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RICE-BASED PRODUCTION SYSTEMS FOR FOOD SECURITY AND POVERTY ALLEVIATION IN THE NEAR-EAST AND NORTH AFRICA: NEW CHALLENGES AND TECHNOLOGICAL OPPORTUNITIES

By:

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Rice-based Production Systems for Food Security and Poverty Alleviation in the Near East and North Africa: New Challenges and Technological Opportunities

by

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Introduction – A Brief Background:

The Importance of Rice

Rice is the staple food for more than half of the world's population. It is the most rapidly growing food source in Africa and is consequential to the food security of an increasing number of low-income and food deficit (LIFD) countries. In 2002, 575 million tons of rice were produced in 113 countries. The rice production in this year, however, was less than the consumption so that large quantities of rice had to be drawn from the buffer stock to meet demand. Today, there are still about 800 million people suffering from malnourishment and hunger -- achieving a sustainable increase in rice production can improve global food security and contribute to poverty alleviation.

Increasing Demand

There is a growing concern that current levels of rice production will not meet future demand. Production technology from the Green Revolution has been exhibiting diminishing returns; the 1990s saw a marked decline in yield growth rate. Since 2000, annual withdrawals from rice stocks have been necessary to bridge the gap between rice production and demand. The world population is projected to increase from 6.13 billion in 2001 to 7.21 billion in 2015 and 8.27 billion in 2030, indicating a corresponding increase in rice demand from 680 million tons in 2015 to 771 million tons in 2030.

Constraints

The intensive nature of the rice cultivation process can impact the environment. Negative effects include reduced soil fertility, water pollution and the emission of greenhouse gases. The intensive use of a limited number of high yielding rice varieties over a wide-ranging area and prolonged period of time has reduced genetic diversity. Inefficient use of agrochemicals and pesticides result in pollution and directly harm farmers' health. In addition, the current demands on land and water for urban and industrial use render the expansion of irrigated rice

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production unfeasible, especially in Asia, where more than 90% of the world's rice is produced there annually.

Water for irrigation is among the most serious constraints to rice production in the Near East. The reduced storage capacity of reservoirs, monsoon rainfall, increased demand (>50%), national policy, and the uncertainty of the monsoon and snowfall are among the many constraints to irrigation, and therefore rice-production. The development of more productive varieties, improved conservation of natural resources, and the development of more efficient technology are required to overcome this challenge.

Opportunities for Increased Production

Opportunities for a sustainable increase in rice production should be exploited. There is a sizable "yield gap" between actual and achievable yields in all Near East Countries except Egypt. This reveals an opportunity to increase the yield of both improved and traditional rice varieties through efficient production methods. Narrowing the yield gap would also lead to an increased income for rice farmers.

Increased efficiency in rice production is possible through varietal technology, advances in yield enhancement, and the successful development of hybrid technology. In Egypt, actual yield (national average) has nearly approached the potential yield; this achievement is possible throughout the Near East region. Countries with extensive scientific expertise, for example, such as Iran and Pakistan may extend their use of hybrid rice technology to improve rice yield. Similarly new rice varieties, hybrid rice, and the recent development of NERICA will help farmers achieve higher yields. It should be stressed that sustainable improvement in rice production for food security must be achieved with increased efficiency, reduced use of natural resources and minimized environmental impact.

Facing the Challenges

The challenge of overcoming hunger, poverty and malnutrition in rice-consuming countries while maintaining productivity and protecting the environment will require a coordinated effort. Increased awareness as well as national, regional and global efforts to secure sustainable rice production are essential. In addition rice research will play a major role in the efficient utilization of cultivated area, improved rice varieties, and the minimization of loss during milling. The major focus of rice research in the next decade must be the development of high-yielding and early-maturing varieties in order to ensure the conservation and efficient use of natural resources.

In order to achieve these goals, the National Rice Research Program in the Near East region should focus its research on the potential for improvement through hybrid rice, technology and biotechnology. Improved utilization of more advanced research techniques would make a significant impact on rice production.

For example, in a region with a potential of 13 tons/ha but a national yield average of only 4.73 tons/ha, improved production techniques in areas of high salinity would have an immense significance.

The Current Situation in the Near East Region:

Rice is the most rapidly growing food source in several Near East countries. (Egypt, Iran, Iraq, Mauritania, Morocco, Pakistan, Sudan and Turkey) Rice follows wheat as the region's second most important staple. Rice is the third largest crop in the Near East in terms of area sown, after wheat and cotton. Although, these nations currently account for only a fraction of the global rice area (2.6%) and global rice production (2.7%). Cultivation area occupies about 3.5 million hectares and produces about 2.7 million tonnes of rice, with a regional production average of 4.7 t/ha/year. The region's rice demand generally exceeds production and, with the exception of Pakistan and Egypt which have an export surplus of 0.5 and 1.8 million tons respectively, Near East nations are net rice importers. Based on projected population growth and increasing per capita consumption, the increase in production required to meet the demand in a decade is estimated at 30% over the present production of 15.7 million tones. Achievement of such a high target would require the growth rate of annual production to remain approximately 3% despite the limited water supply and limited possibilities for the expansion of production area.

Despite low production in the Near East currently, the agro-ecology of the region is quite favorable for high yield. The ecology and climate are ideal for rice agriculture. Yet, production remains stagnant at low levels, with the exception of Egypt. Low yield in many rice producing countries of this region appears to be caused by poor crop management techniques, lack of research and extension systems, and limited utilization of productive varieties.

High variability exists in the rice yield between Near East countries as shown in Table 1 below. The average national yield in Egypt is 9.4 tons/ha, compared to 1.30 tons/ha in Sudan. This type of yield gap is due to differences in biophysical factors (climate, length of growing season, soil, water, pest pressure, etc) and socio-economic factors, crop management, and access to and use of technology. Domestic milled rice production as well as domestic consumption, also vary from one country to another in the Near East region (Table 2, below). Rice consumption per capita ranges from 2 Kg per person in Morocco (perhaps the lowest in the world) to 43 Kg per person in Egypt (one of the highest in the world).

The Trend of Production, Yield and Consumption in the Nineties:

Table (1): Rice Area, Production and Yield in Some Near East Countries in 2002

Country	Area (Hectares) (1000)	Production (Tons) (1000)	Average National yield (Ton/ha)
Egypt	600	5580	9.40
Morocco	5.12	26.60	5.19
Turkey	70	420	6.80
Pakistan	2200	4200	1.92
Iran	600	2400	4.03
Mauritania	13	58.81	4.50
Sudan	5.50	7	1.30
Total	3494	12692.41	4.73

In general, the domestic total of milled rice does not meet the demand of consumption. The exceptions to this, again, are Pakistan and Egypt; both produce a surplus and export to the other countries in this region and throughout the world. Overall, however, domestic rice production is not enough for local consumption and approximately half of the total consumed rice in many Near East countries has to be imported from abroad every year.

The area of rice production in the Near East region is dependent upon the availability of water for irrigation, rice ecology, production cost, and market prices. These factors have a tremendous effect on total rice production and yield in the region, and indirectly affect the import and export of rice in each country.

Table (2): Rice Consumption in the Near East Countries in 2001

Country	Population (Million)	Total milled rice consumption (1000 ton)	Domestic milled rice production (1000 tonnes)	Milled rice imports (1000 ton)	Milled rice exports (1000 ton)	Rice consumption per capita Kg/ person
Egypt	68	2924	3424	---	500	43
Morocco	25	50	15.6	24	---	2
Turkey	67	536	286	250	---	8
Pakistan	145	1450	3250	---	1800	10
Iran	68	2631	1831	800	---	38.7
Mauritania	3.7	148	35.1	91	---	40
Sudan	35	111	4.5	104	---	3
Total	411.7	7739	8846.2	1269	2300	

As the figures indicate, the region overall is exporting more rice than it is importing, but this is, of course, due to the export of rice from Egypt and Pakistan alone. Outside these two countries, rice production can not meet the demand.

Turkey

In Turkey, for example, the domestic milled rice production varies between 200 thousand and 286 thousand tons per year and the total domestic milled rice consumption is between 450 thousand and 536 thousand tons. The area of rice production was more than 70,000 ha in the early 1980s reaching as high as 77,000 ha in 1982, but then decreasing drastically afterwards. The average rice yield per hectare is 5 tons/ha (Table3).

There were two factors responsible for the decrease in areas allocated for rice:

- Shortages of irrigation water subsequent to the period of drought which prevailed between 1985 and 1994.
- Policy restrictions on rice importation and cultivation. Restrictions were made on rice importation before 1984 through the imposition of taxes on rice imports. These restrictions were lifted or their amounts were reduced in 1984 lowering the cost of rice imports. Production costs were often higher for the locally produced rice than for the imported rice, and a number of farmers abandoned rice cultivation as a result. Moreover, in some areas, rice cultivation was forbidden during periods of drought so that, the available water could be used for irrigating other crops such as cotton, maize and vegetables. However, rice area started to increase again from 41,000 ha in 1994 to 58,000 in 1995; and more than 60,000 ha in 1996. The increases in 1995 and 1996 were due to increases in rainfall which provided more available water for irrigation.

Table (3): Rice production and imports in Turkey

Year	Production area (000 ha)	Domestic milled production (000t)	Milled rice imports (000t)	Total milled consumption (000 t)	Rough rice yields (t/ha)
1981	73	198	26	224	4.52
1982	77	210	21	231	4.55
1983	70	189	10	199	4.50
1984	64	168	85	253	4.38
1985	60	162	85	247	4.50
1986	55	165	86	251	5.00
1987	53	165	159	324	5.19
1988	51	158	91	249	5.16
1989	66	198	221	419	5.00
1990	46	138	191	329	5.00
1991	40	120	133	253	5.00
1992	43	129	265	394	5.00
1993	45	135	309	444	5.00
1994	41	120	200	320	4.49
1995	58	176	---*	---	5.10

(*) Data not available

In the last decade, rice imports have increased in Turkey due to the sharp decline in domestic rice production. In 1993 for example imports reached its highest level (309,000 tons) and at times more rice was imported than necessary.

Egypt

In Egypt, the rice growing area averaged 396 thousand hectares during 1984-1989 and climbed to 563.6 thousand hectares in 2002. This was mainly due to expansion in irrigated areas allocated for rice. The total milled rice production increased from 2.4 million tonnes in 1984-1989 to 3.4 million tonnes in 2002 which more than meets the demand of local consumption. Rice exports averaged 87 thousand tons during 1984-1989 and reached 500 thousand tons in 2002.

Because of the fertile soil of the Nile Delta, the high intensity of sunlight, few diseases and insect pests, warm weather and a good irrigation system, rice yields have been among the world's highest at 9.4 tons/ha (Table 4) which is more than three times the world average (3 tons/ha).

The average national yield of rough rice is 9.4 tons/ha which is one of the highest in the world. These high yields were achieved through:

- The release and spread of new short duration high yielding varieties, Giza177, Giza178, Sakha101, Sakha102, Sakha103, Sakha104, Giza182 and Egyptian Yasmine.
- Transfer of appropriate technology to the farming community to improve crop management.
- Monitoring production constrains and farmers problems in the season, and prompt follow-up action by various agencies under the umbrella of the National Rice Campaign.

Table (4): Trends of area, production and yield increase between 1985 and 2002 in Egypt

Year	Area planted (mill/ha)	Production (mill/tonnes)		Yield (t/ha)	
1985		2.4		5.7	
1990	(45%)	3.17	(75.6%)	7.3	(21.6%)
2000		6.00		9.1	
2002		6.04		9.4	

Figures in parenthesis - percentage growth increase between 1990 and 2000

Pakistan

In Pakistan, the other major rice exporting country, rice is the second most important crop to export earnings, contributing about 9% per year to foreign exchange earnings. Pakistan exports about 1 million tons of rice annually, which is about 10% of the world rice trade. The annual export of about 250 thousand tons of long-grained, aromatic, fine-quality rice (basmati), goes mainly to the Middle East market. About 500 thousand tons of long grains are exported each year to South and South East Asia. The international market price for basmati rice has been three times more than that of the modern varieties. In 1995 Pakistan exported 1.6 million tons of rice in response to a strong demand in the world market.

Despite fairly stable irrigation and water supply, rice yields are low for both traditional basmati and modern varieties. The national average yield is 1.9 ton/ha. There is potential for about 25% higher yield at the present input level which could be achieved by advanced rice crop management. The reason for stagnating or declining yields are thought to be the increasing incidence of salinity caused by injudicious use of irrigation water, mismanagement in the use of fertilizer, unfit ground water, soil nutrient depletion, the development of insect-pest and weed complexes peculiar to the rice-wheat system, and inadequate economic incentives for long-term investments in land and soil improvements.

Table (5): Rice Production and Export in Pakistan

Year	Production (tons)	Harvested area (ha)	Yield (kg/ha)	Import (tons)	Export (tons)	Consumption (kg/per/yr)
1980	4,684,800	1,933,100	2423	3	1,086,641	32
1985	4,378,400	1,863,200	2349	7	718,686	-
1990	4,891,200	2,112,700	2315	25	743,889	28.8
1995	5,920,000	2,161,800	2738	68	1,852,267	20.5
1997	6,546,450	2,232,000	2880	-	-	10.0

Table (6): Exports of Rice (basmati & others)

Year	*Quantity (M. Tons)*	
	BASMATI	**OTHER VARIETIES**
1994-95	452,300	1,399,967
1995-96	716,392	884,132
1996-97	457,245	1,309,961
1997-98	552,377	1,538,866
1998-99	588,763	1,200,011
1999-00	569,823	1,346,231
2000-01	502,061	1,792,224
2001-02	543,750	1,100,868
***2002-03 (July-May)**	645,781	1,000,829

Source: FBS - * estimates

Constraints in the Near East and North Africa:

<u>General Constraints affecting Rice Production in the Near East Region</u>:

Climatic:

Low temperatures: Low temperature is a major constraint to rice production especially for late sowing rice varieties.

High temperatures: At a certain stage of development, strong heat may cause a high percentage of sterility potentially reaching 100% at temperatures of 39° in the dry season;

Hygrometry of air, dry and hot winds: Low air hygrometry and dry hot winds in dry seasons affect flowering. Hot winds dry up panicles and can cause the sterility of spikelets.

Rain: Rain can be a constraint during the grain maturation stage, affecting the moisture of the rice grain. This can significantly affect the final rice yield.

Soil and Water:

Salinity of Soils: Soil salinity constitutes a significant constraint to rice in many countries of the Near East region. The use of improper irrigation without drainage could encourage water logging, resulting in salinity buildup and other mineral toxicities.

Irrigation Water: Limited water supply in the region is a major constraint to rice production, which relies heavily on irrigation water. In addition, irrigation water can cause soil degradation due to high levels of sodium bicarbonates. These can lead to a long term phenomena of iodination which may facilitate the rise of pH levels, and result in the destruction of the superficial layer of soil and organic matter.

Biological Constraints:

Weeds: Weeds reduce rice yield by competing for space, nutrients, light and water and by serving as hosts for pests and disease. Under typical conditions, control of weed growth is often not properly handled. The spread of weeds is often caused by, inadequate land leveling, improper irrigation methods, and inappropriate agricultural techniques including: seeds mixed with weeds, insufficient soil tilling, inappropriate sowing methods, and lack of crop rotation. Various weed control methods such as complementary practices, hand weeding, mechanical weeding, chemical weeding and integrated approaches are necessary to improve weed control.

Birds: In the dry season, many farmers avoid cultivation because of the damage birds make to the rice crop.

Field mice: In some places, field mice can completely devastate farms.

Disease: Rice can serve as a host to many diseases and pests, including: bacterial blight, bacterial leaf streak, and bacterial sheath rot. Many viruses have also been identified.

Socio-economic Factors:

Supply of goods: Fertilizer is very expensive and not always available. Quantities of certified seeds are insufficient; this has led some producers to buy bad quality seeds.

Agricultural Equipment: A lack of agricultural equipment or old hydraulic equipment can be a major constraint to rice production. Manual transplantation of the plant population results in fewer plants per acre. The optimum plant population, 90,000 per acre, is difficult to maintain, and manual transplantation typically results in about 50,000 per acre.

Rehabilitation of agricultural perimeters: Perimeters are poorly constructed and don’t last long because of the absence of norms to construction.

Agricultural credit: UNCACEM agricultural credit is confronted with many problems such as:

- poor capacity for financing agricultural campaigns
- heaviness of procedures in obtaining loans
- difficulties related to credit recovery
- weak credit capacity to purchase agricultural equipment

Post-Harvest Technology and Loss in the Near East Region

Harvesting is done manually throughout most of the Near East region. Due to variations in post-harvest techniques and the methodology of harvesting, threshing, storage and milling, varying levels of loss occur in each country.

Between 10-37 % of the product can be lost in post harvest operations.
Current statistics show loss at 1-3% due to shattering through harvesting, 2-7 % in handling, 2-6 % in threshing, 2-6% in storage, 2-10% in transportation, and 1-5 % in drying).

Throughout rice producing areas, rough rice is generally dried for some time after harvesting, and then stored in sacks. The moisture content of rough rice must be below 14% before it can be safely stored. However, rice is normally harvested at a moisture content of 23% or more. If the moisture content is not reduced to below 14% for storage, grain quality deteriorates through microbial activity and damage from pests. Farmers dry the combined-harvested rice through the use of mechanical dryers. However, many mistakes occur during the drying process. For example, not drying the crop within the appropriate time may result in damage to the crop due to fermentation (high moisture content), and drying the crop at temperatures higher than is recommended may result in increased breakage of the milled rice.

Though drying by mechanical dryer between 12 and 24 hours after harvest is recommended, many farmers are still dependent on air drying. Two methods of sun-drying are generally used. The first method is to place harvested rice in lose bundles and leave it to dry in the field for several days. The length of drying time will depend on weather conditions. This traditional method is not commonly used today. The second method is to spread the wet grains on a drying surface immediately after harvesting. Repeated stirring when using this method is necessary in order to obtain uniform drying. Farmers sometimes keep the crop in the sun longer than is required, thus, the rice crop will contain more moisture than is recommended, and if the stirring is not repeated frequently then this may lead to heterogeneous drying. Any of these problems will result in the decrease of head rice yield and grain quality.

Achievements in Research and Technology Transfer in Selected Countries of the Near East Region:

Egypt

Despite limited land and water resources, increases in yield and productivity have been achieved through a well-organized interdisciplinary team. There has been a significant reduction in the gap between yield potential and the national average. Egypt now is one of the few countries in the world with an average yield of 9.4 tons/ha, and demonstration field trails showed potential for even higher yields of 13 ton/ha Table (7).

Table (7): Productivity of the transplanted demonstration fields in Egypt

Variety	No. Fields	Range ton/ha	Average ton/ha
Giza 177	8	9.73 - 11.31	10.45
Giza 178	3	10.45 - 12.14	11.14

Sakha 101	27	9.88 - 13.33	12.04
Sakha 102	3	9.76 - 10.73	10.21
Sakha 103	3	10.38 - 11.04	10.78
Sakha 104	10	13.14 - 10.12	11.69
Total	**54**	**9.73 - 13.33**	**11.52**

The reduction of the yield gap was achieved through the encouragement of farmers by extension services and national campaigns, to adopt improved production techniques.

In an effort to strengthen the rice research in Egypt a Rice Research and Training Center (RRTC) was established in 1987 at Sakha, Kafr El-Sheikh Governorate with strong support of three main agencies.

- Egyptian Ministry of Agriculture and Land Reclamation.
- Technical support of the International Rice Research Institute (IRRI).
- USAID, through funding the Rice Research and Training Project from June 1980 to December 1986 and through the National Agricultural Research Project (NARP) IRRI contract and recently through (ATUT) Project.

The RRTC at Sakha, Kafr El-Sheikh Governorate has a full range of Well-equipped research facilities including: laboratories, glass houses, screen houses, libraries, seed testing centers, cleaning and storage facilities, and mechanical workshops. It is the center for 90 Research Workers, 25 Senior Staff Members, 35 Research Assistants and some 50 Research Technicians. In addition to Sakha, the RRTC has three testing stations at Gemmiza, Zarzoura and Sirw as well as twenty on-farm verification sites in the seven rice growing Governorates namely, Kafr El-Sheikh, Dakahlia, Beheira, Sharkia, Gharbia, Damietta and Fayoum. The Rice Research Program also employs about 200 Rice Production Advisors scattered in the seven rice growing Governorates to help disseminating the improved technology from the Sakha research facilities to the various districts in Egypt.

The Egyptian research program includes the following activities:

- Plant breeding to develop new improved varieties with resistance to diseases and pests, early maturity and short stature.
- Seed production, to put the seeds of the new high yielding varieties into farmers’ hands.
- Agronomy, including plant nutrition, water management and cultural practices to maximize yield of the newly released varieties.
- Plant Protection against weeds, disease, insects and other pests.
- Mechanization, seeking small-scale implements that can be locally manufactured and maintained.

- Economics, keeping in mind that successful new technology usually cuts the cost.
- Extension to verify and transfer new technology to the farmers.

Morocco

Research is currently undertaken within the National Agronomic Research Institute in Morocco (INRA-Maroc). Research is directed towards conservation agriculture. In this respect, different irrigation methods have been tested to take the place of flooding methods. Thus physiological parameters, under Moroccan conditions have been studied under water deficient environments. With regard to rice breeding programs, Morocco depends mainly on the import of rice materials which are of Italian, French, and Egyptian origin. Efforts are being made to release local varieties.

Turkey

The average rice yield twenty years ago was around 4 t/ha. Recently as a result of the development of new varieties and the adoption of new technology, the average rice yield has increased to 6 tones/ha. However, there is still a large gap between farmer yields and experimental results. This gap is between 2.5 - 3.0 tons/ha. Research in Turkey includes in addition to breeding activities, other studies including:

- Rice planting and harvesting time
- The appropriate fertilizer rate and nitrogen form
- Nitrogen application time
- Seed rate per unit area
- Irrigation studies
- Sprinkler irrigation
- Minimum water requirements

In addition to the above, an effective certified seed programme was developed. Certified seeds of commercial varieties are produced every year. The use of these certified seeds has increased both yield and milled rice quality.

Pakistan

Efforts are being made to focus on demand oriented cultivars and research techniques. For instance, the Government is now focusing on the increase of area for fine varieties and introducing hybrid rice in areas where coarse varieties are grown. At the same time, knowledge of improved agronomic practices are also disseminated through different sources and electronic media.

Iran

The Rice Research Institute of Iran (RRII) was officially established in 1993 to coordinate research activities and projects throughout the country. The RRII helps Iranian farmers grow more rice on limited land with less water and less input. The institute conducts research in 16 rice-growing provinces and has two main centers: in Rasht (RRII headquarters) and Amol.

RRII has a total of 250 staff members. The institute puts great emphasis on its relations with the International Rice Research Institute (IRRI) in the Philippines. Through this collaboration, the institute has been able to train numerous staff members in short-term and degree training courses. The institute also collaborates with IRRI in the International Network for Genetic Evaluation of Rice (INGER). Research activities at RRII are currently conducted in the following areas:

- Agronomy and Plant Breeding
- Plant Protection
- Soil and Water
- Agricultural Engineering

The **Agronomy and Plant Breeding** department works on inbred and hybrid rice varieties using conventional breeding, mutation breeding, tissue culture and biotechnology techniques. The principal objectives are to improve grain quality, yield potential, resistance to pests, disease, drought, and lodging, and to develop early maturing varieties.

The **Plant Protection** department focuses its activities on reducing pesticide use, introducing environmentally friendly pesticides, using alternatives to chemicals, mass production using an artificial diet and finding sources of resistance in rice germplasm to major pests and diseases.

The primary objectives of the **Soil and Water** department are to optimize chemical fertilizer input into different soil types; determine the nutrition and water requirements for different varieties and selecting low-input varieties.

The **Agricultural Engineering** department undertakes diverse projects in the areas of food science and technology, machinery, and irrigation. These projects seek to optimize the use of machinery, increase water efficiency, decrease yield loss from production to post-production stages, and utilize waste from rice production.

The institute also has a technical services department, which provides support to all projects and strengthens the institute's scientific capabilities. In recent years, the institute has introduced more than 10 modern high yielding varieties including Fajr, Nemat, Neda, Sazandegi, Churam 1, Churam 2, and Azar. In addition, ten new promising lines are in the final stages of release in Guilan, Mazandaran, Khuzestan, and Fars provinces.

Mauritania

Agricultural research on rice started in 1972 with IRAT (Institut français de recherché pour l'agriculture tropicale et les cultures vivrières).

In 1974, L'OMVS (Organisation pour la Mise en Valeur du Fleuve Sénégal) from the UNDP-FAO at CNRADA was created to cover irrigated crops, and in particular rice. In 1975 a department of rice research was instituted to lead all activities of rice research. Since then, research has seen significant evolution, with steady increases in the number of research activities.

The work done in irrigated rice research has dealt mostly with varietal development and agricultural techniques. Results of research activities have made it possible to mark the performance of existing varieties (such as, the short day's varieties and medium day's varieties). The most recently released varieties are all short duration (8 varieties) with yields ranging between 6-8 t/ha.

Germplasm Availability and Varietal Development in Selected Countries of the Near East and North Africa Region:

Research programs on varietal development are a consistent focus of many research institutions in the Near East and North Africa region. Research institutes are focusing more on market oriented germplasm. Four types of germplasm are commonly grown: Japonica, Indicia, Basmati and Jasmenium. In the Near East region, the most common is the short grain Japonica type. Aromatic basmati varieties, however, are found in Pakistan and Iran.

Egypt

Significant improvements to rice yield in Egypt have been achieved through the development of new improved varieties with high yield potential, early maturation, and high resistance to blast disease. These varieties are widely accepted by farmers and consumers.

Table (8): Yield and Ancillary traits of the new Released Rice varieties in Egypt

Variety	Yield (T/ha)	Duration (days)	Height (cm)	Blast		Grain Type	Milling (%)
				L	N		
Improved varieties:							
Giza 177	10.7	125	100	3	R	Jap. (Sh)	73
Giza 178	12.1	135	100	2	R	Jap. (Sh)	71
Sakha 101	11.5	140	90	2	R	Jap. (Sh)	72
Sakha 102	10.8	125	105	2	R	Jap. (Sh)	72

Sakha 103	10.9	120	99	2	R	Jap. (Sh)	72
Sakha 104	11.4	132	105	2	R	Jap. (Sh)	71
Giza 182	11.7	129	94	2	R	Ind. (L)	70
Egyptian Yasmine*	9.5	150	95	1	R	Ind. (L)	65
Average	***11.1***	***135***	***98.5***	***1-3***	***R***	***Sh-L***	***65-73***
Old varieties:							
Giza 171	7.3	160	140	7	S	Jap. (Sh)	72
Giza 176	8.7	150	100	5	S	Jap. (Sh)	69
Giza 181	9.1	150	95	2	R	Ind. (L)	68
Average	***8.4***	***153***	***112***	***2-7***	***R-S***	***Sh-L***	***68-72***

*Aromatic rice

The high yield of the Egyptian varieties were achieved through:

- The release and spread of new short duration high yielding varieties, Giza177, Giza178, Sakha101, Sakha102, Sakha103, Sakha104, Giza182 and Egyptian Yasmine.
- Transfer of appropriate technology to the farming community to improve crop management.
- Monitoring production constrains and farmers problems throughout the season, and prompt follow-up action by various agencies under the umbrella of the National Rice Campaign.

Morocco

Table (9): Varieties inscribed in the national official catalogue in Morocco

Variety name	Yield (qx/ha)	Duration (days)	lodging	blast	Grain Type
Triomphe	66	143	R	S	Jap. (Sh)
446	62	118	PR	S	Ind. (L)
Dinar	65	139	PR	PS	Jap. (M)
Hayat	68	129	R	PS	Jap. (Sh)
Kanz	66	129	R	PS	Jap. (Sh)
Samar	70	135	R	PS	Jap. (Sh)
Maghreb	71	118	R	T	Ind. (L)
Bahja	71.3	118	R	T	Ind. (L)
Nachat	72.9	118	R	T	Ind. (L)
Farah	100	135	R	R	Ind. (L)
Oumnia	90	130	R	T	Ind. (L)
Gharbia	95	130	R	T	Ind. (L)
Zena	79	114	R	T	Ind. (L)
Riva	80	116	R	T	Ind. (L)

R= Resistant; PR= less resistant; S= sensible; PS =less sensible, T= tolerant

Turkey

Many Japonica type rice germplasm varieties have been introduced from Italy, Bulgaria, Spain, France, Hungary, and Russia. In addition there are 500 – 600 lines currently being developed for a crossing program. Many local materials and materials introduced from the European rice growing community are stored in the national gene bank of Turkey.

Table (10): Some rice varieties in Turkey

Variety Name	Grain yield Potential (t/ha)	Duration (days)	Plant height (cm)	Grain type
Trakya	8.5	128	113	Jap. (Sh)
Ergene	7.0	117	100	Jap. (Sh)
Meriç	8.2	125	110	Jap. (Sh)
İpsala	8.2	125	110	Jap. (Sh)
Altınyazı	7.5	127	112	Jap. (Sh)
Sürek-95	8-10	130	100	Jap. (Sh)
Osmancık-97	8-10	130	95	Jap. (Sh)
Kıral	9-10	125	90	Jap. (Sh)
Demir	10-12	135	85	Jap. (Sh)
Yavuz	8-9	130	100	Jap. (Sh)
Neğiş	7-8	126	106	Jap. (Sh)
Gönen	7-8	126	108	Jap. (Sh)
Kargı	8.0	125	110	Jap. (Sh)

Pakistan

Four types of germplasm are commonly grown. The fine types include Basmati super, Basmati 385 and Basmati 2000, while the coarse types include the common variety irri–6. Varietal development is on-going, and the research institutions are focusing more on market oriented germplasm. Efforts in the public and private sector, with the collaboration of Chinese scientists, are under way to introduce hybrid rice. However, there are several funding constraints. A collaborative approach could help to speed up the on going work in the research sector.

Iran

The most popularly grown local varieties are Hassan Sarai, Domsiah, Binam, Hassani, Salari, Anbarbo and Sang Tarom (Table 11). Despite the low yield of these local varieties (averaging 2.5-3.5 t/ha), they have excellent quality traits (aroma and moderate amylose content) which are preferred by consumers. More than 70 percent of the total rice area in Iran is still cultivating these varieties. Similar to basmati types, they are characterized by a tall stature (125 to 135 cm) and sensitivity to lodging. They also have a long slender grain, a head rice recovery (HRR) of 60 to 63 percent, an intermediate amylose content (Ac), aroma and elongation qualities. These popular varieties can be susceptible to blast and stem borer.

Table (11): Local Rice Varieties under Cultivation by Iranian Rice Farmers

Grain Type	Grain Length	Amylose Content	Plant Height (cm)	Growth Duration (days)	Yield (t/ha)	Variety
Indica	Very long	20	135	120-125	3.5-4	Hassan sarai
Aromatic	Very long	20	130	130-135	3.5-4	Domsiah
Aromatic	Medium	21	135	120-125	3.5-4	Binam
Japonica	Short	22	115	105-110	3-3.5	Hassani
Indica	Very long	23	140	125-130	3-3.5	Salarie
Japonica	Medium	19	130	120-125	2.5-3	Anbarbo
Aromatic	Long	20	125	115-120	3-3.5	Sang tarom

Mauritania

Researchers, through collaboration with international research institutions including WARDA, have developed new high yielding varieties adapted to the agro-ecological conditions of the country.

About 1500-2000 tons of certified seeds are required per year. Seed production, however, is between 900 and 1300 tons. The deficit is covered each year by importation from Senegal: 200 tons in 1998, 400 tons in 1999 and 800 tons in 2000.

The following varieties are performing well in Mauritania:

Short days varieties: SAHEL 108, IR 1561, IR 64, (the potential yield of these varieties can reach 10 tons/ha in research stations.)

Long days varieties: Sahel 202, Sahel 201, (the potential yield of these varieties can go up to 11 tons/ha.)

Research Programs:

The development of interdisciplinary research programs for improved production will succeed in narrowing the yield gap, and encourage more farmers to adopt improved production techniques. A successful program will need to focus on the following disciplines:

- Plant Breeding to develop improved varieties with resistance to disease and pests, early maturity and short stature
- Seed Production to ensure that pure seeds of new high yielding varieties are put into the farmers' hands
- Agronomy including plant nutrition, water management and cultural practices to maximize yields of newly released varieties
- Plant Protection against weeds, disease, insects and other pests

- Mechanization, seeking small-scale implements which can be locally manufactured and maintained
- Economics, cutting cost with successful advancement in technology
- Extension to verify and transfer new technology to the farmers
- Release and spread of new short duration high yielding varieties resistant to disease and pests
- Transfer of appropriate technology to the farming community to improve crop management
- Monitoring production constrains throughout the season and following up promptly with appropriate action by various agencies under the umbrella of the National Rice Campaign

Integrated Crop Management in the Near East and North Africa Region

Yield stagnation in different regions has led to the development of innovative practices for sustainably maximizing the productivity of rice-based systems. Typically, however, the use of such practices will focus on only one area, such as enhancing productivity, profitability or environmental safety. But what is actually achievable through an integrated crop management system would cover the entire production system. This has been the basis for designing and experimenting with various forms of integrated crop management.

Integrated crop management (ICM) may be defined as a 'site specific crop production strategy, harnessing the synergistic benefits of improved/innovative practices towards sustainable productivity'. With the direct involvement of farmers on a location specific basis, this strategy is an effective way to conserve resources, maximize efficiency, and directly transfer technology to the farming community.

The 'System of Rice Intensification' (SRI) is probably the earliest form of ICM developed. SRI stresses transplantation of very young seedlings at one per hill, adopting wide spacing, frequent weeding and stirring of soil in the early stages and intermittent irrigation. In 1986, the New South Wales Department of Agriculture (Australia) developed a package called 'Ricechecks' based on the practices adopted in farms of high yield. The system, with provisions for collaborative learning, encourages farmers themselves to monitor and evaluate crop performance against the level of adoption of the checks. The system with provision for collaborative learning encourages farmers themselves to monitor and evaluate crop performance vis-à-vis the level of adoption of the checks. The system stressing on field layout, timely sowing/transplanting, uniform establishment, application of adequate fertilizer nutrients to ensure 500-1000 tillers at PI stage and top dressing based on NIR tissue test, N-application of before flooding, achieving minimum water depth during early microspore stage and effective post-harvest handling, has been reported to increase yield by 10%. Still more refined ICM practices have been developed quite recently in the farms of Indonesia. These practices involve a more systematic and comprehensive approach from seed to harvesting. Quite recently still more refined ICM package integrating some of the earlier proven skills/practices has been developed and evaluated extensively in research farms and farmers' fields in Indonesia. The system involving all the stakeholders is more comprehensive in its content and systematic in implementation process. The system comprises core options and location specific options, the former enlisting the importance of use of quality seed at low seed rate, transplanting of about 15 day old seedlings and Leaf Color Chart (LCC) and Nutrient Omission Plot (NOP) based N and K or P application and the latter including planting 1-2 seedlings/hill, square or paired row planting adopting wide spacing, intermittent (dry-wet) irrigation management and harvesting at right grain moisture, proper drying and storage.

Evaluation of a large number of farmer managed ICM sites has revealed yield advantage of over one ton/ha and overall profit exceeding US $100/ha/season over the non-ICM farms. Accelerated research during the last 10 years at IRRI and the NARES in tropical Asia has led to the development of many efficient alternative technologies in tillage, crop establishment, water and nutrient management, pest-weed management and post harvest handling.

Recognizing the advantage of ICM packages will prompt extensive adoption of ICM practices, and could have a wide impact in the Near East and North Africa region. Integrated crop management systems involving varieties/hybrids with new yield thresholds will prove a valuable strategy to maximize productivity on a sustainable basis.

Future Prospects:

The average rice yield in the Near East region is about 4.73 ton/ha; which is higher than the international average of 3.3 t/ha. The total land area under paddy rice cultivation in the world is 147 million hectares. Comparatively the average is much lower in the Near East region than in other temperate regions such as in Australia, California, Spain and Greece. According to FAO statistics, the Near East countries currently produce only a limited amount of rice globally, estimated at around 13 million tons. This is only about 2.2% of the total world production (575 million tons).

There are big differences in the productivity of each country in the region, the highest level of productivity is in Egypt (9.4 ton/ha), the lowest in Sudan (1.3 ton/ha).

The potential for improved productivity in the region however, is high, making development in rice production all the more crucial and important. The conditions for rice-cultivation are the same as those in countries which record high productivity.

Productivity can be increased with the introduction of improved rice varieties and new growing techniques. Recently, new high yielding varieties have been developed in the region showing potentials of up to 10 ton/ha.

Also, increasing cultivation area, though dependent on irrigation water, will make it possible to increase productivity as well. Therefore, efforts must be made to focus on demand oriented cultivars and research techniques.

Governments in the region are focusing on an increase in area for the production of fine type rice, and on an introduction of hybrid rice in countries such as Pakistan and Egypt. Further development of policies on a national level will continue to be necessary for sustainable rice production.

Strategies for Sustainable Rice Production in the Near East Region:

Definitions:

Agricultural sustainability has been defined and described in many ways, but all of these point to one dynamic concept, *the growing need for agricultural production should be catered to without degrading the natural resource base on which agriculture depends*. Sustainable agriculture can evolve indefinitely toward greater human utility, greater efficiency of resources and a balance with the environment that is favorable to mankind and other species.

There are several concerns to address:

- Food production must continue to increase in order to meet the demand of rapidly expanding populations (about 2% per year).

- Total agricultural employment as well as individual income from agriculture must expand

- Efficiency in use of capital, land and production inputs must increase sustainability

- Production systems must be structured to maintain the lowest possible use of pesticides

Sustainability Factors:

A sustainable production system depends on four major areas:

- Government policy
- Improved technology
- External support
- Farmer participation

Government Policy

Political stability and commitment from government ministers to village leaders plays an important role in sustainable production through the establishment of various facilities, the allocation of budget and step by step follow-up to the implementation of programs. A focused national strategy with clear production goals and objectives will further advance sustainable improvements in rice production.

Improved Research and Technology

Improvement in research related to the social and economic aspects of production technology:

- Breeding high-yielding, early-maturing varieties with resistance to the major diseases and insect pests,
- Crop management to maximize yield of the improved varieties and increase efficiency of irrigation water and fertilizers
- Integrated pest management to control weeds, diseases and insects.

External Support

Marketing inputs and outputs have an immense effect on sustainable rice-based systems. The floor and ceiling prices must be determined and announced well before harvesting, and inputs such as seeds and fertilizer must be made available to farmers at the appropriate time.

Farmer Participation

Farmer participation and acceptance of new technology is of course the most important factor affecting the success sustainable rice-based systems.

Challenges and Opportunities:

Constraints in the Near East and North Africa region such as: Shrinking water resources, deteriorating soil health due to excessive nutrient mining and salinization, low production growth coupled with high population growth, and continued dependence on imports can be addressed. The development and use of high yielding varieties and more efficient crop management techniques will increase productivity, cost effectiveness and ecological security.

By virtue of agroclimatic advantages like intensive sunlight and an arid/semi-arid environment, the Near East is a potentially high-production region. If efforts to narrow the yield gap are coupled with an efficient use of resources, the region can be made truly food secure.

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