Rice in India has a long history dating back to prehistoric times. Rice improvement programmes in a planned manner can however, be said to have started from the beginning of this century. The development of new varieties suited to different situations received the greatest attention and this gradual improvement was through the traditional methods of breeding. This continued to be so till the introduction of the new short statured and high yielding varieties. Their introduction led to a new era often called “the era of green revolution”. During this period, new changes occurred not only in the varietal concept but also in the agro-technology essential for the realisation of high yields. However, the spread of these new high yielding varieties raised both hopes and fears. Despite the increase in production and productivity, the rice production in the country still remained linked to the vagaries of monsoon. Ways and means to mitigate the adverse effects of climatic factors of rice production were soon advanced. Ed.

RICE IMPROVEMENT IN INDIA

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Rice, probably the oldest and the most important food-crop of India, as indeed of Asia, is of great antiquity. The rice grown in the countries in Asia (Oryza sativa) has evolved from an annual progenitor over a broad belt extending from the Gangetic plains along the foot hills of the Himalayas across Upper Burma, Northern Thailand, Laos to Northern Vietnam and South China (Roschevitz; Ramiah; Chatterjee; Chang). The cereal was brought under cultivation simultaneously but independently at more than one site. In India, excavation at Lothal has revealed the use of paddy husk in potteries, bricks, etc., Lothal civilization was around 3800-2800 B.C.

Besides the primary centres of origin, secondary centres of origin in India could well have been in Assam and the adjoining areas and Jeypore tract in Koraput District (Orissa). Rice in India presents a panoramic picture, its diversity and consequently a great variability providing a vast scope for genetic improvement.

The cultivated annual forms in South and South-East Asia belong to 3 sub-species, viz., indica, keng or japonica, and javanica (bulu and gundi). The javanica is restricted in its distribution in Indonesia; japonicas originally from North China later spread to Japan and Korea. The japonicas and the javanicas are products of selection from the indica sub-species distributed in South and South-East Asia.

Rice improvement in India, in a strict sense, can be said to have begun from the early part of this century although varietal classification and the use of rice for different purposes can be traced back to much earlier period. At the initial stage, improvement was
mainly through selection—inter and intra-
variety. Introduction and selection played a 
role in the next phase. Varieties from one 
state were tested in other states and the best 
released (SR 26B, N 22, FR 13A, FR 43B, 
Ptb 10, etc.). To create variability, the basis 
for selection, hybridization between varieties 
was later initiated and this marked the third 
stage. Crosses were effected between related 
types and even with semi-wild forms 
(O. sativa var. longistaminata). Simulta-
eously, introductions from other countries 
came to be tested for their suitability. 
Shinei, Ch. 45, Ch. 988, Ch. 1039 are examples 
of successful introductions. These diverse 
approaches led to the release of a series of 
varieties in the country (Ramiah, et al.; Ghose, 
et al.).—In 40 years since 1911, the rice 
research stations developed nearly 450 varie-
ties of which, a large majority of varieties are 
tall, of varying durations and with tendency 
to lodge. These have local adaptability and 
a stability of performance under low risk and 
low management conditions. Yields are 
relatively low, but stable.

The beginning of second half of this century 
witnessed the first major programme reorienta-
tion. The indica × japonica hybridization 
programme, sponsored by the F.A.O., was 
initiated in 1950 (for the benefit of South-
East Asian countries) to develop varieties 
that combine wide adaptability of the indicas 
and the fertilizer response (especially to 
nitrogen) and high yield potential of the 
japonicas. A similar programme was 
launched at the national level by the Indian 
Council of Agricultural Research (I.C.A.R.) 
in 1951 for the benefit of states in India. 
The latter programme led to the development 
of ADT 24 in Tamil Nadu. A limited success 
can be attributed to (i) failure in many cases 
to grow the segregating populations under 
high fertility (N-level), (ii) nature of segre-
gation (being of quantitative nature) for most 
characters differentiating the parents, (iii) a 
low segregating population that did not permit 
the expression of all character combinations 
and consequently less selection efficiency, 
(iv) the inherent differences in the response 
of the varieties (indicás and japonicus) to 
differences in day length and temperature and 
their consequent effect in the selection pro-
cess, (v) the occurrence of sterility to varying 
degrees in the cross combinations, (vi) the 
belief that the increased yield is often associ-
ated with an increase in height and duration, 
(vii) the complication involved in the environ-
mental influence or the character expression 
especially height and duration, (viii) a wide 
difference in the grain characteristics and 
cooking quality between the varieties belong-
ing to the two sub-species and (ix) a probable 
bias on quantity rather than on quality.

Meanwhile, crosses were also effected 
between indicás and bulús at the Central Rice 
Research Institute (CRRI), Cuttack. CR 104, 
a late maturing, tall and non-lodging variety 
with medium slender grains and good cooking 
quality was developed from the cross T 90 × 
Urang U-sangan.

At about the same period, a relatively short 
statured variety (late named “Dee-geo-Woo-
gen”) was identified in a population of a 
local variety “Woo-gen” in Taiwan. “Dee-
geo-Woo-gen” was crossed to a Chinese 
cultivar “Tsai Yuan Chung” in 1949 and 
from this cross was evolved Taichung (Native) 
1 (T(N)1). T(N)1 was released in 1956. 
This is insensitive to day length, early in 
maturity (115 days), short statured (90 cm), 
non-lodging and with erect, thick and dark 
green leaves. Tillering is good and leaves 
have late senescence. Under good manage-
ment and high nitrogen level, T(N)1 records 
6 to 8 tonnes per hectare.

Taichung (Native) 1, Dee-geo-Woo-gen and 
I-Geeo-Tze were brought from Taiwan to the 
International Rice Research Institute (IRRI) 
in 1960 (Manila, The Philippines) and 
crossed with several varieties. From the 
combination Peta × Dee-geo-Woo-gen was 
developed IR 8–288–3. This along with 302 
lines (including TN1) were tested at the 
Central Rice Research Institute, Cuttack, in
1965. Three lines from this combination and a few from Peta × Tong-kai-Rotan combination (IR 5 series) gave yields ranging from 5 to 7 tonnes per hectare. Meanwhile, in 1965, the TRRI named IR 8-288-3 as IR 8. IR 8 was later released in India in 1966 followed by Jaya (TN 1 × T 141) and Padma (T 141 × TN 1) in 1968. The introduction of T(N)1 and IR 8 in the country in the mid-sixties and their utilisation in the national programme for the development of new varieties marked the beginning of the era of “Green Revolution”.

Since then, 2,161 varieties have been released by agricultural universities and State Departments of Agriculture besides 23 by the Central Sub-Committee for Variety Release (Seetharaman and Shoba Rani⁹,¹⁰). Of these, Jaya, IR 8, Mahsuri, IR 20, Pankaj, Jagannath, Raina, Tella Hansa, Rasi, Surekha, Sita, Phalguna, RP 4-14, ADT 31, Vani, Iman, MR 136, Triveni and a few others have sizable coverage. The rest have restricted distribution.

Rice improvement in terms of increased productivity is dependent on the variety and adoption of suitable agro technology. Alongside variety improvement programmes, changes were hence introduced in crop management. There was a shift in emphasis from low fertilizer application to high fertilizer use and then to moderate level of fertilizers coupled with adoption of low cost input technology for the efficient use of fertilizer. In this adoption process, the effectiveness of granulated compost, urea briquettes, neem cake coated urea, etc., in fertilizer use technology was soon recognised (Anonymous¹). A judicious adoption of an organo inorganic fertilizer combination technology was suggested not only for yield optimisation but also for its maximisation.

The introduction of fertilizer responsive varieties and high cost input technology, however, aggravated problems of increased disease and insect attack. Diseases and insects which were considered of less importance earlier began to assume greater importance.

A few of these observed earlier during one season only began to affect the crop during both the seasons. To have an effective control, new pesticides (dust, spray, granule formulations) were identified. However, their frequent use led to pest resurgence. To meet the new challenges, a two-pronged approach (development of resistant lines and recourse to need-based application of insecticides based on economic threshold level) was adopted. These programmes were later effectively supported by a pest surveillance and monitoring system. These rapid developments led to the adoption of an integrated pest management system, the components of which included variety, moderate levels of fertilizer use, good crop husbandry, need-based chemical control and pest surveillance.

Increased production potential of new varieties led to a large scale adoption. However, the trend in coverage under the high yielding varieties was slow (Fig. 1) due to (i) growing awareness for quality; (ii) susceptibility of most of the varieties to one or more diseases and/or insects and (iii) non-realisation of the anticipated yield in the rainfed areas (lowlands and uplands). Quality improvement was attempted in the high yielding varieties besides incorporation of genes for resistance. Simultaneously, to compensate the earlier bias in the variety improvement programmes, emphasis shifted to productivity increase in rainfed rice.

The rainfed rice (rice in lowlands and uplands) in India constitutes 70–75% of the country’s total rice acreage. Large areas in parts of Bihar, Orissa, West Bengal, Uttar Pradesh remain waterlogged during kharif and in the absence of adequate drainage, yields are low. Productivity improvement was sought to be achieved through variety substitution and through improvement in agro-technology to the extent possible. Phalguna, IET 5656 (Swarna Dhan), CR 1006, CR 1009, CR 1015 came to be cultivated besides Mahsuri in ill-drained areas. The introduction of these new strains, however
resulted only in a slight upward trend in productivity.

Likewise, productivity increase in the uplands was low, the success being marginal due to the development of early drought tolerant lines (Cauvery, Kanchan, Rasi, Bhavani, Kiran, etc.); even here, yield stability could not be realised for want of effective weed control and inability to provide life-saving irrigation at critical stages of crop growth.

Present prospects of increased productivity in the rainfed lowlands are also limited in the absence of drainage. Takase and Kano (1968) cited by Chattopadhyay visualised productivity increase and growth in production as a development process involving stepwise improvement in infrastructure (Fig. 2).

Need for qualitative and quantitative improvement in infrastructural development can hardly be over emphasised. Without such improvements, increase in yields can only be moderate; nor can the yield potential be realised in the presence of several location specific constraints.

State-wise productivity figures for the years 1979–80 and 1978–79 are projected in Fig. 3. In the favourable year of 1978–79, against the national average of 1.33 tonnes/ha, Madhya Pradesh, Assam, Bihar, Orissa, Rajasthan and Uttar Pradesh recorded yields of 0.70, 0.96, 0.98, 1.0, 1.11, 1.15 tonnes/ha respectively. In the drought year (1979–80), Madhya Pradesh, Uttar Pradesh, Rajasthan, Bihar and Orissa had respectively average yield of 0.38, 0.49, 0.54, 0.70, 0.71 tonnes/ha. The national average was 1.08 tonnes/ha. Yield improvement in Madhya Pradesh, Uttar Pradesh, Bihar and Orissa—the focal States—has to be achieved for a general increase at the national level. The area under rice in these states constitutes 49% of the total acreage. Yield improvement in these States shall receive greater attention.

Recent estimates indicate that the potential for N-use, for stabilising mean yield at 2.4 tonnes/ha, on a national scale, assuming that the percentage area irrigated will rise by
50% and the coverage under HYVs to around 42% is likely to be around 65 kg N/ha as against the current level of 25 kg N/ha. Fertilizer use (especially nitrogenous) has to be stepped up and in this process, the use of a combination of organo-inorganic sources of nitrogen holds promise. Increased productivity requires adoption of high cost input technology; but, the latter should not be a substitute component to low monetary input techniques.

In the remaining decades of this century, efficiency of increased fertilizer use would have far reaching importance in the light of soaring prices of inorganic form of fertilizers and our dependence on non-renewable sources of energy to meet the increasing demand of modern agriculture. To meet this input demand and to achieve increased production to meet growing economic demand for rice, assured and controlled water supply through irrigation development is a pre-condition. The differing roles of irrigation, (i.e., stabilization of harvest fluctuations and a consequent increase in the average yield over the years, the introduction of additional crop wherever possible, flexibility in the cropping pattern and cropping intensity, increased use of fertilizers, better fertilizer efficiency and adoption of better farming techniques) make it obligatory to improve water management both qualitatively and quantitatively. This approach alone can delink the Indian agriculture from the vagaries of monsoon.

Greater production in the context of overall 'self-sufficiency' would mean a switch over from productivity from one crop to productivity per unit land area. Success in the new strategy hinges on "turn around" time. Partial mechanization (if not full) alone would reduce this period. More and more power tillers, harvesters and driers would be needed. A greater use of mechanical power is visualised.

Progress since the mid-sixties is considerable; but challenges still exist. Forecasts have been
made about the rate of progress needed to achieve the projected objectives. With emphasis on an integrated systems approach in the background of overall cropping pattern and cropping intensity, it should be possible to realise the production targets.