Rice Sector in India
Past, Present and Future
Challenges Ahead

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Rice Sector in India: Past, Present and Challenges Ahead

The brochure incorporates mainly the performance in the past, performance at present, emerging problems, recent innovations and priorities for future in the rice sector of India.

It is estimated that around 3 billion people in the world eat rice every day. Rice is vital to global food security and more so with the rice growing countries like India. Eleven per cent of the planet's arable surface is planted with rice crop. The status of area, production and yield of rice in the world along with top performing three countries is presented below.

Area (m. ha)	**1991**	**1997**	**2001**
India	42.5	42.2	44.5
China	33.2	31.4	28.2
Indonesia	10.4	11.1	11.7
World	147.5	149.8	151.2
Production (paddy) (m. tonnes)			
China	186.6	190.1	179.7
India	111.3	123.0	131.9
Indonesia	44.9	51.1	49.4
World	517.4	562.3	485.1
Yield (paddy) (kg/ha)			
Egypt	7068	8291	8154
Australia	8650	6788	9531
Oceania	7910	6585	9231 (Turkmenistan)
World	3508	3827	3870

Role of Rice in Indian Economy

Rice occupies a pivotal place in Indian agriculture as it is the staple food for more than 70 per cent Indians and a source of livelihood (food and employment) for about 80-90 million rural households. Rice is grown over about 45 million ha with 23, 36 and 44 per cent areas under total crops, foodgrains and cereals, respectively. India ranks first in area and second in production (132 million tonnes) next to China. However, productivity is too low (2964 kg/ha) compared to the global average of 3870 kg/ha (2001). Rice is grown under various ecosystems – irrigated (45%), rainfed low land (33%), flood prone (7%) and upland (15%). Upland rice area is very large compared to 2% of China and Philippines and 1% of Thailand.

Growth in Area and Yield of Rice

Between 1968-90 India witnessed a spectacular increase in yield from 1151 to 1745 kg/ha showing a growth rate of 2.22% per year. Rice area increased from 38.3 to 42.2 million ha with a growth rate of 0.56% per year during the same period. The growth rate in yield has decreased to 1.16 % per year from 2.22% during 1990-2001. However, rice area showed an increased growth rate of 0.61% during 1990-2001 against the earlier growth rate of 0.56%. India should achieve more growth rate in yield than in area.

During the Green Revolution period (1968 onwards) following three factors were mainly responsible for rapid growth in rice sector.

- Technologies : Use of High yielding varieties, improved crop management practices, Biotechnology tools etc.

- Inputs : Expansion of area under irrigation, adoption of proper land and water management, proper nourishment of crop, providing of credit facilities etc.

- Policy Support : Fixing of minimum support price in time, taking the cost of production into consideration, timely interference in marketing with procurement and creation of needed marketing facilities, etc.

Impact studies on Green Revolution indicate that necessary actions were taken by the Govt. of India to meet the demands of the increasing population in 1960s. The major objective was to meet the food requirement through increasing productivity and production. Modern varieties played a significant role to improve the market economies by increased profitability and productivity of rice per hectare. Both the National and State Governments extended the required support through policy decisions and provision of infrastructure.

Technological Innovations

The number of modern varieties (MVs) of rice released from different states/institutions in India were 630 during the period 1965-2000. Out of these 335 varieties are for irrigated, 167 for rainfed low land and 118 for rainfed upland ecosystems.

Source of Origin for MVs

The number of varieties released are higher than the varieties developed in almost every state, which shows positive contribution of the free inter-institutional and inter-state movement of the improved germplasm through the coordinated network mechanism of AICRIP. About two-thirds (68%) of total varieties released were from the same states, while about 6%, 9%, 13% and 4% were respectively from 'other states' AICRP, ICAR and IRRI.

Adoption rate of the popular MVs

Farmers adopted only 309 of the 620 varieties released in India. During 1998-2000, the coverage of modern varieties reached 81% of total rice area. Among all adopted MVs, the top 30 MVs that were adopted in more than one state, covered 61% of total MV area and 48.7% of India's rice area. Nearly one-thirds of the India's rice area was occupied by the most popular six varieties which are Swarna from A.P. grown in 10 states (12.2%), IR 36 from IRRI grown in 8 states (5.5%), IR 64 from IRRI grown in 8 states (4.7%), Vijetha from A.P. grown in 8 states (3.6%), BPT 5204 from A.P. grown in 5 states (3.3%) and Mahsuri an exotic, grown in 6 states (2.3%). Mahsuri, a variety introduced in India in the early 1960s from Malaysia, is an important genetic material that has remained popular with Indian farmers. Approximately three-fourths of the total area planted by the top 30 MVs were under those MVs ("old MVs") that were developed and released before 1990, although about 40% of the MVs were released in and after 1990s.

The rate of adoption of MVs by the source of their origin is presented in table below.

Source / origin	No. of adopted MVs	States grown (number)	Area planted	
			m. ha.	% of India's rice area
AICRIP	20	11	1.74	4.0
ICAR	33	12	4.04	9.4
IRRI	14	13	5.23	12.1
Exotic	5	8	2.10	4.9
Indian States				
Andhra Pradesh	46	11	10.45	24.2
Karnataka	6	2	0.14	0.3
Tamil Nadu	18	3	1.65	3.8
Kerala	10	2	0.46	1.1
Punjab	11	3	1.67	3.9
Haryana	5	2	0.14	0.3
Uttar Pradesh	12	3	1.96	4.6
Assam	8	1	0.50	1.2
Bihar	10	2	0.69	1.6
Madhya Pradesh	6	3	2.24	5.2
Orissa	5	2	1.27	3.0
West Bengal	3	1	0.15	0.4
Maharashtra	4	2	0.46	1.1
Gujarat	5	1	0.10	0.2
ALL INDIA	221		35.0	81.0

The direct releases of the IRRI's breeding material as MVs covered about 12% of total rice area in India while

it was about 5% under the exotic varieties, introduced into India largely through IRRI (table). The MVs developed in ICAR were planted in about 9.4% area in all states while 4% area were covered under the direct releases of AICRIP-headquarter (Directorate of Rice Research, Hyderabad, India). Almost every state has contributed to the adopted MVs and their area coverage, but with large variation among the states. Andhra Pradesh is the largest source of adopted MVs that were planted in about 24% of India's rice area (10.5 million ha). The MVs originated from Andhra Pradesh were grown in 11 states, contributing closely one-thirds of the India's rice production from total MV area. The table shows that MVs developed in states where the irrigated ecosystem predominates have been widely adopted across the country, compared to the MVs developed in states where the rainfed ecosystem predominates.

Contribution of Andhra Pradesh to other Indian States

About 25 per cent of rice area in India is occupied by the Modern varieties originated from A.N.G.R. Agricultural University (Andhra Pradesh). Out of this area, A.P. accounts for 34%, West Bengal for 23%, UP for 11%, Madhya Pradesh for 9%, Orissa for 9%, Bihar for 9% and other states accounts for 5%.

Andhra Pradesh contributes about 55 per cent of the total MV area of West Bengal by its varieties. The other major contributors are IRRI varieties(19%), AICRIP

varieties (9%), ICAR varieties (8%), Orissa varieties (5%) and the rest 4% by own varieties of WB.

The percentage of total MV area occupied in Karnataka is 28% each by AICRIP and IRRI varieties, 22% by A.P. varieties, 9% by Karnataka varieties, 7% by Kerala varieties and the rest 6% by ICAR varieties.

The percentage of total MV area occupied in Uttar Prades is 38% by its own varieties, 23% by A.P. varieties, 17% by exotic varieties, 10% by IRRI varieties, 5% each by Punjab and ICAR varieties and the rest 2% by varieties from other states.

The percentage of total MV area occupied in Bihar is 34% by IRRI varieties, 21% by A.P. varieties, 20% by ICAR varieties, 15% by Bihar varieties, 7% by AICRP varieties and the rest 3% by exotic varieties.

The percentage of total MV area occupied in Punjab is 64% by its own varieties, 27% by ICAR varieties, 4% each by IRRI and UP varieties and the rest 1% by AICRIP varieties.

The mean yields of all adopted MVs and contribution of different sources for major rice producing states in India are presented in the following table.

The direct release ot the IRRI's material and the exotic MVs together contributed about 19% of overall productivity gains of adopted MVs.

State	Yield of MVs (t/ha)	Contribution (%) from	
		NARS	International spillovers
Andhra Pradesh	4.95	70.6	29.4
Karnataka	4.72	35.3	64.7
Tamil Nadu	4.10	56.7	43.3
Kerala	4.90	54.9	45.1
Punjab	5.70	30.2	69.8
Haryana	4.67	33.6	66.4
Uttar Pradesh	3.67	45.3	54.7
Assam	2.94	29.9	70.1
Bihar	3.27	52.6	47.4
Madhya Pradesh	3.66	50.1	49.9
Orissa	3.82	66.5	33.5
West Bengal	4.43	45.3	54.7
Maharashtra	3.10	70.7	29.3
Gujarat	4.30	39.0	61.0
ALL INDIA	4.02	53	47

However, the international spillovers of the improved germplasm played a significant synergetic role to the increased productivity levels through their contribution to the genetic improvement of adopted MVs. About 47% of the overall productivity gains of all adopted MVs in India are on account of the international spillovers of improved germplasm —27% by the IRRI's direct material and 20% by the exotic material. The remaining 53% came from the genetic improvement within the Indian NARS system. In

general, the states under irrigated region such as Punjab, Haryana and Karnataka have received higher contribution from the international spillovers to the productivity gains of MVs as compared to the eastern Indian states, except in Assam – about 70% of productivity of MVs contributed by the international transfer in this state. It may be noted that the contribution of the international spillovers of the improved germplasm was higher to productivity gain of adopted MVs than that when measured for the genetic improvement of released MVs.

Emerging Challenges

The demand for more rice supply in India is due to :

- Increasing population-1.5-1.7%/yr.
- More yields to produce from less land due to increasing urbanization and diversification
- Increasing demand for fine quality rice varieties in many Asian countries i.e. rapid diet diversification in favor of high quality products, as economy develops
- Real challenge is much complex: to increase yields with higher quality without environmental effects through research.

The adoption rate of MVs is 22% in 1970 which has increased to 98% by 1995 in India. The yield level also followed the similar trend in increase but stagnation in rice yields was observed during the last two decades. This

creates a doubt whether the existing technology potential has been exhausted.

Recent case studies, based on sample surveys in the irrigated ecosystem, also report that about 74% of rice area on sample farms was under those MVs that were released before 1990. This implies that the varietal replacement rate has come down in the 90s. An explanation of this observation was made by the 'founder-father' of AICRIP, Dr. S.V.S. Shastry (1999), "Prodigality in release of varieties and their instant rejection (avoidance) by farmers must indicate one of the following: a) Later releases are marginal improvements over the old, b) Testing programme is not playing the predictive roles, and c) Parochialism overtakes the performance assessment".

Even after release and adoption of modern varieties and technologies, still there is wide yield gap between experimental station and average farmers' yield.

Yield	RRS	RWS	AVERAGE
Max.exp.	8254	6620	7596
Max.farm	7893	6680	7486
Avg.farm	7073	5970	6630
Min.farm	5937	4280	5270

The yield loss due to biotic and abiotic stresses under irrigated rice systems was estimated to be 536 kg/ha/year. This loss is 34% due to insects/pests, 26%

due to diseases, 24% due to soil related problems and 16% due to water related constraints.

New Innovations

Advent of biotechnology as powerful tool has opened new vistas in breaking genetic yield barriers. To sustain food security, India needs to push up rice yields to 5.4 t/ha. Under the present situation of area stabilization around 42-44 m ha, yield improvements are to be achieved through better management and hybrid technology. The technology has been successful in China (50% area under hybrids), Vietnam and Philippines. In India it is picking up but very slowly.

Main reasons for non-acceptance of hybrid rice are:

- Non-availability of hybrids for specific situations
- High cost of hybrid seed
- Seed production technology not fine finished
- Lower price due to inferior quality and lower head rice recovery over inbred varieties
- Inadequate linkage and coordination among research, seed production and technology transfer agencies

Within a span of 10 years, India has developed 13 rice hybrids in public sector (first two coming from ANGRAU – Andhra Pradesh) and 8-10 in private sector. As per the studies of Janaiah and Mahabub Hussain (IRRI), the average yield gain of hybrid rice over that of popular

inbred varieties was 16% with additional input cost of 19% and lower net returns by 5%.

Demand for special aroma rices, colour rices, nutritive rices is increasing with growing prosperity of consumers. Asians who migrate to Middle East, European and American countries can afford the best quality Basmati and Jasmine rice at price. The output of China-bred super hybrid rice has hit a new world record to reach 1138 kg/kg mu (17 t/ha) – in an experimental area of Yuan Longping, Father of world's hybrid rice. Golden rice with b-carotene, the precursor of Vitamin A, has been achieved by Ingo Potrykus at Swiss Federal Institute of Technology. Varieties further fortified with iron, zinc and other essential metals coupled with resistance to biotic and abiotic stresses are likely - through genetic engineering. Genetic code of rice has been cracked to clear the path to further succeed in the development of wonder rices.

Though the yields of hybrids are marginally higher over those of varieties, the profitability is less as seen from farm level performance of rice hybrids in India. The reasons might be:

- Lower output price on account of inferior grain quality
- Higher input cost (for seed & plant protection)
- Less yield gain

Farm level Constraints to hybrid rice cultivation in India are:

- Inferior grain quality in terms of keeping, eating and taste -location specific

- Higher seed cost-but only a short run issue
- Unstable yield
- Sterile/chaffy grains in the productive tillers
- Lower head rice recovery after milling

Future Challenges

- Farmers' Profitability (higher yield or higher price or both)
- Quality rices for export purpose
- Early maturity varieties
- Labor saving devices/methods
- Multiple resistance to stresses
- Supply of adequate credit in time
- Improving marketing and storage infrastructure
- Need for reduction in HIGH level of subsidies in developed countries
- Proper awareness among the farmers on
  - soil fertility
  - fertilizer and pesticide use
  - water management

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