

GENETIC IMPROVEMENT OF CROPS

Gene manipulation using conventional and advanced approaches as well as genetic resource conservation and evaluation is an on-going activity that supports the national crop improvement programme to cope with the biotic and abiotic stresses while maintaining high level of productivity, profitability and quality.

The main focus remained on self sufficiency in wheat maize, sugarcane; export enhancement in rice; import substitution in edible oil (sunflower & canola), & pulses and value addition in fruits (citrus, mango, apple, banana) and vegetables (potato, tomato, chillies, onion, peas, cucumber, radish, cauliflower, cabbage etc.). Among biotic stresses rust, blight, rot, fruit fly, stem borer, hoppers and aphids were of major concern. Heat, cold, drought and salinity were the important a biotic stresses addressed.

The major research thrusts in wheat and barley were high yield, better quality, resistance to rusts, drought, heat and salinity, in rice the major focus was on high yield, better quality, short duration, salt and cold tolerance and resistant to insects (stem borer, leaf folder and white back plant hopper). Similarly in pulses and oilseeds crops the main emphasis was given on recovery, better ratooning, heat, frost, salt and drought tolerance. For horticultural crops the main emphasis was given on yield increase and better quality.

WHEAT

- Out of 400 bread wheat lines tested at NARC for their yield potential, following three lines were selected for their high yield under drought conditions and for disease resistance.

Parentage	Grain Yield (Kg/ha)	Yellow Rust
FERT2/KUKUN//FRET2	4990	5MS
WBLL:I*/TUKURU	4763	0
FRET2/TUKURU//FRET2	4731	0



National Uniform Wheat Yield Trial

- Rain-fed wheat variety selection studies identified NR-234 as maximum grain yielder (3600 kg/ha) than prevalent rain fed wheat varieties (Wafaq-2001, Margalla-99, GA-2002). In another similar study disease resistant NR 283 produced 5.0 t/ha grain yield under rain-fed conditions.



Wheat Line NR-283 for rainfed agriculture

- Rust resistance studies identified line NR-267 with Inqalab background having 29% more grain yield (4.11 t/ha) than local check (GA-2002) in National Uniform Yield Trials (NUYT) at NARC that showed genetic resistance against yellow and leaf rust and barley yellow dwarf virus.

BARLEY

- An advance barley line (NRB-32) developed by NARC was top yielding (2.97t/ha) in National Uniform Yield Trials followed by another NARC line (NRB-37) by producing 2.90 tonnes per hectare.



NRB-32

RICE

- High yielding and short duration rice variety 'SHAHKAR' with good quality and resistance to insect pests and diseases was developed from germplasm identified by PARC and released for cultivation by Rice Research Institute.



Shahkar variety in the field

- Testing for high yield identified promising lines 00521 and 00516 in the aromatic group, and lines RD25 and KSK202 in the coarse group.
- The hybrid development studies identified GNY403 and 402 better performing compared to the check variety KS-282.
- The cold tolerant testing of rice identified HEXI 22 to be the candidate for further studies.
- Stem borer resistance studies identified seven resistant lines out of 52 tested.
- Leaf folder resistance investigations identified 2 wild rice species *Oryza rufipogon* and *O. brachyantha* resistant to leaf folder.
- White Backed Plant Hopper (WBPH) studies identified one WBPH resistant line from 55 advance breeding lines tested under semi-controlled condition at NARC.

PULSES

The Pulses Improvement Programme concentrated studies on mash, mung, chickpea and lentil.

- Mash variety trial identified NCH 3-4 highest grain yielder with 806 kg per ha followed by VH-9440034-1 with 798 kg per ha and NCH-9-2 (796 kg/ha). However, in the National Uniform Yield Trial at NARC VH-9440023-1 gave the maximum grain yield (848 kg/ha).
- Mung bean preliminary yield trial found Line 40521 as the highest yielding genotype (1076 kg per ha).
- In national lentil testing trials 98-CL-008 was significantly high yielding with across the locations mean seed yield of 1261 kg per ha.

MAIZE, SORGHUM AND MILLET

- Millet variety Bajra Super-1 and sorghum variety Johar were recommended by the Variety Evaluation Committee for cultivation.
- Maize variety development trials identified two of the NARC Elite Hybrids NARC-2704 and NARC-2705 that performed at par with the best commercial hybrids and produced more than ten tons per ha during spring. Three maize varieties Swan-3, EV-3001 and EV-4001 are in the pipeline.

OILSEEDS

Sesamum

- Genetic resource studies identified 58 higher seed yielding accessions out of 115 tested ranging in yield from 495 to 1110 kg/ha.

- Sesamum yield trial found three lines SG-54, SG-29 and SG-60 producing seed yield of 542, 540 and 533 kg per ha against the check variety TS-3 with seed yield of 511 kg per ha.

Groundnut

- Genetic resource studies selected 66 lines from among 612 tested on the basis of yield and other economic trades for further evaluation.
- Groundnut hybridization studies evaluated 80 progeny rows in F-6 and F-7 of different crosses of groundnut and 31 entries from F-6 and 17 from F-7 generation were selected for use in preliminary yield trials.

Soybean

- Soybean yield trial found four high yielder lines AGS-5, 95022, 95037 and AUST-92-4 producing yield of 2205 to 2420 kg per ha against check (Ajmeri) yielding 2021 kg per ha from among 14 genotypes evaluated.

Linseed

- Genetic resource evaluation found 10 high yielder entries (1127 to 2053 kg/ha) than Chandni (Check with yield of 1193 kg/ ha).
- In variety evaluation trial, out of 10 varieties tested 6 produced more seed yield than the check.

Safflower

- In germplasm evaluation trial 2 entries SAF-23 and SAF-19 produced higher yields of 2853 and 4133 kg/ha from among the 25 entries tested.

Sunflower

- Twenty-four inbred lines are under different stages of development and 64 inbred lines have been maintained for use in hybrid combinations. Seven hybrid combinations were evaluated in preliminary yield trials.

Rapeseed

- Twenty-four F-1 hybrids were evaluated for heterosis and combining ability. The highest seed yield of 1785 kg per ha was produced by Mustard entry BARD-1 followed by Rapeseed entries Shiralee with seed yield of 1613 and 19-H with seed yield of 1607 kg per ha.

SUGAR CROPS

- Evaluation of National Uniform Yield Trials found nine varieties resistant against whip smut out of 16 tested.

- Sugarcane varieties HSF-242 for Punjab, LRK-2001 for Sindh and Mardan-2005 for NWFP developed through coordinated programmed of PARC were approved and released for commercial cultivation in their respective areas.
- A pool of 405 lines of national and international sugarcane germplasm was maintained at NSCRI Thatta for variety breeding and development programme. In preliminary yield trial, performance of nine promising sugarcane genotypes was tested against check variety Thatta-10. All of the genotypes were promoted to advance variety trial for further evaluation.

Evaluation of sugarcane germplasm pool



FODDER

- On the basis of National Fodder Uniform Yield Trials following lines of the fodder crops (sorghum, millet oats and berseem) have been selected for release as varieties:

Fodder crop	Varieties
Sorghum	98CS007 F9917
Oats	Scott 677
Millet	AF-pop Composite
Berseem	S-1 S-2

- Alfalfa variety evaluation trial found variety Siriver highest yielder with 80 tons per ha and 07 fresh cutting per year from among 6 varieties tested.
- Berseem variety trial found Agaiti as highest yielder of 60 tons per ha.

VEGETABLE CROPS

The vegetable germplasm evaluation studies focused peas, radish, chillies and potato:

- Ten high yielding pea accessions with the yield of 5-10 t/ha were selected.
- One high yielding radish accession with root yield of 40.0 t/ha was selected.
- Three high yielding chillies lines were selected (yield 675-900) gm/plant).
- Potato clone SH-5 (28.63 t/ha) was selected for release as new variety in Pakistan.
- Three newly developed true potato seed hybrid families (TPS-9804, TPS 9813 and TPS 9815) were found at par with imported hybrid families.

FRUIT CROPS

- Citrus hybrids were developed through reciprocal crosses between mandarin (kinnow) and Orange (Mussambi, Salustiana) having characters of early fruit maturity and lower acid content as compared to Kinnow.

PLANT GENETIC RESOURCES

Genetic resources collection, evaluation and conservation focused on vegetables, medicinal plants, grapes, cereals and pulses.

- A total of 250 accessions of vegetables, medicinal herbs and grapes were collected from various agro-ecological zones of Pakistan and conserved in the Gene bank.
- Clonal repository of grapes comprising 146 accessions collected from various parts of Pakistan was established and maintained at NARC for characterization and future utilization.
- Total 2462 accessions of cereals, pulses and vegetables were tested for seed viability through standard germination tests. Accessions showing less than 85% viability will be rejuvenated in the field during next cropping season.
- Genetic characterization of wheat, brassica spp., sorghum, maize, barley and rice germplasm revealed wide variation for traits of economic importance.
- Screening of *Pisum sativum* germplasm for Powdery mildew (*Erysiphe pisi*) revealed that three genotypes were highly resistant (Acc# 019788, 022420, 022421). Among 377 accessions, eight with high yielding characters were identified.
- Wheat lines early in maturity, longer spikes, more grains per spike and 1000- grain weight were selected. Five accessions moderately resistant to leaf rust were identified under natural conditions.
- Forty-nine accessions of guar germplasm were evaluated against bacterial blight (*Xanthomonas axonopodis* pv. *cyamopsidis*) under natural field conditions. Of these, sixteen entries were found resistant whereas eight showed moderately resistant reaction.
- A total of 1112 accessions of various underutilized/medicinal crops were multiplied and rejuvenated in the field. These accessions were characterized and evaluated for various morphological and agronomic traits. Based on field evaluation data, some elite lines for yield and yield related traits were identified.
- A total of 42 accessions of sesame were studied for the presence of seed borne mycoflora. Results revealed that pathogenic fungi *Fusarium oxysporum*, *F. solani*, *Rhizoctonia bataticola* and *Alternaria sesami* were present in accession 19568, 19542, 19613, 19602 and 19607, whereas saprophytic fungi like *Aspergillus niger*, *penicillium rubrum*, *Aspergillus flavus* and *Rhizophus stolonifer* were found in higher percentage in almost all accessions.
- Pea germplasm was analyzed for total seed protein and data were used to explore relationship between disease and SDS-PAGE markers but no linkage was observed. Seed proteins exhibited medium to high genetic diversity, whereas this technique did not reveal any intra-specific variation in most of the legumes. SDS-PAGE of total seed proteins for 95 accessions of rice including wild species and 160 accessions of wheat revealed variation for total seed proteins and HMG subunits, respectively. SDS-PAGE was also employed to evaluate genetic diversity in rice (90 accessions) and maize (30 accessions).
- Protocol for DNA isolation from seed was standardized and DNA from 41 varieties of wheat, 50 varieties of rice and 32 accessions of *Nigella sativa* was extracted and quantified. A number of random primers were utilized to amplify the DNA using PCR.

AGRO-BIO-TECHNOLOGY

Agro-biotechnology studies continued to focus development of transgenic rice, wheat and tomato, wheat:

- Transgenic plants of rice were regenerated from independent calli in seven rice cultivars (Basmati 385, Basmati 2000, Super Basmati, JP-5, Swat-1, Swat-2 and DR-83). Increasing the concentration of acetosyringone enhanced transgenic plant production. 400 μ M acetosyringone promoted maximum production of transgenic plants. GUS expression was found higher in DR-83 (90%) as compared to other cultivars.
- An efficient *Agrobacterium* mediated transformation protocol was developed in wheat by using mature embryos (4 days old) as an explant source. Inclusion of phenolic compounds like acetosyringone at the rate of 100 μ M was vital for transformation. The transformation efficiency was 6.4% and 7.31% for Chakwal 97 and Inqilab 91, respectively.
- In tomato effort was focused on introducing gene for bacterial wilt resistance in different cultivars (Riogarande and Moneymaker). Hygromycin at 25 mg/l was optimized for selection of transformed calli and plants. Transformation efficiency of Riogarande and Moneymaker was 24% and 6.6%, respectively. Twelve transgenic plants of Riogarande and four of Moneymaker are under evaluation.