Gains in Groundnut Productivity Illustrate Success of Resistance Breeding Based on Exotic Germplasm

by A.K. Singh and S. N. Nigam

Groundnut *(Arachis hypogaea)* is a major oilseed crop in India, accounting for 34.5 percent of total oilseeds area (24.5 m ha) and 41.3 percent of total oilseeds production (20.3 m t) in the country. Since the late 1980s there has been a gradual increase in area (12 percent), production (9 percent), and productivity (6 percent) of the main rainy-season groundnut crop. The average pod yield has increased from 794 kg ha in 1980 to 988 kg ha in 1994, again of around 1.4 percent per annum.

Although improved cultivars selected from local populations* were released around 1940, there was an almost complete lull in varietal development activities from then until 1960. Although more than 80 cultivars were released from 1960 to 1995, average productivity remained stagnant until the mid-1980s because of poor production technology, the susceptibility of released cultivars to abiotic and biotic stresses, and their poor adaptation to emerging production systems.

Joint collection by NBPGR and ICRISAT of variability in groundnut from a farmers' market (Courtesy of ICRISAT)

In the late 1980s a gradual increase in productivity was apparent, with exotic germplasm making significant contributions towards it. Many old and new leading cultivars-such as JL 24, GG 2, ICGS 11, ICGS 44, Kadiri 3, ICGS 76, and M 13-owe their origin to exotic germplasm. Until 1976, Indian groundnut breeders had access to only about 5,000 germplasm accessions with a narrow range of genetic variability. The variation available for abiotic and biotic stresses in these accessions was little understood or non-existent.

*AK 12-24, TMV 2, Gangapuri, Kopergaon, and TMV 1.

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ICRISAT World Repository of Groundnut Germplasm

In 1976 groundnut was included in the mandate of ICRISAT which was designated by IBPGR and CGIAR as the world's repository of groundnut germplasm. Since then, ICRISAT has collected and assembled about 15,000 accessions, including 450 accessions of wild *Arachis* species from 9 1 countries in collaboration with such national/international organizations as NBPGR in India; Centro Nacional de Recursos Geneticos e Biotecnologia (CENARGEN) in Brazil, center of origin and primary and secondary center of diversity of genus *Arachis* (see DIVERSITY, vol.7, nos. 1&2,pp.59-61); USDA; and IBPGR/IPGRI.

Systematic screening for resistance to various abiotic and biotic stresses has resulted in the identification of numerous sources of resistance in cultivated groundnut and their utilization in the breeding program (see Table). The availability of these sources of resistances has reoriented the breeding objectives not only in India but in all groundnut-growing countries with active breeding programs.

Since 1980, ICRISAT has distributed 38,362 seed samples to groundnut researchers in India, leading to increased use of exotic germplasm in the national breeding program. On average, 46 percent of the new groundnut varietal proposals between 1985 and 1995 in the All India Coordinated Research Project on Oilseeds dealt with varieties which had exotic germplasm in their parentage.

The first Indian groundnut cultivar with multiple disease resistance, Girnar 1, was released in 1988. One of the parents of this cultivar was NC Ac 17090, a landrace from Peru assembled from North Carolina. Since then, two more cultivars with multiple resistances, ICG(FDRS) 10 and ICGV 86590 have been released in India. Now, most of the new cultivars have resistance/tolerance to one or more stresses. The full impact of these cultivars at the farm level is yet to be realized as they need further improvements to their agronomic characteristics, e.g., in shelling outturn and crop duration. However, their performance in disease and insect pest endemic areas has been considerably better than that of local cultivars.

Wild Species Provide More Resistance

Another significant development, since 1980, has been the exploitation of wild *Arachis* species in resistance breeding. The wild *Arachis* species have provided both a higher level of resistance than that available in cultivated groundnut to some, e.g., rust, early leaf spot, late leaf spot, peanut bud necrosis disease and *Spodoptera,* and resis-

SCREENING AND USE OF GROUNDNUT (*ARACHIS HYPOGAEA*) GERMPLASM ACCESSIONS AT ICRISAT ASIA CENTER

Specific trait	*Number screened*	*Number identified*	*Number utilized*
Disease resistance			
Late leaf spot (*Phaeoisariopsis personata*)	10,201	59	19
Rust (*Puccinia arachidis*)	10,201	154	35
Peanut bud necrosis virus	7,400	23	6
Peanut mottle virus	6,944	2	2
Aspergillus flavus	582	17	4
Pod rot (*Sclerotium rolfsii*)	3,222	24	6
Pest resistance			
Thrips (*Thrips palmi*)	5,345	14	7
Jassids (*Empoasca sp.*)	6,845	30	7
Termites (*Odontotermes sp.*)	520	20	6
Aphids (*Aphis craccivora*)	600	4	1
Leafminer (*Aproaerema modicella*)	10,201	18	6
Abiotic stresses/nutrition			
Drought	820	38	8
N fixation	342	4	2
High oil	8,868	44	10
High protein	8,868	51	[illegible]

tance to such stresses as peanut mottle and peanut clump virus, for which resistance is not available in cultivated groundnut.

Some of these resistances have been successfully incorporated into cultivated groundnut from compatible wild *Arachis* species, e.g., *A. cardenasii,* resulting in the production of large number of *A. hypogaea*-like stable tetraploid interspecific derivatives. These are now being utilized in resistance breeding programs. Attempts are also in progress to introgress desirable gene(s) from incompatible species using *in vivo* hormonal application, *in vitro* embryo rescue, and genetic transformation techniques.

Although the gains in groundnut productivity have not been as spectacular as in cereals, the progress achieved in the last decade suggests that greater research emphasis and utilization of emerging technologies could achieve much higher rates of growth in future.

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South Asia Partnerships Forged to Conserve Rice Genetic Resources

by G. Loresto and M. Jackson

In South Asia-Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka-rice is highly diverse in terms of genotypes and growing conditions. Domestication brought about a number of morphological and physiological changes compared with the wild rices. Cultivar preferences and social and religious practices contributed further to the diversity in rice varieties. Panicle type, grain shape, size and weight, color and awning, maturity, and plant height are among the most morphologically diverse traits of this staple crop of half the world's population.

As one of the primary centers of origin for cultivated rice *(Oryza sativa),* ***India*** contains a rich and diverse genetic wealth of rice, and many varieties have been used as parents to breed modem cultivars with resistances and high quality. In ***Bangladesh,*** rice varieties are classified as *aus* (short-duration summer crop), transplanted *aman* and broadcast *aman* (main crop and photoperiod-sensitive), and *boro* (adapted to cool climate). In ***Bhutan,*** rice farming is concentrated in the central zone valleys, from the foothills to areas with an altitude of about 2,500 m. The traditional rice varieties grown at higher altitudes are important sources of cold-tolerant germplasm.

In ***Nepal,*** rice is cultivated from an elevation of about 40 m in the subtropical southern terai region to 2,800 m in the Jumla Valley in the cold-temperate northwest hill region, the latter containing some of the world's highest rice fields. Cultural types range from the upland, cold-tolerant, rainfed type in the mid-hills to the floating rices in-the eastern terai. In ***Pakistan,*** rice grows under average temperatures of 33° C in the upper Sind region. Rices from this area are good genetic sources for grain quality. In ***Sri Lanka,*** a group of varieties with short and bold grains, locally known as Samba, is popular for its good cooking and eating quality. The varieties are mostly long-duration and photoperiod-sensitive types, although varieties grown from April through October are insensitive to photoperiod.

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Six wild rices are endemic to South Asia. One species, *O. eichingeri,* which is abundant in central and eastern Africa, has been found in forest pools in Sri Lanka. The wild progenitor of Asian rice, *O. rufipogon,* and its weed race, *O. nivara,* grow abundantly in swamps, open ditches, swampy grassland, and deepwater rice fields throughout South Asia. *O. granulata* is found in deciduous forests and bamboo thickets in India, Sri Lanka, and Nepal. *O. rhizomatis* (described only in 1990) is from the tropical forests and open, tall, scrub vegetation in Sri Lanka. *O. officinalis* is abundant in India and has also been reported in Bangladesh.

International Partnerships

International partnerships to conserve rice germplasm in South Asia have been effective for more than three decades. The International Rice Research Institute (IRRI) provides safety duplicate storage of rice germplasm from the region at its International Rice Genebank (IRG) in the Philippines. In 1970, the first batch of 600 samples of *O. sativa* from the Assam Rice Collection at the Central Rice Research Institute, Cuttack, India, was sent to IRRI. In 1972, another batch of 2,540 samples was sent through the Indian Council of Agricultural Research (ICAR), followed by a third batch of 2,885 in 1977. Other countries have also duplicated all or parts of their rice collections at IRRI (see table).

Following an international symposium on rice breeding held at IRRI in 1971, the institute initiated a coordinated program to collect farmer varieties. By 1978, more than 3,400 samples had been collected in India, 735 in Pakistan, and 121 in Bhutan.

IRRI scientists worked with Bhutanese farmers to establish research priorities. (Courtesy of IRRI)

In 1978, the International Board for Plant Genetic Resources (now the International Plant Genetic Resources Institute, IPGRI) committed funds for a five-year period to support rice germplasm exploration in South and Southeast Asia, leading to the collection of 1,096 samples in Nepal and more than 2,200 samples in Sri Lanka. The teams of IRRI and national staff made special efforts to collect farmer varieties of Asian rice in remote areas and special types in unusual rice-growing habitats. In the late 1980s the collecting emphasis turned to the wild species of rice. Up to 1992, 692 wild rice samples had been collected from India, 119 from Sri Lanka, 100 from Bangladesh, and 40 from Nepal.

Collecting efforts continue today with