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COLLECTION, EVALUATION AND CONSERVATION OF RICES OF SOUTH ASIA WITH SPECIAL REFERENCE TO NORTH-EAST INDIA

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South Asian countries are rich in rice germplasm resources which are maintained under varied phsiography, climate, topography and tribal cultures. IRRI has conserved nearly 50,000 accessions of rices from this region. Above 8000 diverse germplasms of rice were collected from north-eastern hilly region of India by different agencies. NBPGR Regional Station, Shillong further collected 1541 accessions of rice from this region between 1985-1990. Diversity in rice germplasm resources, conservation ex situ *or* in situ, *exploitation of these resources in rice improvement programmes and potential use of wild relatives of rice from above region is discussed. Further, systematic collection from unexplored areas in the region is suggested.*

The climate of south Asia is dominated by the monsoon. There are great climatic variations within the region. The countries of south Asia include some of the wettest regions on earth as well as both hot and cold deserts. Climatic variations range from the equatorial ocean climates of the Maldives to the most extreme mountain climates in the region of the Himalayas. The NE region of India records heavy rainfall during monsoon. The world's highest rainfall is received at Cherrapunji which recorded maximum of 12000 mm, annually. However, the rainfall range in the region is between 2000 to 12000 mm. Temperature varies with the altitude and ranged from 0°C to 37°C during a year (Kaul, 1981). The altitude varies from 50 to 5000 m. The staple food of the region is rice. Under varied physiography, climate, topography and ethnic races, rice cultivation has been a major practice for production of food in this region. Much emphasis has been laid on rice cultivation and to enhance its production, keeping in view the increased population.

The collection of rice germplasm from NE region of India is important. The region comprising the states of Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura which represents 5 distinct agro-climatic areas of India. Sixty seven (67) types of ethnic tribes inhabit this region who dwell mostly in the hilly area. Due to these geographical variations and ethnic diversities, the region is endowed with a wide range of crop genetic diversity including rice. Further, proximity to other South Asian countries such as China, Bangladesh, Bhutan and Burma, has also helped in mobility, exchange as well as microspeciation of the rice germplasm. The selections made unknowingly by various ethnic groups inhabiting different altitude and climatic situations, who practiced different forms of primitive cultivation in different seasons, helped to preserve and contribute to the diversity of rice crop, especially the local landraces. Collection and conservation of these landraces of rice would be useful for posterity.

COLLECTION OF CULTIVATED RICE GERMPLASM

All south Asian countries launched and expedited their crop germplasm collection programmes since seventies. Systematic survey of rice crop germplasm has been emphasized by most of the south Asian countries since then. Chang (1975, 1984) reported the status of conserved rice accessions in different south Asian countries. Table 1. substantiates the efforts of collection of rice germplasm by the representative countries till 1982.

Table 1. Rice germplasm collected by the different south Asian countries till 1982

Countries	Total accessions (approximate)	Estimated Total
Bangladesh	6,372	8,000 +
Bhutan	121	1,000 +
India	35,000	36,000 +
Nepal	1,670	1,500 +
Pakistan	1,419	1,500 +
Sri Lanka	3,152	4,000

India leads in terms of rice germplasm collections and the estimated total. Paroda and Malik (1990) stated that about 50,000 landraces of rice are expected to exist in India. Considering the national and state collections together, a total of nearly 66,000 accessions have so far been collected. If about 50 per cent of these are duplicates, about 17,000 landraces of rice still remain to be collected. Systematic collection of rice germplasm especially from NE region of India have been made sporadically and most of the collections were maintained at Assam Agriculture Department at Titabor, Karimganj. Before 1970, two national rice germplasm collection programmes were made in the region; Manipur (MNP) collection of 904 (1955-70), while Assam Rice Collection (ARC) conducted in between 1968-71, accumulated 6,630 accessions. Emphasis on rice germplasm collection was given only during 1967-72 under the ICAR/PL 480 scheme. The survey and collection of rice germplasm made by different workers is given in Table 2.

Table 2. Area explored in the North-Eastern states of India (1960-1990)

Area covered	References
1. Arunachal Pradesh (5 districts); Nagaland (3 districts); Manipur (5 districts); Assam Hills & plains (6 districts); Meghalaya (3 districts) and Tripura (2 districts)	Sharma *et al.*, 1971, Sharma, 1982
2. Assam and Manipur	Padmanabhan, 1971; Krishnamurty and Sharma, 1970
3. Sikkim	Kihara and Nakao, 1960; Arora, 1982
4. Nagaland	Kulkarni, 1962
5. Tripura	Sashikumar and Sardana, 1987
6. Arunachal Pradesh	Asthana and Mazumdar, 1981
7. Mizoram	Anonymous, 1986
8. All north-eastern States, except Sikkim	Hore and Sharma, 1985-1990

The NBPGR Regional Station, Shillong intensified the collection of crop germplasm from the region since 1985. According to Sharma *et al.* (1971), a total of 8003 diverse rices (mostly landraces) were collected from North eastern hilly region of India by different agencies. In addition, NBPGR Regional Station, Shillong further collected 1541 accessions of rice from this region (Table-3) during the period 1985-1990.

WILD SPECIES OF *ORYZA*

Very few systematic attempts of collection have been made by the south Asian countries. However, the occurence of various wild species of *Oryza* in this region is given in Table 4. IRRI has collected almost all 22 wild taxa of *Oryza* spp. which are being maintained and used for various breeding programmes.

Table 3. Rice germplasm collected from NEH Region

States	Year						Total
	1985	1986	1987	1988	1989	1990	
Arunachal Pradesh	—	—	61	99	51	24	235
Assam	—	152	230	173	—	16	571
Manipur	—	—	—	—	10	—	10
Meghalaya	70	23	22	52	20	45	232
Mizoram	—	—	—	—	56	57	113
Nagaland	—	81	—	73	—	46	200
Sikkim	—	—	—	—	—	—	—
Tripura	—	48	—	94	38	—	180
Total	70	304	313	491	175	188	1541

Table 4. Occurence of wild *Oryza* spp. in the south Asian countries

Countries	Species	Remarks
Bangladesh	i) *Oryza rufipogon* ii) *Oryza* Sp.	— Floating rice without shattering habit
Bhutan	Unknown	Exploration and collection required
India	i) *Oryza nivara* ii) *O. officinalis* iii) *O. rufipogon* iv) *O. granulata*	Thorough and systematic germplasm collection yet to be done
Sri Lanka	i) *O. officinalis* ii) *O. eichingeri* iii) *O. rhizomatis* iv) *O. rufipogon* v) *O. nivara* vi) *O. granulata*	Collection and conservation needed
Pakistan	Unknown	Inventories of the collection not available
Maldives	Unknown	Exploration and collection needed.

In India, collaborative collection programme on wild *Oryza* species was taken from time to time. A collaborative team of CRRI-IRAT-ORSTOM collected *O. nivara* and *O. officinalis* from western India in 1984 (Krishnamurty and Sharma, 1987). Indo-Japanese team also surveyed the M.P., U.P. and Orissa states several times. NBPGR-IRRI joint exploration was also undertaken in the coastal mid-land and mountainous areas of Kerala (Vaughan and Muralidharan, 1989) and north Orissa, south Bihar and West Bengal (Malik and Vaughan, 1989). Seventy five and 132 samples, respectively, consisting of *O. officinalis*, *O. granulata*, *O. rufipogon, O. nivara and O. malampuzhaensis* (a tetraploid form of *O. officinalis*) were collected during these two trips.

No systematic effort has so far been taken to collect the wild *Oryza* spp. in the NE Region of India, in particular. However, herbarium records provide the information that *O. nivara, O. rufipogon, O. granulata, O. meyeriana* and *O. officinalis* occur in foothills of Meghalaya and various low-lying areas of Assam, Manipur and Tripura.

DIVERSITY IN RICE GERMPLASM RESOURCES

The categorical report on the collected rice genetic diversity from each south Asian country is very scanty. However, an overview has been discussed by Vaughan and Chang (1980) on Bangladesh and Sri Lanka. Further Chang *et al.* (1982) briefed about the evaluation by workers in various National Rice Research Centers of Asia.

India's rices possess wide diversity in their morphological and physiological characteristics. They vary in duration from 60 to over 200 days and can grow in varied elevations from sea level to 2300 m; they are well adapted to different seasons of the year under both upland and deepwater conditions. At one extreme are the deep water rices growing in 5-6 m water and at the other rice grows with an annual rainfall of 650-700 mm. The landraces of rice collected from NE region show the following characteristics; (a) Mostly tall, leafy plant type, a few short statured (70-105 cm) with dark green, semi-erect leaves; (b) In the collections from high elevation of Arunachal Pradesh (2000-2500 m) plant and grains much resembled the Japonica type (Vairavan *et al.*, 1973); (c) Glabrous nature of leaf and husk was rare; (d) The Manipur collection showed a good range of agro-botanical characters; (e) Some varieties were glutinous; (f) Many of the collections were drought resistant types, particularly those from the Garo Hill district of Meghalaya and high elevation Jhum area of Nagaland; (g) Protein content varied from 6 per cent to 14 per cent, in some of these collections, whereas the amylose content varied from 0 to 29.5 per cent (Sharma *et al.*, 1971) and (h) Fourteen (14) cultivars of ARC collection, from NEH region show high levels of resistance to blast (IARI-5774, 5805, 5987, 6225, 6231, 6241, 6620, 7105, 7124, 10345, 10686, 10709, 10998, 11215). All these cultivars have also shown the resistance to gall midge and stem borer (Singh, 1973). Asthana and Majumdar (1981) evaluated 235 land races of rice and a catalogue was published for 56 characters. Various ecotypes have been identified with the help of metroglyphs. Sasikumar and Sardana (1987) evaluated 134 cultivars of rice collected from Tripura and found high degree of variation for different characters. Mehra and Arora (1982) remarked that collections made from north-eastern hilly region of India provided valuable genes for disease resistance, adaptability and grain types.

NBPGR Regional Station, Shillong screened 1075 accessions of rice varieties from the NE region. Morpho-agronomical characters were recorded for these accessions, following the rice descriptors of IRRI. Promising accessions have been recorded in the Annual Report of the station from 1985-1990. Further, 378 accessions of rice germplasm were screened against leaf roller (*Cnaphalocrocis medinalis*) incidence. The accessions showing less than 5 per cent leaf rolls per plant were NKG 211, C 2018, NKG 1177, C 1987, C 1942, C 1691, MMH 6/5, MMH 6/3, IC-89127, MMH 6/9, MMH 6/12, MMH 6/13, MMH 6/17, MMH 6/18, MMH 6/19, BD 103, IC-89632, BD 142, BD 150, IC-89433, KHD 8, DKH 54 and DKH 62. Fifty accessions of rice germplasm were screened for blast caused by *Pyricularia oryzae* Cav. in the uniform blast nursery against the check variety HR 12. Among these resistant accessions were BDS 7/360, NKG 1046, IC-81392, NKG 1009 and moderately resistant were NKG 1047, NKG 359, C 1981, BDS 7/383.

CONSERVATION OF RICE GERMPLASM

Status of genetic conservation of rice in south Asian countries as per (Chang, 1982) is given in Table 1. Further, details of rice germplasm conservation in the south Asian countries are given below.

Bangladesh : "Boro", "Aus", and "Aman", are the three common types and sown in different seasons in Bangladesh. The varietal diversities are pronounced. Practically, conservation in the form of assemblage of material began since 1911. The total rice germplasm accessions conserved is 6372.

Bhutan : The Bhutanese collection maintained at IRRI is represented by only 121 accessions.

India : Land under rice covers a vast array of ecolological niches, and the diversity of rice germplasm both cultivated and wild is enormous. The conservation task for germplasm is handled by the NBPGR, New Delhi. The Rice germplasm holdings including other cereals is 35000. However, this include duplicates too. There is no genebank at present in the north-eastern part of the country and the NE region collections may also be refered to the long term repository at NBPGR, New Delhi.

Nepal: Thousands of rice varieties are grown in this small hilly country. The germplasm holding of rice (cultivar + landraces) is 1670 accessions.

Pakistan : The national collection is represented by a total of 1419 accessions. Out of these, 936 varieties have been kept in IRRI for long-term storage.

Sri Lanka : Although, Sri Lanka is a small island, it has marked variations in climatic, edaphic and hydrologic conditions. the island is a microcenter of varietal diversity. Wild rice species are widely distributed. The national collections hold 3152 accessions including 2516 landraces. Entries of about 2069 are now in IRRI cold storage as duplicate. The country has recently established its own gene bank.

Most of the wild species of *Oryza* occurring in Africa, Asia and Australia have been collected by IRRI and are being maintained for breeding utilization. The total size is around 1100 samples, many of which are heterogenous populations rather than pure strains (Chang *et al.*, 1982).

IN SITU CONSERVATION OF RICE GERMPLASM

Mostly the wild species of *Oryza* grow wildly in their respective habitat. Importance is gradually given to conserve it in the places where they are relatively safe. Vaughan (1989) has identified some areas in India and Sri Lanka where the wild relatives of *Oryza* species are conserved. Nasiruddin and Miah (1983) reported from Bangladesh that wild and weedy races of rice are mostly endemic in the deepwater rice areas especially in the central region of the country. For Bhutan, occurrence of various wild species of rice is insufficiently known. Nepal has got some varieties on floating rice in the eastern terai while wild rice species are concentrated mainly in the foothill areas. Nothing is known about the habitat preservation or so far the conservation of wild species of rice at lower altitude in Nepal where they are facing threatened. In Pakistan, Thatta district of Sind province is said to be a potential source of wild rice germplasm.

Both *ex situ* and *in situ* conservation of varieties, landraces and taxa of cultivated and wild species of rice in north-eastern region of India is practically nil. Systematic maintenance of this germplasm have not given much attention. However, a good number of collections of cultivated rice have been done by Assam Agricultural University, Jorhat; ICAR Research Complex for NEH Region, Shillong and NBPGR, Regional Station, Shillong and they are maintaining some of this material for their research purpose only. Since the establishment of NBPGR Regional Station at Shillong in 1985, systematic exploration, collection, characterisation of rice germplasms was done and the characterised germplasm sent regularly to its headquaters, at New Delhi for medium term conservation. With regards to *in situ* conservation of wild species, attention is yet to be given to both exploration and conservation aspects. Many areas are still inaccessible and unexplored and hence the status of wild rice species is necessary in this region in order to priortise *in situ* or *ex situ* preservation/conservation of such materials.

USES

Most of the national centers have made profitable use of the dwarfing gene (sd-1) contributed by *Dee-geo-woo-gen* and varying numbers of the pest resistance genes derived from IRRI lines or IR varieties. In additon to this, through local screening and selection, several national centers have incrorporated desired genes/characters for resistance or tolerance from other sources into their improved cultivars.

In south Asia, India alone has developed 322 varities up to 1985. Out of these 208 varities had one of the parent from exotic germplasm. IR-8 is alone involved in the development of 86 varities. Extensive testing of indigenous germplasm was conducted against pests and diseases. The drought resistant N22 was used in breeding Bala. TKMG, which has multiple resistance to insects and diseases, became a parent of *Ratna, Saket-4, Parijat,* CR44-1 and their improved cultivars. TKMG (a strain of *Oryza nivara*) was extensively used at IRRI as a donor of disease and insect-resistance (Khush, 1977). The tungro virus resistance of PTB-10 has been bred in to improve cultivars such as *Jyothi, Rohini,* and *Triveni.* PTB-18 possessing multiple resistance has been widely used in India and at IRRI. FR 13A is an outstanding source for flood tolerance. Salt tolerant varieties like Pokkali and cold tolerant varieties like Himdhan were developed by the Indian breeders. Introduction of TN-1, Mahsuri, China-1039, IR-8 also become beneficial as sources of dwarfism in Rice Improvement programmes in India. Mahsuri of Malaysia and Leb Mue Nahng of Thailand were used to develop photoperiod-sensitive varieties.

In north-eastern states, the best varieties which still occupy a sizeable area are the selections from indigenous paddy material. Mention may be made of *Khonorulu* relaeased in 1965 in Meghalaya for altitudes ranging rom 1300-2000 m; *Nagaland Special* tolerant to blast, *Cercospora,* leaf spots, leaf roller, brown hopper etc., released in Nagaland; *Ngoba,* a selection from local material of Nagaland released in 1966 in Meghalaya; and *Pawn Buh* released in Mizoram. All these varieties possess tolerance to blast, *Cercospora,* and leaf scald, and also have tolerance to leaf roller, white and brown hoppers. Some indigenous varieties like *Manipuri* (in Assam & Meghalaya) are also popular among farmers and occupy top place among cultivars.

Rice breeders of Sri Lanka have used the outstanding levels of resistance to insects and tolerance to adverse soil factors found in their diverse germplasm. BG-400-1 derived from OB678/IR220/H4 has resistance to gall midge, blast and the bacterial diseases. BG 276-5 originating from OB678/2, BG34-8 is resistant to gall midge and bacterial blight. BW

100 selected from H501/Podiwee-A8/H5 has resistance to blast as well as to tolerance to iron toxicity.

In Bangladesh, rice breeders have made substantial progress in improving their deepwater rices from indigenous germplasm (Zaman, 1977). Two sister lines (BR 51-91-6 and BR 51-46-C1), both derived from IR20/IR 5-114-3 and selected by the Bangladesh Rice Research Institute, have been recommended for release in Burma and India for their promising yield performance.

POTENTIAL USE OF WILD RELATIVES

Six Asian wild species of *Oryza*, contributing some useful traits are presented in the Table 5. Extensive evaluation of wild *Oryza* spp. proved that these were valuable source of resistance to insect pest. Difficulties arise in recovering desirable progenies when the genomes of the parents differed in wild rice species. But, one strain of *O. nivara* (IRRI Acc.-101508), an annual Asian weed race, has been successfully used in incorporating resistance to grassy stunt virus into the semidwarfs (Khush, 1977).

Exploitation of wild rices for rice improvement has a positive impact in the production of hybrid rice. The necessary CMS line was obtained through a cross between *O. Sativa* var. spontanea with cultivated rice. Due to this phenomenon, the rice production could be enhanced by 24-30 per cent (Lin and Yuan, 1980).

FUTURE NEEDS

Systematic collection of rice landraces and its wild relative of rice from the unexplored regions of south Asia is to be intensified in order to evaluate and conserve them before they are lost for ever. Characterisation and evaluation of unscreened rice germplasm from NE region based on diverse ecosystem is needed for crop improvement work.

Ex situ conservation of landraces, cultigens of rice, and both *in situ* and *ex situ* conservation of wild relatives of *Oryza* (at generic as well as specific level) are necessary (Anon., 1982). The potentialities of wild *Oryza* species are astonishing and it may bring major changes to tackle various stress problems to obtain the desired rice production level. Plucknett *et al.* (1986) stated that wilds" plants have been under constant pressure from pathogens, pests, severe climates and unfavourable soils and have evolved myraid strategies for survival. It is this array of defensive traits, the product of millions of years of evolution, that is so valuable in Agriculture". Genetic resources of crops including gene pools of wild species as well as its cultivated forms are surely one of most important biological treasures (Chang, 1984). Harlan (1976) stated the multifaceted advantages and utility of wild relatives which

Table 5. Wild Oryza spp. of south Asian countries and their useful traits

Species	Genome group	Distribution	Useful traits
1. *Oryza nivara* Sharma & Sastry (*O. fatua, O. sativa* var. *spontanea*)	AA	South and south-east Asia and southern China	Resistance to grassy stunt virus and blast.
2. *O. officinalis* Wall. ex Watt. (*O. mala-mpuzhaensis*)	CC	South and south-east Asia, southern China, Papua New Guinea.	Resistance to BPH, WBPH and GLH (Heinrichs *et al.*, 1985).
3. *O. rufipogon* W. Griff. (*O. perennis, O. fatua, O. perennis* subsp. *balunga*	AA	South and south-east Asia and southern China	Tolerance to stagnant flooding and acid sulphate soils.
4. *O. granulata* Nees & Arn. (*O. indanada-manica*)	Diploid	South and south-east Asia	Shade tolerant and possible adaptation to drought conditions due to its bulbous culm base (Vaughan *et al.*, 1991).
5. *O. rhizomatis* Vaughan	CC	Sri Lanka	Drought resistance (Vaughan *et al.*, 1991)
6. *O. eichingeri* A. Peter	CC	Sri Lanka	Shade tolerance and multiple pest resistance (Vaughan *et al.*, 1991).

can serve disease and pest resistance, wider adaptation and possibility of getting new cytoplasms, resistance to stress and, unpredictable characters.

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