3.1. Introduction to ICAR

Indian Council of Agricultural Research (ICAR) is premier body in the field of agricultural research, education and extension. The genesis of ICAR goes back to 19th century. The Famine Commission of India, 1880 recommended that improved agriculture should be the main step for securing against disastrous failures in food supply. It also recommended the establishment of agriculture research institutes and to impart quality education on agricultural frontiers to meet demand for improved agriculture. As a result Imperial Agricultural Research Institute was established at Pusa (Bihar) in 1905, based on the recommendations of above-mentioned Famine Commission and Irrigation Commission. Later this Institute was shifted to Delhi in 1935 following the devastation caused by earthquake in Pusa in 1934.  

In 1926, the Royal Commission on Agriculture was set up which suggested that there should be coordination between agriculture research institutes and colleges. Hence the Imperial Council of Agricultural Research (ICAR) was formally born on 16 July 1929. It was an autonomous organization under the Ministry of Agriculture, Govt. of India, and New Delhi. After independence of India in 1947, it is known as the Indian Council of Agricultural Research (ICAR).  

Imperial Agricultural Research Institute was also renamed as Indian Agricultural Research Institute after independence. ICAR has established number of various institutes in various disciplines of agriculture. Presently 50 National & Central Institutes, 27 Project Directorates, 17 National Research Centres, 6 National Bureaux, 138 substations of ICAR institutes, 562 Krishi Vigyan Kendras (KVKs), 76 Technology Assessment and Refinement through Institutes – Village Linkage Program (TAR-IVLP) Centre, 130 All India Coordinated Research Programmes (ACIRPs), 60 State Agriculture Universities (SAUs), 5 Central Agricultural University, and 4 Central Universities having faculty of agriculture. Besides there are 4 deemed universities in agriculture are under the umbrella of the ICAR.
Rice belongs to the genus Oryza, Sativa. It is one of the few crop species endowed with richest genetic diversity. There are 21 recognized species in the genus Oryza. The Oryza Sativa is believed to have originated at more than one place along a board arc stretching from northeastern India to Myanmar, Thailand. The Asian Rice complex comprises a perennial wild species an annual wild species.
3.3. Importance of rice research

Rice is the most important food crop in India and several other countries especially in Asia which contributes 23% of the calories consumed by the worldwide human population. It is the most important food crop in Asia where 55% of the world’s population lives and 92% of rice is grown and consumed (Wilson and Talbot, 2009). Rice plays significant role in agriculture and economy of India. Rice belongs to the genus *Oryza* and the tribe *Oryza* of the family Gramineae and has a genome size of $0.45 \times 10^{-9}$ bp (Arumuganathan and Earle, 1991), which is a model system for cereal genome analysis. The slogan ‘Rice is life’ suitably describes the significance of rice in food and nutritional security. In India, it is the major source of food providing 39% food requirement of the Indian population (Rani, 2011). In India, rice is cultivated in diverse ecosystems. India ranks first in the world in terms of area (44.6 m ha) and second in terms of production (107 m tones) (DRR Newsletter, 2013). About 60-65% of the Indian population depends on rice as the primary source of nutrition.

3.4. Economic importance of rice in India

Rice is the leading food crop in the world and that directly supply more than 50% of all calories consumed by the entire human population. Rice provides 21% of global human per capita energy and 15% of per capita protein. Although rice protein ranks high in nutritional quality among cereals, protein content is modest. Rice also provides minerals, vitamins, and fiber, although all constituents except carbohydrates are reduced by milling.

The world average consumption of rice in 1999 was 58 kg, with the highest intake in some Asian countries; Myanmar has the highest annual consumption at 211 kg/person. Rice eaters and growers constitute the bulk of the world’s poor: according to the UNDP Human Development Report for 1997, approximately 70% of the worlds 1.3 billion poor people live in Asia, where rice is the staple food.

Rice is also the most important crop to millions of small farmers who grow it on millions of hectares throughout the region, and to the many landless workers who derive income from working on these farms. In the future, it is imperative that rice production continue to grow at least as rapidly as the population, if not faster. Rice research that develops new technologies for all farmers has a key role to play in meeting this need and contributing to global efforts directed at poverty alleviation. Apart from, the rice we can utilize for some other importance like, preparation of Rice Face Mask and Rice Recipe and different rice Biryani.

3.5. ICAR – National Rice Research Institute, Cuttack.
National Rice Research Institute (NRRI), formerly known as Central Rice Research Institute (CRRI), was established by the Government of India in 1946 at Cuttack, as an aftermath of the great Bengal famine in 1943, for a consolidated approach to rice research in subsequently transferred to the Indian Council of Agricultural Research (ICAR) in 1966. The Institute has two research stations, one at Hazaribag, in Jharkhand, and the other at Gerua, in Assam. The NRRI regional substation, Hazaribag was established to tackle the problems of rainfed uplands, and the NRRI regional substation, Gerua for problems in Krishi Vigyan Kendras (KVKs) also function under the NRRI, one at santhapur in Cuttack district of Odisha and the other at Jainagar in Koderma district of Jharkhand. The research policies are guided by the recommendations of the Research Advisory Committee (RAC), Quinquennial Review Team (QRT) and the Institute Research Council (IRC). The NRRI also has an Institute Management Committee (IMC) for formulating administrative policies.

Figure 3.2: A view of National Rice Research Institute, (Formerly Central Rice Research Institute) Cuttack, (Odisha)-753006

3.5.1. Organogram of NRRI
3.5.2. Activities of NRRI

The goal is to improve the income and quality of life of rice farmers in India.

The Mandate of the Institute are:

- Conduct basic, applied and adaptive research on crop improvement and resource management for increasing and stabilizing rice productivity in different rice ecosystems with special emphasis on rainfed ecosystems and the related adaptive stresses.
- Generation of appropriate technology through applied research for increasing and sustaining productivity and income from rice and rice-based cropping/farming systems in all ecosystems in view of decline in per capita availability of land.
- Collection, evaluation, conservation and exchange of rice germplasm and distribution of improved plant materials to different national and regional research centers.
- Development of technology for integrated pest, disease and nutrient management for various farming situations.
- Characterization of rice environment in the country and evaluation of physical, biological, socio-economic and institutional constraints to rice production under different agro-ecological conditions and in farmer’s situations and develop remedial measures for their amelioration.
- Maintain database on rice ecology, ecosystems, farming situations and comprehensive rice statistics for the country as a whole in relation to their potential productivity and profitability.
• Impart training to rice research workers, trainers and subject matter/extension specialists on improved rice production and rice-based cropping and farming systems.
• Collect and maintain information on all aspects of rice and rice-based cropping and farming systems in the country.

3.5.3. Achievements of NRRI

• The institute has released 114 rice varieties including three hybrids stable for cultivation in upland, irrigated, rainfed lowland, medium-deep waterlogged, deepwater and coastal saline cologies. Besides, three high yielding varieties and the varieties suitable for aerobic germination, low glycemic index, high protein content, super rice etc, were identified.
• The institute maintains more than 30,000 accessions of rice gremplasm including nearly 6,000 accessions of Assam Rice Collection (ARC) and 5,000 accessions from Odisha. Compiled database on passport information for more than 30,000 gremplasm accessions.
• Marker-assisted selection was used for pyramiding BB and blast resistance genes and for developing resistance rice cultivars.
• Developed a rice-based farming system including rice-fish farming system integrating multiple enterprise initiatives with a rationale for ensuring food and nutritional security, stable income and employment generation for rural farm family.
• Different bio-agents for management of rice pests and growth promotion of rice have been developed with suitable formulation for field application.
• Identified biochemical and biophysical parameters for submergence and other abotic stress tolerance in rice.
• Developed crop modeling of GxE interaction studies that showed that simulation of crop growth under various environments could be realistic under both irrigated and favorable lowlands situations and climate resilient rice varieties.
• Developed suitable rice production technologies for rainfed uplands, lowlands and irrigated ecology including production technologies for transferred to farmers.
• Addressing rice production constrains in eastern India through BGREI programme.
• Commercialized three hybrids, LCC and IPM for rice based cropping system. Submitted one plant and developed agri-enterpreneurship.

3.5.4. Number of rice research workers and their scientific productivity of NRRI

A total of 1770 rice research workers in NRRI have contributed 5362 publication during the period of 1949 to 2014.

3.5.5. Thrust areas of NRRI
This organization is committed to trait evaluation of specific germplasm and their utilization for gene discovery, allele mining and genetic improvement. Designing, developing and testing of new plant types, next generation inbred and hybrid rice with enhanced yield potential.

- Identification and deployment of genes for input use efficiency, tolerance to multiple biotic/abiotic stress and productivity traits. Developing nutritionally enhance rice varieties with increased content of pro-vitamin A, vitamin E, iron, zinc and protein.
- Intensification of research on molecular host parasite/pathogen interaction and understanding the pest/pathogen genomes for biotype/pathotype evolution, off-season survival and ontogeny for devising suitable control strategy.
- Development of climate resilient production technologies for different rice ecologies and development of cost effective and environmentally sustainable rice based cropping/farming systems for raising farm productivity and farmer’s income.

3.5.6. Linkages
The NRRI has linkages with several nationals and international organizations such as the Council for Scientific and Industrial Research (CSIR), Indian Space Research Organization (ISRO), SAUs, state Departments of Agriculture, NGOs, Banking (NABARD), and the institutes of the Consultative Group for International Agriculture Research (CGIAR), such as the International Rice Research Institute (IRRI), Philippines and International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru. (NRRI: Annual Report, 2014 – 2015)

3.6. ICAR – Indian Institute of Rice Research
Fifty years ago, establishment of All India Coordinated Rice Improvement Project (AICRIP) was a watershed in the history of rice research that helped launch a revolution in food production in India. While developing and testing semi dwarf varieties and related production technologies, the AICRIP has grown as a holistic system over the years. Established by Indian Council of Agricultural Research (ICAR), the AICRIP got elevated to the Directorate in 1975 and the same has aptly been upgraded to Indian Institute of Rice Research (IIRR) on the 50th year of its service to the nation. Indian Institute of Rice Research is vested with the mission to maintain AICRIP and develop technologies to enhance as well as sustain rice productivity, resource use efficiency and profitability of rice cultivation with least adverse impact on the environment. The Institute is also spearheading the rice research in irrigated rice ecosystem focusing on making the country not only self sufficient in food production but
also earn foreign exchange through surplus rice exports.

Figure 3.4: A view of Indian Institute of Rice Research, Rajendranagar, and Hyderabad-500 030.

3.6.1. Organogram of IIRR
The Institute with its vision and mission works under ICAR as per the system indicated in the Organogram.

3.6.2. Activities of IIRR

- To organize, coordinate and monitor multi-location testing at national level to identify appropriate varietal and management technologies for all the rice ecosystems.
- To conduct basic, strategic, applied and anticipatory research in the major thrust areas of irrigated rice aimed at enhancement of production, productivity and profitability while preserving environmental quality.
- To initiate, organize, coordinate and monitor research networks relating to problems of national and regional importance.
- To serve as major centre for exchange of research material and information.
• To accelerate the pace of technology transfer through development and adoption of innovative extension training models, self-learning modules, organizing formal training courses, frontline demonstrations, exhibitions, farmers’ day etc.
• To develop linkages with national, international and private organizations for collaborative research programmes.
• To provide consultancy services and undertake contractual research.

3.6.3. Achievements of IIRR

• More than 1037 rice varieties and 69 hybrids have been released through multi-location testing for various agro-ecological systems prevalent across the country. 46% of these varieties are meant for irrigated areas, 18% for rainfed shallow lands, 12% for rainfed uplands, 4% for irrigated areas in hills, 4% for deep and semi-deep water, 4% irrigated saline/alkaline soils, 6% for scented rice and rest for the other rice ecologies.
  - IIRR developed and released 44 varieties & 3 hybrids. Recently released varieties include DRR Dhan 39, DRR Dhan 40, DRR Dhan 41, DRR Dhan 42, DRR Dhan 43, DRR Dhan 44
  - Novel resistant genes fine mapped: $Xa33$ (for BB), $Gm3$ & $Gm8$ (for gall midge).
  - DRRH3, First medium slender type hybrid similar to Samba Mahsuri commercialized with 24 private companies.
  - Developed High Zinc and high protein lines and are under multilocation testing. Identified low GI varieties (Lalat, BPT 5204, Sampada)
  - Rice Knowledge Management Portal (RKMP), a one stop shop for rice-related information was launched. RKMP is now serving as an information highway for sharing rice knowledge across the country and globally.
  - Molecular marker technology is deployed in development of “Improved Samba Mahsuri” variety resistant to BLB with 3 genes $xa5$, $xa13$, $Xa21$.
  - IIRR has been recognized as one of the best DUS centers for maintaining a large reference collection of 629 varieties. About 1400 tons of quality seed of varieties/parental lines of hybrids developed and distributed
  - Identified superior alleles of blast resistance genes $Pi54$, $Pita$ and $Pib$ which widened the spectrum of resistance and helped to establish suitable gene deployment strategies.
  - Novel resistant genes $Xa33$ (for BB), $Gm3$ & $Gm8$ (for gall midge) are fine mapped
  - Pheromone mediated monitoring (8 traps with 5 mg impregnated lures per hectare) as well as mass trapping (20 traps per hectare) of yellow stem borer was developed
• Integrated Pest management modules suitable different ecosystems were developed and evaluated
• A national facility of AICRIP MIS was developed and successfully hosted at the URL http://www.aicrip-intranet.in

3.6.4. Number of rice research workers and their scientific productivity of IIRR
A total of 1718 rice research workers in IIRR have contributed 2951 publication during the period of 1966 to 2014.

3.6.5. IIRR future thrusts of IIRR
• This institute is committed to develop technologies to enhance rice productivity, resource and input use efficiency and profitability of cultivation without adverse effect on the environment.
• The goal is also to enhance the efficiency of the organization to take up challenges and deliver desired results with competitive funding and timely delivery. Technology transfer for rapid adoption of the new technologies by the farmer and transform these into enhanced production.
• The major targets are redesigning rice plant type with more photosynthetic efficiency, biomass and harvest index to enhance genetic yield potential, stabilizing rice productivity through improving biotic/ abiotic stress tolerance and high quality seed, improving the grain and nutritional quality and value addition of rice, evaluation and identification technologies suitable for different ecologies.

3.6.6. Linkages of IIRR
IIRR has strong and wide network of linkages and collaborations with organizations from India and abroad. The underlying principle behind these collaborations is the common philosophy these organizations share about the welfare of rice farmers. Several linkages that have proven to be successful are CG organizations (IRRI, ICRISAT), national organizations (DBT, CSIR, CDFD), Universities (Delhi University, CUH, SAUs), NGOS, KVKs, Private Sector players etc. IIRR at a glance (2015)
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