THE EXECUTIVE SECRETARY ON THE IMPLEMENTATION OF THE COMMISSION'S TWENTIETH SESSION RECOMMENDATIONS

Mr Nguu Van Nguyen

I INTRODUCTION

The Twentieth Session of the International Rice Commission was held from 23 to 26 July 2002, in Bangkok, Thailand during which the Commission confirmed its support to the efforts of member countries and FAO with a view to having the United Nations declare 2004 the International Year of Rice. The Commission's Secretariat worked for the United Nations declaration together with member countries and partners. On 16 December 2002, the United Nations General Assembly (UNGA) declared 2004 the International Year of Rice (IYR) and requested that FAO facilitate its implementation. The dedication of an International Year to rice, a single crop, is unique in the history of the United Nations.

The Twentieth Session also made a series of recommendations to its member countries, CGIAR (Consultative Group on International Agricultural Research) centres, FAO and others involved in enhancing sustainable rice production, especially in the area of rice integrated crop management. This report covers the following areas: the International Year of Rice and its implementation; the implementation of other recommendations of the Twentieth Session, especially with regards to the development and dissemination of rice integrated crop management systems; and the regular activities of the IRC Secretariat.

II THE INTERNATIONAL YEAR OF RICE: ITS IMPLEMENTATION AND RESULTS

In 1999, FAO and the International Rice Research Institute (IRRI) joined forces to focus international attention on the rice industry and its role in achieving global food security. With the support of the member countries of the International Rice Commission, especially the Philippines, the FAO Conference at its 31st Session approved Resolution 2/2001 calling for the United Nations to declare the International Year of Rice in 2004. The UN General Assembly at its 57th Session in December 2002, noting that rice is the staple food of more than half of the world's population, and reaffirming the need to focus world attention on the role that rice can play in providing food security and eradicating poverty in the attainment of the internationally agreed development goals, including those contained in the Millennium Declaration, declared 2004 the International Year of Rice (IYR).

The IRC Secretariat, FAO technical units and members of the IRC Steering Committee, dedicated time and resources to facilitating the preparation and implementation of IYR in collaboration with Member Governments, the United Nations Development Programme (UNDP), CGIAR, other relevant organizations of the UN System, non-governmental organizations (NGOs), the private sector and other civil bodies worldwide. The IYR implementation in 2004 was remarkably successful.

II.1 Preparation for the implementation of the International Year of Rice

In January 2003, the FAO Steering Committee of the International Rice Commission (IRC) met at FAO Headquarters in Rome and established the FAO IYR Organizing Committee. The IRC Secretariat also organized in March 2003 the Informal International Planning and Coordination Meeting for IYR. This meeting established the Informal International Working Group (IIWG) for IYR, with representatives from 17 rice-producing and consuming countries as well as six UN agencies, five CGIAR centres, NGOs and the private sector, in order to provide guidance to the planning of and preparation for IYR implementation.

The Informal International Working Group selected *Rice Is Life* as the slogan for the Year. The mission of the International Year of Rice was to promote improved production and access to this vital food crop, which feeds more than half of the world population while providing income for millions of rice producers, processors and traders. The development of sustainable rice-based systems will reduce hunger and poverty and contribute to environmental conservation and a better life for the present and future generations for whom *Rice Is Life*.

Guided by IIWG and the FAO IYR Organizing Committee, the IRC Secretariat was strengthened in order to prepare and publish a series of documents for distribution to member countries and IYR partners, including: (1) the concept of IYR; (2) the global communication plan for IYR; (3) guidelines for national IYR committees to establish their action programmes; (4) “fact sheets” providing basic facts on sustainable rice production and global food security; and (5) a 4-minute video clip on *Rice Is Life*. The official IYR Web site (http://www.fao.org/rice2004/) was also established in order to serve as the virtual meeting place of all participants and provide an opportunity to take the message of IYR to an even wider audience. The official IYR Web site is in seven languages: Arabic, Chinese, English, French, Italian, Japanese and Spanish.

The FAO IYR Organizing Committee organized several events to promote IYR 2004 to the general public and to attract donor support prior to 2004. Briefing materials on IYR were prepared and presented to delegates of major FAO bodies, including the Committee on Agriculture (COAG), Council and Conference. Senior managers of the FAO Agriculture Department and the IRC Secretariat accepted invitations to be interviewed on the issues, challenges and options for sustainable rice production, and the implementation of IYR was widely covered in the press as well as on radio and television. Other promotional materials – such as the IYR poster, 2004 IYR calendar and IYR banners – were produced and provided to organizers of IYR exhibitions around the globe.

IYR was officially launched on 30 October 2003 at the United Nations in New York. For this occasion, the FAO Director-General addressed the Economic and Social Committee of the United Nations (ECOSOC), highlighting the need to increase rice production while decreasing pressure on the diminishing land and water resources – complicated tasks that he said could only be achieved by a global community working together.

II.2 The implementation of the International Year of Rice in 2004

In 2004, more than 800 activities were implemented in 68 countries on five continents to celebrate IYR. The IYR events in 2004 took on various forms, such as conferences, meetings, symposiums, field days, festivals, fairs, exhibitions, popular contests and cooking demonstrations at all levels (global, regional, country and local). The IYR events were organized by government institutions, UN agencies, CG international institutions, NGOs, the private sector, youth and religious groups, and farmers’ associations. The participants of IYR events came from all walks of life. Detailed information of the implementation of IYR in 2004 can be found in the report to the United Nations. A synthesis of the report is provided below.

II.2.i Global events

The major IYR events at global level are listed below:

- **International Rice Conference,** FAO. In February 2004, over 500 policy-makers, rice specialists and rice industry representatives from 90 countries participated.
- **IYR Global Scientific Contest**. The Global Scientific Contest was coordinated with the invaluable support of IRRI. Submissions were received in two categories: Rice Crop Management (rice agronomy) and Rice Crop Improvement (plant breeding, including rice biotechnology). Over 200 entries were received on a variety of rice-related issues. Two scientists, one from China and one from Japan, won the award.
- **IYR Global Photography Contest.** The IYR Global Photography Contest, *Rice Is Life*, was conceived as part of a broad publicity campaign. More than 460 entries from 53 nations qualified for the contest that was judged by a panel of professional photographers and rice experts, including two members of IIWG.
- **World Food Prize International Symposium**. In October 2004 the World Food Prize, awarded annually by the State Department of the United States of America, went to Professor Yuan Longping for his role in the successful development of hybrid rice, and Dr Monty P. Jones for his achievement in developing NERICA rice.

- **World Rice Research Conference**. The Conference was organized by the Japanese Ministry of Agriculture, Forestry and Fisheries from 4 to 7 November 2004 in Tokyo and Tsukuba. More than 1 200 of the world's leading rice researchers and scientists participated in the Conference and exchanged information on the latest breakthroughs and ideas that could benefit the world's millions of rice farmers and consumers and help to develop improved livelihoods.
- **CropLife International Symposium, Belgium**. CropLife International organized in December 2004, a symposium called "Rice and Brussels Sprouts". The symposium was held in Brussels to examine the future of the rice crop in terms of improving its production and enhancing nutrition.

II.2.ii Regional and national events

All FAO Member Nations had the opportunity to discuss the potential and constraints of sustainable rice production during their 2004 FAO regional conferences: Africa (March, Johannesburg, South Africa), Asia and the Pacific (May, Beijing, China), Europe (May, Montpellier, France), Latin America and the Caribbean (April, Guatemala City, Guatemala) and the Near East (March, Doha, Qatar). The other major IYR events are listed below.

Major IYR events in Asia and the Pacific. In a historic show of support for the goals of IYR, the leaders of all ten member governments of the Association of Southeast Asian Nations (ASEAN), plus China, Japan and the Republic of Korea, signed the IYR poster during the Summit meeting held on 13 January 2004 in Jakarta, Indonesia. The Asian Development Bank (AsDB), in collaboration with its member countries and IRRI, celebrated IYR in November at its headquarters, with participation of high-level policy-makers from countries in the region. Throughout the year, IRRI hosted or co-hosted 15 regional and international conferences and workshops for delegates from some 36 countries.

A series of IYR events were also organized in Australia, Cambodia, China, India, Indonesia, Japan, the Republic of Korea, the Lao People's Democratic Republic, Malaysia, Myanmar, Pakistan, Sri Lanka, the Philippines, Thailand and Viet Nam. The most spectacular were: the Royal Ploughing Ceremony in May 2004 in Bangkok presided over by the King of Thailand; the 2-month IYR exhibition (July-August) held at the gallery of the United Nations Information Centre (UNIC) in Tokyo; and the International Rice Forum in Manila in December that attracted around 200 participants from 27 countries.

Major IYR events in Europe. Italy, Europe's largest rice producer and the host country of FAO, was deeply involved in IYR implementation; it not only provided funding to assure that developing countries had the opportunity to participate, but also organized its own celebratory events. It held 29 conferences and public events on rice and its contribution to livelihood. The University of Turin hosted the International Conference on "Challenges and Opportunities for Sustainable Rice-based Production Systems".

IYR events were also organized by public institutions, UN agencies, the private sector, NGOs and youth groups in Austria, France, Germany, Portugal, Spain and the United Kingdom. The most memorable was the special conference on "Rice as a Staple Food" organized in June 2004 by the Oldenburg Model United Nations, established by young, motivated senior high school students.

Major IYR events in Latin America and the Caribbean. The Brazilian Agricultural Research Corporation (EMBRAPA) organized a conference on "Genetic Development of Rice in Latin America and the Caribbean" to examine the current advances in rice crop improvement technologies and to formulate regional initiatives for sustainable rice production. The International Centre for Tropical Agriculture (CIAT) and its Latin American Fund for Irrigated Rice (FLAR) supported EMBRAPA and other institutions in Brazil in the organization of the "Latin American Congress on Rice Economics" held in Porto Alegre.

A series of IYR events were also organized in Colombia, Costa Rica, the Dominican Republic, Guatemala, Honduras, Peru, Uruguay and Venezuela. The most exciting event was the large festival in Costa Rica held at el Paseo Colón, in San José, during which 272 kg of rice were cooked and offered free of charge to 5 000 people.

Major IYR events in the Near East and North Africa. Egypt's Agricultural Research Centre organized in Alexandria a conference on "Advanced Rice Research" for scientists and policy-makers in the Near East region to examine the current state of rice research and to focus on ways to assure that farmers obtain the highest production possible from their fields. In the Republic of Iran, 290 paintings on different aspects of rice were made by elementary school students in Teheran, while the workshop on "Sustained Food Security – Priority Research Agenda for Decades Ahead" was held in July at the Agricultural Biotechnology Research Institute in Karaj.

Major IYR events in North America. In the United States of America, the Fowler Museum of Cultural History organized an exhibition on "Rice and its Culture" during which the American Center for Wine, Food and Arts participated with a theme on "The Art of Rice: Spirit and Sustenance in Asia". Yale University organized a symposium on "The Future of Rice Biotechnology: Scientific Advances and Policy Issues", while in Arkansas, the time capsule, which was sealed in 1954 at the Carlisle Elementary School to commemorate the first Arkansas rice crop, was opened in October to celebrate IYR and the centennial of rice cultivation in Arkansas. In Canada, the Dundas Studio Tour 2004 exploring the theme of rice as a symbol of cultural identity and global unity was organized, and a food drive for a local food bank with emphasis on rice was held.

Major IYR events in sub-Saharan Africa. The Pan-African celebration of IYR took place at the International Conference Centre in Accra with the theme "*Rice Is Life* for Africans". The celebration attracted 600 participants including ministers of agriculture, senior officers and heads of government departments, participants from international scientific institutions and representatives of diplomatic missions in sub-Saharan Africa. The Africa Rice Center (WARDA) organized the Third Biennial Regional Rice Research Review for rice researchers from national research systems in sub-Saharan Africa to review and formulate strategies to improve rice productivity in the region.

IYR events were also organized in Burkina Faso, the Democratic Republic of Congo, Côte d'Ivoire, the Gambia, Kenya, Liberia, Madagascar, Nigeria, Senegal, Sierra Leone and Uganda. The most important events included: the field day to celebrate IYR in Nigeria with the participation of the President of the Federal Republic, his cabinet and civil and religious leaders; and the month-long rice festival including Malagasy art and culinary demonstrations held in November in Madagascar.

II.3 Major achievement of the implementation of the International Year of Rice in 2004

The implementation of IYR was remarkably successful. It raised awareness among the global population of the role that rice can play in providing food security and eradicating poverty. Also, it generated considerable information on rice technologies and other aspects of rice-based production systems.

II.3.i Raising awareness, understanding and support

The implementation of IYR raised awareness among all stakeholders of the contribution of rice-based systems to world peace through enhancing food security, reducing poverty and conserving the environment and natural resources. Governments and donors now have enhanced awareness of the need to support new rice initiatives. At their 26th Annual Meeting in October 2004, the Ministers of the Association of Southeast Asian Nations endorsed in Yangon, Myanmar, a 10-year research plan that focuses on three major challenges of rice production in the region, namely, water shortage, global warming and inadequate human resources. The Asian Development Bank has funded a project since 1998 on sustaining food security in Asia through the development of hybrid rice technology and approved, in 2004, funding support for the implementation of a 3-year project on "Enhancing farmers' income and livelihood through integrated crop and resource management in rice-wheat systems in South Asia". In sub-Saharan Africa, the African Development Bank approved funding support to promote NERICA development and sustainable use in West Africa.

II.3.ii Information generation and dissemination

An investigation using the Google search engine indicated that about 200 Web sites and pages worldwide linked to the official IYR Web site. IYR witnessed a phenomenal proliferation of books, proceedings, journals, magazines, reports of workshops on CD, CD movies and calendars. All in all, there were 30 major books and proceedings published, as well as some 18 articles in scientific journals, magazines and periodicals, in addition to a variety of other information material. In particular, the book Rice around the World in 300 Recipes was published by the UN to commemorate IYR. The book was the product of a joint project of the Geneva-based UN Special magazine, the UN, the World Health Organization (WHO) and FAO.

II.3 iii Promotion of global fight against poverty

IYR officially ended on 31 December 2004, but for the billions of people who rely on rice for their lives and livelihoods, the positive effects of the year's activities will continue to be felt. The consensus that grew throughout the implementation of IYR recognized the need for new ways of thinking about the future of rice and rice-based systems, and the renewal of commitment from all stakeholders. Rural people (as well as consumers) need to feel secure about the future of rice production, and that security will only come from the development of technologies, economic models and investments that keep pace with the changing patterns of human development. It also requires the continued support of all the people in the rice industry, especially policy-makers and funding donors for the efficient transfer of existing technologies to improve productivity at field level as well as the development of new technologies and innovations for sustainable rice development. The report of the implementation of IYR was presented at the 60th Session of the UN General Assembly in November 2005. In its Resolution, the Second Committee on Poverty Eradication of the 60th UNGA Session recognized the contribution of the implementation of IYR in 2004, highlighting:

> *"the important contribution that the observance of the International Year of Rice, 2004, has made in drawing world attention to the role that rice can play in providing food security and eradicating poverty in the attainment of the internationally agreed development goals, including the Millennium Development Goals."*

III IMPLEMENTATION OF THE RECOMMENDATIONS OF THE TWENTIETH SESSION

In addition to its support for the International Year of Rice, the Twentieth Session also made several recommendations to member countries, CG centres, FAO and other UN agencies. The Secretariat of the International Rice Commission and the members of the FAO Steering Committee of the Commission have devoted considerable effort to implementing the recommendations, with priority given to the development and dissemination of rice integrated crop management (RICM) systems for productive and environmentally friendly production.

III.1 Development and dissemination of rice integrated crop management (RICM) systems

Over the last 4 years, in Asia, the FAO Secretariat of the International Rice Commission has worked with government institutions in Indonesia, the Philippines, Thailand and Viet Nam to develop and disseminate RICM systems as a pilot test for possible implementation in other countries. In Latin America, the activities were carried out in collaboration with a para-public/farmers'-association-led FLAR in Brazil and Venezuela, with funding support from the Common Fund for Commodities (CFC) since 2002. The detailed results of these initiatives formed the main part of "From Concept to Practice" in the Keynote Address and in the following presentations from FLAR at this Twenty-First Session. There follows an outline of the major results of the development and dissemination of RICM systems:

- **Effect of RICM systems on irrigated rice yield.** Positive effects of RICM systems on rice yield were reported in most cases.
  - In Indonesia, the application of the RICM system increased the yield of rice crops planted in 25 out of 26 villages in the three cropping seasons during 2001-02. A yield increase of 20 percent or more above 5 tonnes/ha due to the application of RICM was observed in 12 villages.
  - In the Philippines, full compliance with the eight checks as specified in the PalayCheck system resulted in yields of over 8 tonnes/ha compared to an average of 4.5 tonnes/ha with conventional crop management systems. The more key checks farmers successfully achieved, the higher the yield they obtained.
  - In Thailand, the Thai RiceCheck helped farmers in Pathumtani, Prachinburi, Sakhon-Nakorn and Phitsanulok to increase yield by an average of 26.7 percent.
  - In Brazil, adoption of just one practice – seeding on the appropriate date – led to an increase in rice yield of as much as 30 percent.
  - In Venezuela, excellent yields, often exceeding 9 tonnes/ha were obtained from RICM demonstration plots in Calabozo Portuguesa during the 2003/04 dry season.

- **Effect of RICM systems on the cost and profit of irrigated rice cultivation.** The Thai RiceCheck reduced cultivation costs by an average of about 16.8 percent. Similar reduction in the cost of rice cultivation was obtained with the Vietnamese system, "3 Increases, 3 Reductions". The application of RICM in Indonesia, however, increased cultivation costs in 7 districts and reduced them in only 3 districts. Economic analysis of data from the adoption of RICM systems in Indonesia and Viet Nam showed that the profit of rice cultivation increased with the application of RICM systems. In Brazil, the application of RICM led to an increase in economic return of more than US$31 million (or US$19 317 per participating grower). In the Philippines, the results showed that farmers who achieved eight crop management areas as measured by the key checks in the PalayCheck system had an average gross margin of US$828 per ha, while farmers who achieved only three crop management areas had an average gross margin of US$421 per ha.

III. 2 Recommendations of the Asian Expert Consultation Workshop, 28 February – 2 March 2005, Ho Chi Minh City, Viet Nam

The Consultation Workshop on Rice Integrated Crop Management Methodology – RiceCheck was organized under the framework of the Trust Fund project – GCP/INT/933/ITA Promoting, Coordinating and Implementing Observance of the International Year of Rice 2004 – to provide continuity of IYR implementation. It was also a collaborative effort between FAO and the Ministry of Agriculture and Rural Development (MARD) of Viet Nam. The workshop was attended by 50 experts from Australia, Cambodia, Fiji, Indonesia, Japan, the Philippines, Sri Lanka, Thailand and Viet Nam. It was agreed that there is a need to upscale and further develop, adapt and disseminate RICM systems throughout the developing world for Good Agricultural Practices in rice-based production systems for healthy/safe food, sound environment, farming productivity and economics. The following recommendations were made:

1. All participating countries should introduce, develop and evaluate RICM systems as a means of improving yields and profitability for food security, livelihood improvement and environmental conservation.
2. A regional RICM workshop should be held in Southeast Asia in 2007 to share experiences in the development and application of RICM systems.
3. Administrative procedures, particularly research and extension, should be put in place to involve and integrate all stakeholders for the successful development and application of RICM systems.
4. Participating countries should adapt, develop and evaluate an RICM system using a range of approaches and experiences.
5. RICM systems should be adapted to other crop enterprises to assist in the diversification of rice-based farming systems.
6. The outcomes of RICM systems should include grain yield, grain quality, profitability and sustainable environment.
7. A short course (3-5 days) should be developed for training frontline and supervisory research and extension officers in participating countries in RICM concepts and principles, in practices of RiceCheck and other approaches, and in related extension methodology, in particular group facilitation and dynamics.
8. Participating countries should formulate and undertake a pilot project to develop and evaluate an RICM system suitable for their local situation.

III.3 Lessons learned from the activities of the last 4 years

The experiences gained from the development and dissemination of RICM systems led to the following observations and conclusions:

- Full yield potential (10 tonnes/ha or more) of existing rice varieties is obtainable without additional cost by application of RICM systems.
- Highest rice yields are obtained when solar radiation is high during the last 45 days of the crop; determination of the correct date of planting should, therefore, be an essential component of RICM systems.

- Successful RICM systems will occur only where governments, NGOs, research and extension officers, and farmers work together to achieve common outcomes. All parties must learn about RICM systems.
- Successful RICM systems must include compatible and complementary extension processes to help farmers learn and use the relevant technology; these processes must be recognized by governments, and appropriate administrative structures put in place.
- Countries and/or regions have their own agro-economic and socio-ecological systems; they should develop and evaluate a range of RICM systems to suit their specific environment.
- An important consideration in developing an RICM system is to "hasten slowly". A minimum of 2 years is needed for a pilot project to develop and evaluate a preliminary local RICM/RiceCheck model, before advancing/upscaling to a medium-term plan.

III.4 Implementation of other recommendations of the Twentieth Session

In the implementation of the other recommendations of the Twentieth Session, the FAO Secretariat and members of the Steering Committee of the International Rice Commission also formulated and implemented and/or participated in field projects to assist member countries in the following areas:

- **Hybrid rice development and use.** FAO participated in the AsDB-funded project on "Sustaining food security in Asia through the development of hybrid rice technology" and implemented a Technical Cooperation Project (TCP) in Egypt. The major results of these activities were the planting of about 1.5 million ha of hybrid rice in Asian countries outside China in 2005.
- **Development and dissemination of NERICA rice.** FAO participated in the UNDP project GUI/01/006/A01/99 "Multiplication and distribution of seed of NERICA rice in Guinea". Also, three Trust Fund projects for the dissemination of NERICA rice in Ghana, Sierra Leone and Uganda were successfully formulated. The projects have already been approved by fund donors and will be soon implemented.
- **Capacity-building for seed production.** FAO implemented the following projects: (1) TCP/CMR/3002 "Support to the multiplication and distribution of good rice seed in Cameroon", (2) TCP/SIL/0167 "Emergency support to quality seed production in Sierra Leone", (3) GCP/SIL/023/GER "Development of a sustainable seed programme in Sierra Leone", and (4) OSRO/SRL/401/JPN "Emergency provision of quality seeds and rehabilitation of certified seed production to assist vulnerable farmers in conflict-affected areas of Sri Lanka".
- **Rice breeding.** FAO implemented the project TCP/RLC/3102(A) "Capacity-building in rice breeding in Latin America and the Caribbean", while FAO and the International Atomic Energy Agency implemented the following projects: (1) MYA/5/010 "Development of improved rice with tolerance to drought and soil salinity in Myanmar", (2) PAK/5/042 "Induced mutation to improve salt tolerance in non-aromatic rice varieties in Pakistan", (3) SIL/5/007 "Development of high-yielding rice varieties for low-input agricultural systems using mutation technique", (4) VIE/5/014 "Rice mutant varieties for saline soil" and (5) VIE/5/015 "Enhancement of quality and yield of rice mutants using nuclear and related techniques".
- **Weed management in rice production.** FAO implemented project TCP/RLA/2913(A) "Control del arroz maleza/rojo en áreas de arroz in Latin America".
- **Rice-aquaculture system.** FAO implemented project TCP/RLA/3003 "Introduction of aquaculture and other integrated production management practices to rice farmers".
- **Rice production in general.** FAO implemented the projects: (1) TCP/RWA/2802(A) "Intensification of rice production in Rwanda", (2) TCP/RWA/2905(D) "Support to the programme on intensification of rice production for food security in Rwanda", (3) TCP/NIR/3003 "Accelerated rice production in the Nigeria Rice Basin in Nigeria", and (4) TCP/SUD/3101 (T) "Training on improved rice technologies for the enhancement of irrigated rice production in the White Nile State in support of food security and poverty alleviation in Sudan".

IV REGULAR ACTIVITIES OF THE SECRETARIAT OF THE INTERNATIONAL RICE COMMISSION

In its support to the International Rice Commission, in addition to providing technical support for the implementation of the International Year of Rice and other recommendations of the Twentieth Session, the Secretariat also performed the following regular functions:

IV.1 Provision of forum/meetings

From 2002 to 2004, the Secretariat organized:

- Four meetings of the IRC Steering Committee, held in 2002, 2003, 2004 and 2005, to review and follow up the preparation and celebration of IYR.
- Consultation Workshop on Rice Integrated Crop Management Systems – Rice Check Methodology for Food Security, Livelihood Improvement and Environmental Conservation, from 28 February to 2 March 2005, Ho Chi Minh, Viet Nam.

IV.2 Collection, analysis and dissemination of information on rice-based production systems

The Secretariat realized the following publications and information:

- Four issues of the IRC Newsletter: vol. 51 (2002), vol. 52 (2003), vol. 53 (2004) and vol. 54 (2005).
- Proceedings of the Twentieth Session of the IRC held in Bangkok, Thailand, 23-26 July 2002.
- *Rice Is Life* – International Year of Rice 2004 and its implementation, book published to raise awareness on the role of rice in reducing hunger and poverty (hard cover).
- Report of the implementation of the International Year of Rice in five languages.
- IRC Web site (http://www.fao.org/ag/AGP/AGPC/doc/field/commrice/welcome.htm) revised and updated.
- Technical book on Promising technologies for rice production in West and Central Africa, in collaboration with The Africa Rice Center (WARDA).
- Proceedings of the regional workshop on Adoption of Hybrid Rice in Asia: Policy Support, in collaboration with IRRI and the Ministry of Agriculture and Rural Development of Viet Nam.
- Manual on Guidelines for Identification of Field Constraints to Rice Production.
- Technical book on Genetic Diversity in Rice Production.

IV.3 Support to the cooperative networks on rice

The Secretariat provided technical support to the following offices and rice networks:

- FAO Near East Office, which organized an Expert Consultation in 2003 on the transfer of hybrid rice technology and the rice integrated crop management system for food security in Near East countries.
- International Task Force on Hybrid Rice (INTAFOHR), to promote hybrid rice development and use of hybrid rice in Asia and Egypt.

V CONCLUSIONS

Since the last IRC Session, the Secretariat and members of the IRC Steering Committee have been actively involved in the preparation and implementation of and the follow-up to the events of the International Year of Rice, through numerous meetings, conferences, exhibitions, contests, publications, information development, project formulation and implementation. More than 80 countries, as well as numerous international and regional agencies, enthusiastically participated in observing and celebrating IYR. The Secretariat did its upmost to implement the Twentieth Session's recommendations, with emphasis on promoting the integrated crop management system under the Australian RiceCheck concept, with pilot trials in a few selected countries, such as Viet Nam, Thailand, Indonesia, the Philippines, Brazil and Venezuela. The initial results are very promising. The members of the FAO Steering Committee of the International Rice Commission implemented 28 projects to provide support to member countries in Africa, Asia and Latin America in their implementation of the recommendations of the Twentieth Session. In addition, the Secretariat of the Commission has also undertaken regular activities to provide a forum and information on rice-based systems to member countries.