ANNUAL REPORT
2021-2022

Pakistan Agricultural Research Council

PARC

Annual Report 2021-22

PARC

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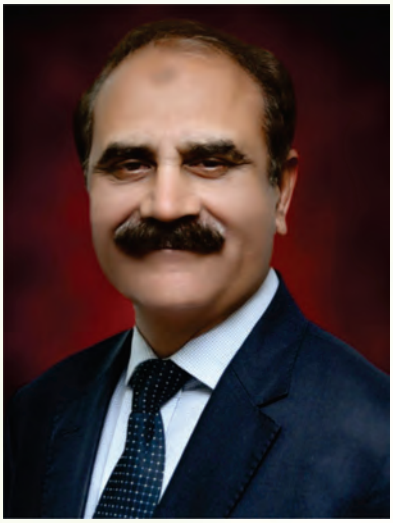
FOREWORD FROM THE CHAIRMAN



Agriculture is the mainstay of Pakistan's economy. Sustainable growth of the agriculture sector stands vital for our food security and rural development. A vibrant agriculture sector is vital for social and economic growth. A major portion of our population is still living in rural areas. Raising the income of farmers and rural landless laborers is one of the key steps towards rural development and urban employment enhancement. It is obvious that there cannot be any significant economic development in the country without drastically increasing productivity of agriculture sector. Agriculture research is the only solution that can really produce a deep impression on the agricultural productivity and has to be given due and far most priority in planning for economic development. Under Sustainable Development Goals (SDGs) Pakistan has set the target to double the agricultural productivity and income of small food produce by 2030.

Currently, agriculture is facing numerous challenges to the food production sector and climate change has been evolved as the leading one amongst others. To withstand the adverse impacts of climate change, this sector needs to be transformed as vibrant and resilient to conceal the livelihood of resource poor farmers and agro-based industry. PARC being one of the apex research organizations is striving its best to revolutionize agricultural research system with advanced technologies for productivity enhancement of this sector in order to ensure food security of the general masses.

In order to enhance crop productivity, numerous initiatives have been taken under Prime Minister's Agriculture Emergency Program. The key interventions include promotion of mechanization (crops specific machinery), development of high yielding varieties/hybrids, promotion of improved crop management through demonstration and ensured availability of certified/tested seed. In addition to that, extension services will be re-organized at all level as well as crop processing and value addition with upgraded facilities.

The major focus of Plant Sciences Division (PSD) is sustainable improvement in productivity and quality of crop commodities. Salient activities towards achieving this goal includes development of varieties/hybrids, resistant and resilient to key biotic and abiotic stresses, and improved packages of production technologies. The report also highlights the activities effective linkages with national and international research organizations/institutes. Furthermore, salient highlighted findings of various studies conducted to increase productivity through enhanced resilience in our cropping systems are of great importance and will benefit the farming community.

The knowledge generated by Natural Resources Division (NRD) for conservation of land, water, range and agro-forestry resources has a great worth for farming community and sustainable use of natural resources. Major focus was on climate smart agriculture, redefining the agro-ecological of the country, the integrated nutrient management, bio-fertilizer development for various crops, piloting of climate-smart agriculture intervention, introduction of responsive drip irrigation system, water conservation and proper utilization, integration of solar and high efficiency irrigation system for high value crop, quality honey production, range improvement and agro-forestry.

Animal Sciences Division (ASD) focused at improving productivity of livestock through

management, feeding, disease control and genetics of the native breeds. Genetic improvement of livestock, optimization of artificial insemination techniques in small ruminants and development of mono-sex tilapia fish remained on high agenda. Agricultural Engineering Division's (AED) worked on design, develop, adapt and promote energy-efficient and precision agricultural machinery and post-harvest technologies for cereal, fruits, vegetables and other crops. Design and operation of regenerative agriculture machinery is the landmark success of our machinery scientists.

Similarly Planning and Development Division played its significant role in successful implementation of PSDP projects and processed quality projects under competitive grant under Agricultural Linkages Program (ALP).

Dr. Ghulam Muhammad Ali
Chairman

PLANT SCIENCES DIVISION

Plant Sciences Division (PSD) is focusing on sustainable improvement in productivity and quality of crop commodities, following PARC's mandatory role of undertaking, aiding, and coordinating agricultural research in the country. Major activities towards achieving this goal includes development of improved varieties, provision of relevant germplasm from various domestic and overseas sources to relevant partners belonging to National Agricultural Research System (NARS). The presented report highlights the outcome of significant in-house studies as well as coordinating activities performed during the report period.

Major coordination activities include

i. **Germplasm Acquisition** for evaluation/characterization and Distribution to NARS partners for utilization in breeding programs and enhancing the genetic diversity (Figure 1).

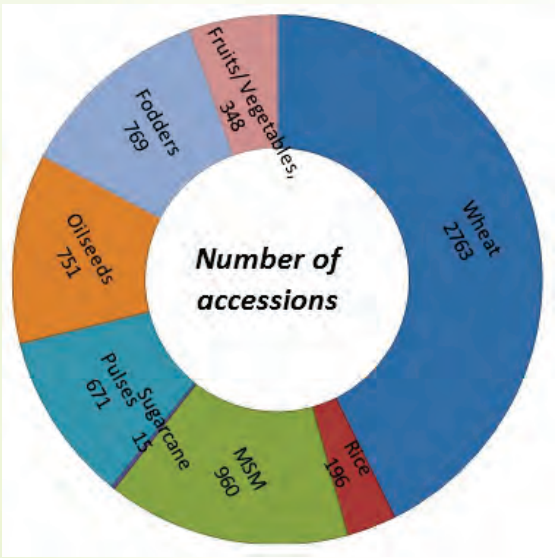


Figure 1: Germplasm Acquired/Distributed

ii. **Conducting National Uniform Yield / Adaptability Trials.** These trials provide the basis for commercial release of potential varieties/hybrids in the target ecologies (Figure 2).

iii. **Variety Evaluation Committee Meetings** held for oilseed crops (21-09-2021), potato (21-10-2021), and maize/ sorghum/ millet (09-05-2022).

iv. 27 varieties/hybrids of oilseed crops, 6 of potato, and 79 of MSM found promising and recommended by VEC to be released for commercial cultivation.

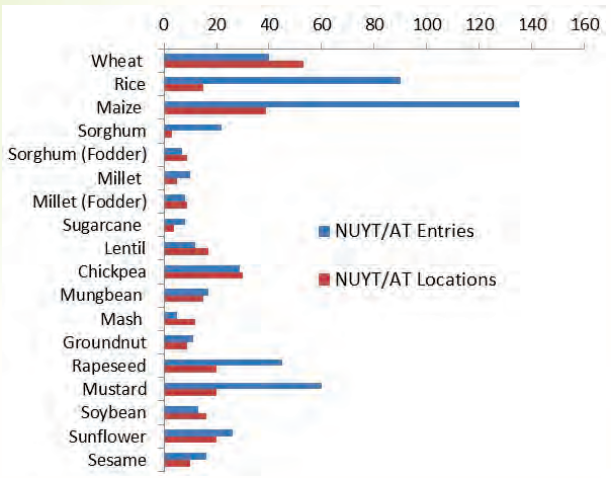


Figure 2: NUYT/AT Entries/Locations

WHEAT

i. 676 advance lines under station yield trials and national regional (multi-location) yield trials, 20 advance lines to the Provincial Uniform Wheat Yield Trials, 06 advance bread wheat lines and 02 durum lines were contributed for testing and further evaluation.

ii. Characterized and assessed 1485 test entries for yield potential, diseases resistance and high zinc content. About 750 crosses were attempted to develop diverse recombinants.

iii. Maintained 1130 populations at different filial generations.

iv. Speed Breeding Facility (Greenhouse) has been constructed and it has started functioning.

v. 15 experiments were conducted to find out the most suitable Planting time, Seeding density, Fertilizers levels, Biofertilizers, Nano particles, Zinc application, Biochar, growth promotors etc. to find out the best management practices.

vi. Spot examination of an advance line NR 533 has been done.

vii. 125 demo plots were planted on farmer fields/ research centers on zero tillage planting, planting of

wheat on beds and ridges, improved wheat varieties etc. in different ecologies.
viii. 15 Field Days /Trainings conducted in different ecologies of Pakistan.
ix. 10 students from various universities completed their internships.
x. 325 tons of wheat seed of different categories i.e. 2.0 tons BNS, 25 tons Pre-Basic 180 tons Basic and 100 tons certified seed of varieties i.e. Pakistan-2013, Borlaug-2016, Zincol-2016, Markaz-2019 and AZRC Dera.

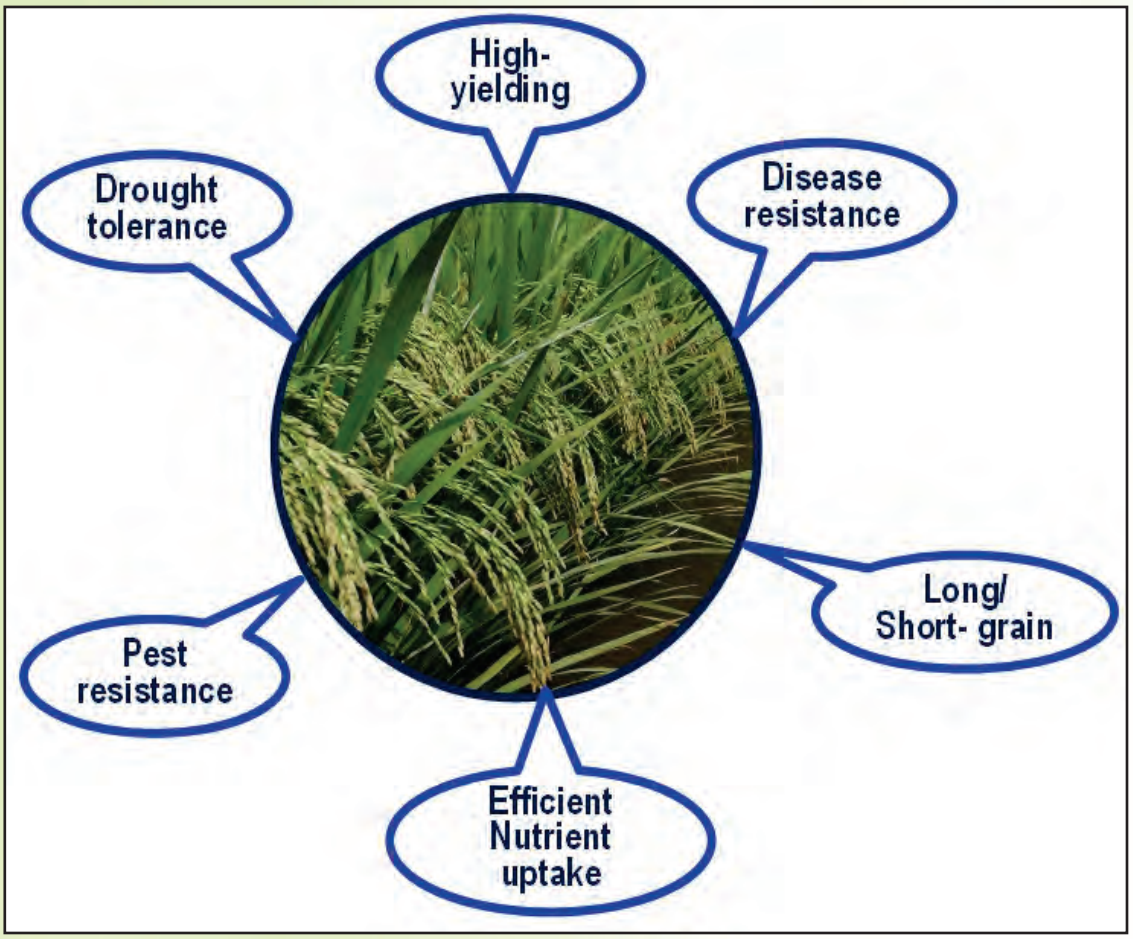

NARC wheat research field area

RICE

i. 03 Advanced Yield Trials (AYT-I 2021, AYT-II & AYT-III) at 16 locations evaluated.
ii. 01 Preliminary Yield Trial with 65 lines screened and 20 high yielding lines selected.
iii. 69 entries comprising of IRRI INGER nursery have been evaluated.
iv. 15 genotypes acquired from different public and private sources, planted for evaluation and utilization in breeding program.
v. 20 GSR lines and commercial hybrids screened against drought stress by the application of PEG at 3 different levels (10%, 15% & 20%), 08 of them were tolerant.
vi. A set of 35 promising lines planted for the evaluation of potential to withstand the higher water level in case of floods. 10 lines found to exhibit significant level of tolerance.
vii. Testing of Filial generations has been done as F1 (50 genotypes), F2 (32 genotypes), F3 (Reverse breeding from commercial hybrid) lines.
viii. F3 (Reverse breeding from commercial hybrid) lines. 103 lines for Off-season generation advancement also practiced at RRI Dokri, Sindh.

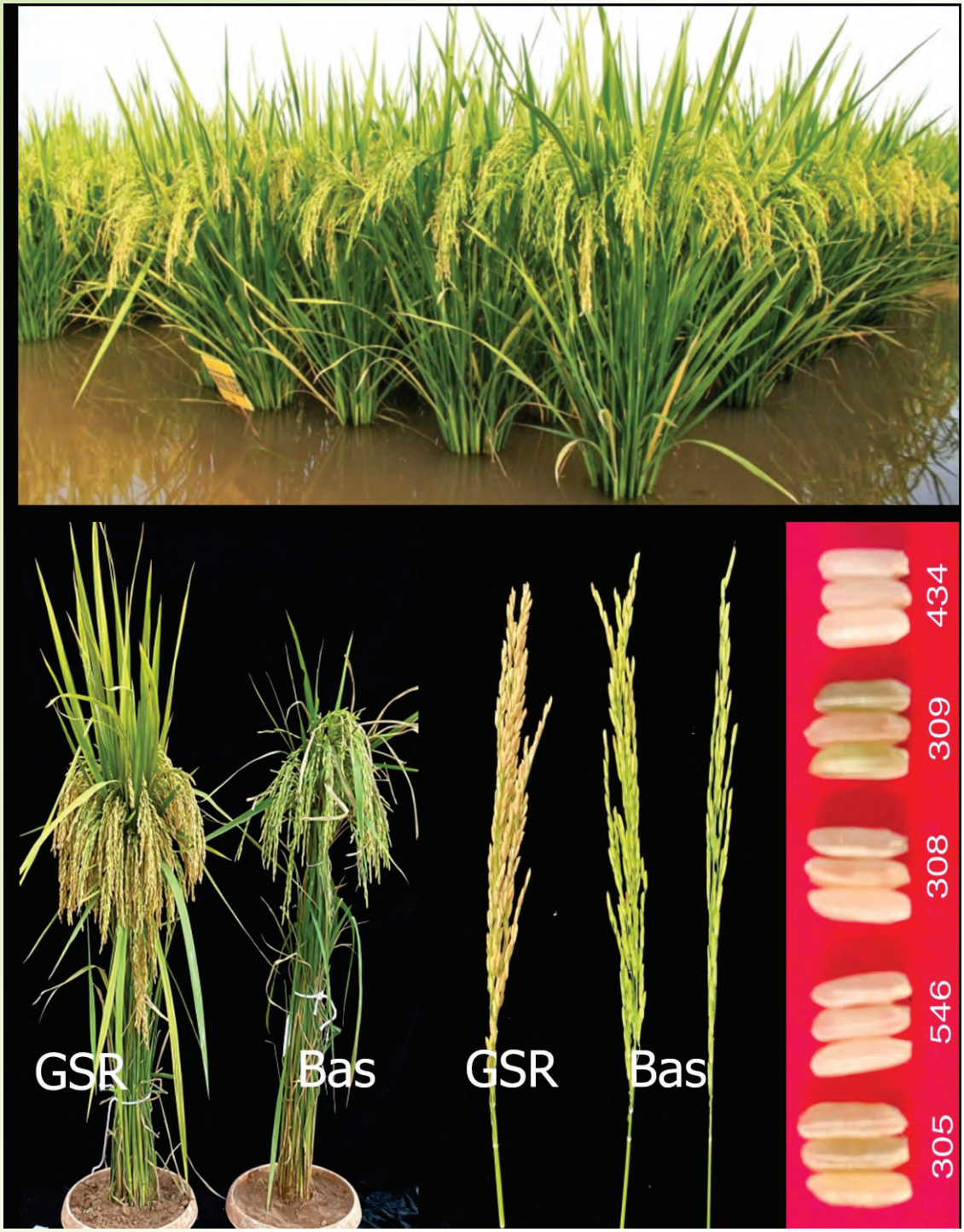

NARC rice research field area

ix. Crossing Block comprising of 95 genotypes (old and new rice varieties, GSR lines and hybrids etc.) planted. 250 fresh crosses attempted, out of which 64 harvested successfully.
x. Marker Assisted selection has been performed where 80 parental lines have been tested against BLB resistant genes by using SSR markers.
xi. 21 rice genotypes i.e. hybrids, landraces, varieties and GSR, examined at varying water availability (100%, 50% less and 75% less than normal).
xii. PK-1121 a promising commercial variety planted by three methods. Mechanical transplanting



Pyramiding of Desirable Traits

Comparison between GSR Lines and Basmati Lines



Development of 552Advanced Lines of High Yielding & Long Grain Green Super Rice (GSR) at National Institute for Genomics & Advanced Biotechnology (NIGAB), NARC, PARC, Islamabad

method found most efficient with enhanced productivity and profitability.
xiii. 05 MS and 01 PhD researchers conducted research.

MAIZE, SORGHUM & MILLET

i. 02 Maize varieties i.e. NARC 2 and NARC 3 recommended by VEC.
ii. 03 Maize elite varieties CZP132001, MSMOPV2, and MSMOPV3 characterized and also completed the DUS data for the 2nd year.
iii. An experiment on three Maize OPVs (Haq Nawaz Gold, CZP132001, MSMOPV3) with 4 fertilizer treatments. 5-7% yield increase recorded in treatment with Biozote combination.
iv. 250 Maize inbred lines (local and exotic sources) evaluated under glass house for various roots architectural parameters.
v. 100 pearl millet accessions planted for assessment of grain yield and some of the accessions were selected for second year evaluation.
vi. 03 NUMYT trials, Maize Hybrid Trial Year 1(129 entries), Maize Hybrid Trial Year II (63 entries) and Maize OPVs (07) evaluated.
vii. 04 NUYTs i.e. 2 Maize hybrids with 183 and 102 entries, 01 Sorghum with 14 entries and 01 pearl millet with 52 entries conducted.
viii. 6 tons of maize, sorghum and millet seed was produced.
ix. 03 MS and 06 BS students conducted research.


NARC maize research field area

PULSES

i. 05 Promising advance genotypes contributed to NUYTs (2 Mung, 1 chickpea and 2 lentil).
ii. 18 disease resistant lines identifies i.e. 07 chickpea lines against Ascochyta Blight and 11 lentil lins against stem rot identified as resistant.
iii. Identified and selected 11 genotypes in lentil and 33 genotypes in mash having erect plant type suitable for machine harvesting.
iv. 68 Lentil and 26 Chickpea lines identified as tolerant against Lectofen herbicide.
v. 13 new cross combination were developed in chickpea, lentil, mung and mash to create genetic variability through hybridization.
vi. 639 germplasm genotypes evaluated for genetic diversity i.e. chickpea (175), lentil (130), Mung


NARC pulses research field area

(120), Mash (50), Fababean (80), Red kidney bean (59) and Cowpea (25).
vii. 200 demo plots of Chickpea, Mung, Mash and Lentil planted in Potohar region and Jafferabad to disseminate improved production technology of pulses.
viii. 05 farmer field days, 03 awareness seminar and 2 training courses conducted at Chakwal, Attock, Bhakkar, Karak and Jafarabad with total of 1000 participants.
ix. 20 tons of quality pulses seed produced (Mung 12 , Mash 01 , Lentil 1.6 & Chickpea 5).

OILSEEDS

i. Four (04) Oilseed varieties (Two Groundnut i.e. NARC-2021 and NARC-ORP-1, one Til i,e, PARC-Til and one Soybean i.e. NARC-Soy-2021) recommended by VEC.
ii. 48 Sunflower and 245 Rapseed inbred lines (A, B & R) and 276, 265, 100 and 100 accession/lines of Groundnut, Soybean, Rapeseed-Mustard and Sesame were planted for screening, purification, maintenance and seed increase.
iii. Thirty one (31) sunflower and 30 Rapseed hybrid combinations were made.
iv. Spot examination of three varieties i.e. PARUSN-3, SMH-0927 (Sunflower) and NARC-Soy-2021 (Soybean) planted at different ecologies was done.
v. 14 advance lines/ hybrids included in NUYT trials that included 02 Sunflower hybrids, 05 rapeseed-mustard lines, 02 Soybean lines, 03 Sesame lines and 02 Groundnut lines.
vi. 12 BS students facilitated for internship training.
vii. 107.9 tons of quality seed i.e. Soybean (100 tons), NARC Sarson (7.5 ton) and Groundnut (0.4 ton) produced and given to farmers.


NARC oilseed research field area

SUGARCANE

i. 10.5 kg Sugarcane fuzz have been collected from different commercially cultivated Sugarcane varieties at Thatta, Sujawal and Badin and sown in trays (greenhouse as well as open field). Around 10,500 seedlings developed in fuzz nursery and shifted to polythene bags for planting in the field.
ii. Around 5.5 kg poly-cross fuzz of different sugarcane varieties provided to different research institutes i.e. NARC Islamabad, NIBGE & AARI Faisalabad, SSRI Mardan, QAARI Larkana and


NARC sugarcane research field area

ARI Tandojam for varietal development in different ecologies.
iii. Infrastructure developed i.e. glass house and four photoperiod chambers to strengthen Sugarcane breeding program at NSTHRI Thatta.
iv. Introduced "Sugarcane Transplanter Machine" which help in mechanized transplanting of bud chip nursery seedlings.
v. 209,500 sugarcane seedlings (Thatta-326, Thatta-2109 and YT-55-Thatta) developed through bud chip method in the nursery and planted on 22.5 acres on grower's field and sugar mill farms at different locations of Sindh and Punjab.

FODDER & FORRAGE

i. 04 oat, 05 Vetch and 05 Millet advance lines were contributed in national uniform yield trials (NUYT). Conducted adaptability trials of 05 Korean rye grass lines i.e. GF, GF2, GC, GC2 and IR604 with one local check.

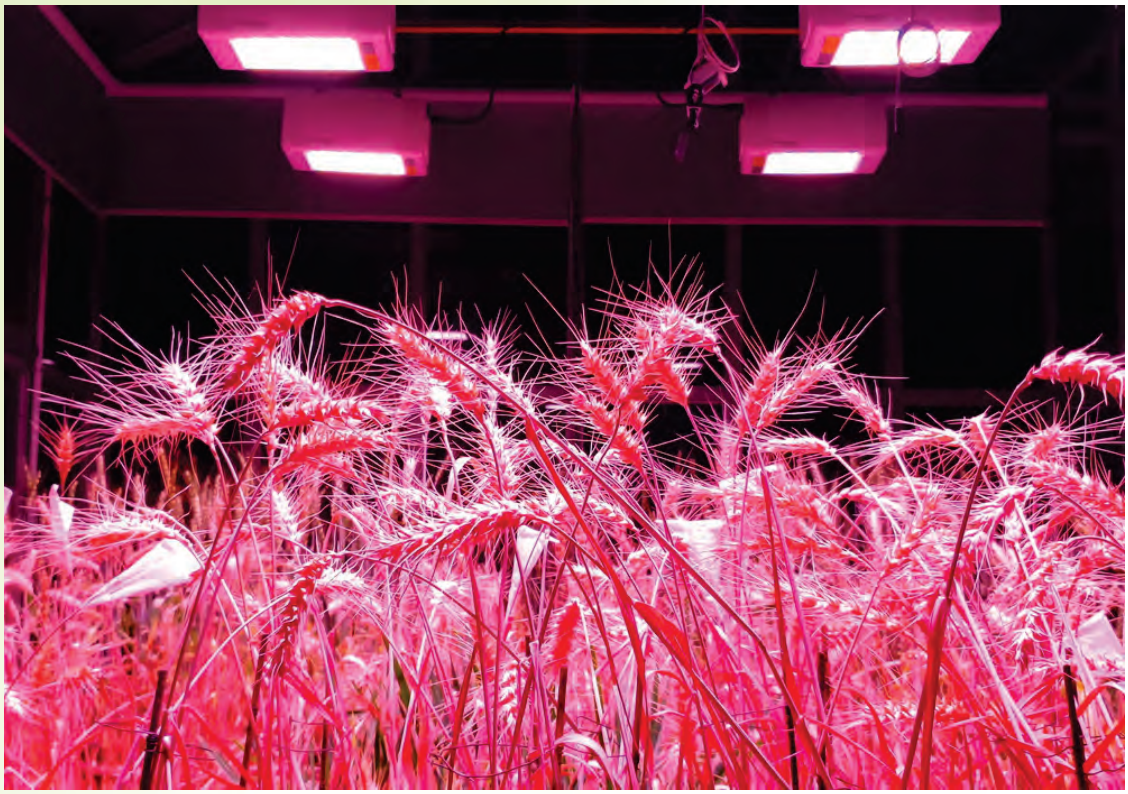

NARC fodder research field area

ii. DNA profiling of PARC Oat for Distinctness, Uniformity and Stability (DUS) completed.
iii. 764 germplasm/lines i.e. Sorghum 170 lines, Millet 130 lines, Sudan grass 21 lines, Oats 400 lines, barley 30 lines and vetch 13 lines were evaluated and 70 lines were selected for further testing.
iv. 02 PhD, 04 MS and 08 BS students conducted research.
v. 72 tons of quality seed i.e. Oats 70, Millet 0.5, Mott grass cuttings (1.24 tons) produced.
vi. 05 farmer field days for 350 farmers conducted at five different ecologies with demo plots.

PLANT PHYSIOLOGY

i. 12 NUYT lines (wheat) and 08 commercial wheat varieties showed heat stress tolerance (35-40 °C) at reproductive stage i.e. Ghazi-19, Anaaj-2017, AZRC Dera-19, Bhakkar Star-2019, Pasina-2017, Akbar-2019, Sindhu-2016, NIFA Awaz-19, NRP-21 and NRP-05.
ii. 18 NUYT (wheat), 04 advance lines and 08 wheat varieties were observed drought tolerant at (35% FC) i.e. Bhakkar-Star-2019, Pakistan-2013, Barani-2017, Sindhu-2016, Pasina-2017, NRP-21& 05.
iii. 04 NUYT (wheat) and 06 commercial wheat varieties were found salt tolerant i.e. Zincol-2016, Bhakkar-Star-2019, Sindhu-2016, Pasina-2017 and NRP-05.
iv. 08 wheat lines (CIMMYT material) proved climate adapted with better yield.
v. 03 Sunflower lines i.e. SF-2, SF-10 and SF-11 proved drought tolerant at germination and seedling stage under PEG (20%) induced drought stress.
vi. 04 Maize lines i.e. HNG, ILC-314, ILC-88 and C2P132001 identified as salt tolerant.
vii. 09 Green Super Rice (GSR) lines i.e. NRP C-1, NRP C-2, NRP C-4, NRP C-5, NRP C-6, NRP C-16, NRP C-17, NRP C-18 and IR-6 proved salt tolerant.
viii. 06 BS and 05 M.Phil students conducted research.
ix. Published 02 research articles in refereed journal.

Aerial view of wheat speed breading facility at CSI, NARC



Wheat crop at maturity stage under speed breading facility at CSI, NARC

FRUITS & VEGETABLES

i. 05 fruit varieties developed and approved by the KP Seed Council for general cultivation in their respective ecologies. 1. NARC-Avocado-2, 2. NARC-Avocado-1. 3. NARC-Fuerte, 4. NARC-cyclone purple, 5. NARC Mexican Lime.
ii. NARC-Avocado-2 is an early maturing, cold resistant with strong disease/pest resistance. It has an upright canopy having production of 8100 kg per acre.
iii. NARC-Avocado-1 is an early maturing, cold resistant with strong disease/pest resistance. It has Upright canopy having production of 7150 kg per acre.
iv. NARC-Fuerte is mid seasoned maturing variety, spreading canopy with planting density of 70 plants per acre with 6300 kg Production per acre.
v. NARC-Cyclon Purple is early maturing, cold hardy, can be grown from subtropical to mild temperate climate with strong disease/pest resistance. The plants attain spreading canopy with 70

NARC-Avocado-1

NARC-Avocado-2

plant per acre with 5600kg Production per acre.
vi. NARC-Mexican Lime is seedless variety, mature in summer having mild acidic taste, plant canopy is spreading type and production is 5808 kg per acre.
vii. 02 seedless grape varieties i.e. superior seedless and Razaki were examined for DUS and spot

NARC-Cyclone Purple

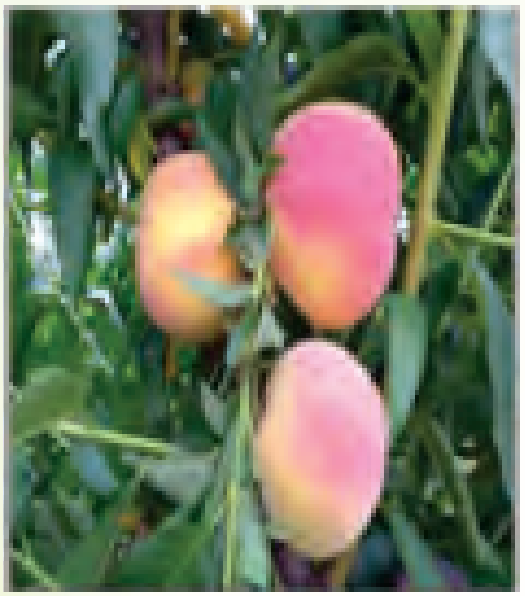
NARC-Fuerte

examination by FSC&RD.

viii. Fruit load optimization in early maturing peach: 02 Peach cultivars i.e. Early Grand and Florda King were examined and found promising in terms of yield and early maturing and escape fruit fly attack if timely harvested. Fruit thinning spaced at 10 cm after 05 days of fruit set is recommended for quality fruit production.

ix. Evaluation of Citrus and Kiwi varieties: 18 exotic citrus varieties and 07 exotic citrus rootstocks and 08 varieties of Kiwi are being evaluated at NARC.

NARC-Mexican Lime



Peach load management

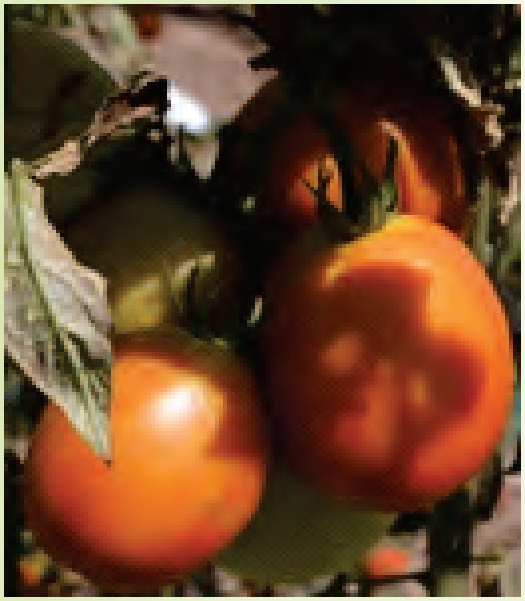
x. Out of 123 round fruit shape advance lines of indeterminate tomato, 20 lines yielded 42.41 to 64.35 t/ha against check Saalar-F1 (59.08 t/ha) and out of 116 oblong fruit shape advance lines, 03 lines yielded 79.53 to 116.67 t/hand 18 lines yielded 44.60 to 68.47 t/ha against check Sunder-F1 (60.43 t/ha).

Evaluation of exotic citrus & Kiwi varieties

xi. A promising onion strain "NARC Onion-05" selected on the basis of high bulb yield (16 t/ha) as compared to cultivated varieties (Swat-1 & Phulkara) completed its 2nd year visits for DUS.

xii. International Potato Centre (CIP), Lima, Peru provided 32 potato which were multiplied by tissue culture techniques for micro tuber production. 27 clones were selected and through seed

multiplication 800 kg basic seed produced.
xiii. 400 kg potato mini tubers of 105 clones were produced from local crosses and 600 kg mini tubers of 51 local crosses were produced for further multiplication. 400 kg basic seed of 32 CIP clones




Fruits of advance lines of indeterminate tomato in F7

produced for further multiplication.
xiv. Seed of 03 potato varieties i.e. NARC-Potato-I, NARC-Potato-II and NARC-Potato-III were produced in ample quantity which will be sent for DUS and NUYT.
xv. Germplasm Unit (GPU) of fruits certified by FSC&RD developed at NTHRI Shinkiari.
xvi. Processed 05 ton green and 01 ton black tea.
xvii. Registration of 4 varieties i.e. Tea, and kiwifruit have been under process with FSC&RD.
xviii. Olive plantation on 333 acres in Hazara Division & planted 82,000 olive cuttings.
xix. Produced 1,100 true to type kiwi plants of 8 different kiwifruit cultivars. Produced 5,000 kiwi


NARC-Onion-5

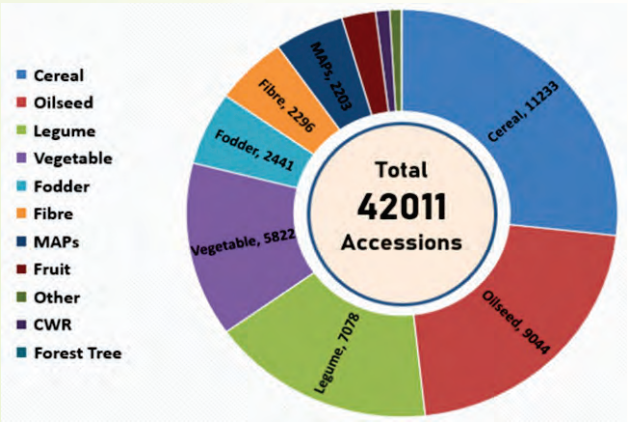
NARC-Potato varieties

seedling root stock from kiwifruit seeds. Planted 15,000 kiwifruit shoot cuttings for the production of true to type plants. Obtained 1 ton of kiwifruit and collected 1 kg seed.
xx. Budded/grafted 8800 plants of various fruits species i.e. apricot (2000 plants), peach (2500 plants), plum (2000 plants), almond (500 plants), cherry (300 plants), pear (1000) Persimmon (500 plants) to produce plants for the growers.
xxi. Around 400 liters of extra virgin olive oil extracted.
xxii. Processed fruit pulp 700-kg for value addition and processing produces approximately 2100 jam and squash bottles.
xxiii. Provided more than 3500 certified nursery plants of various fruits species to the growers and 5000 bud wood to fruit nurseries growers.
xxiv. Supervised 27 students of different Universities for their research in horticulture field.
xxv. Published 12 research articles in various reputable Journals.

Chairman PARC, Dr. Ghulam Muhammad Ali alongwith Senator Dr. Sania Nishtar inaugurating Ginger harvest at Chakwal.

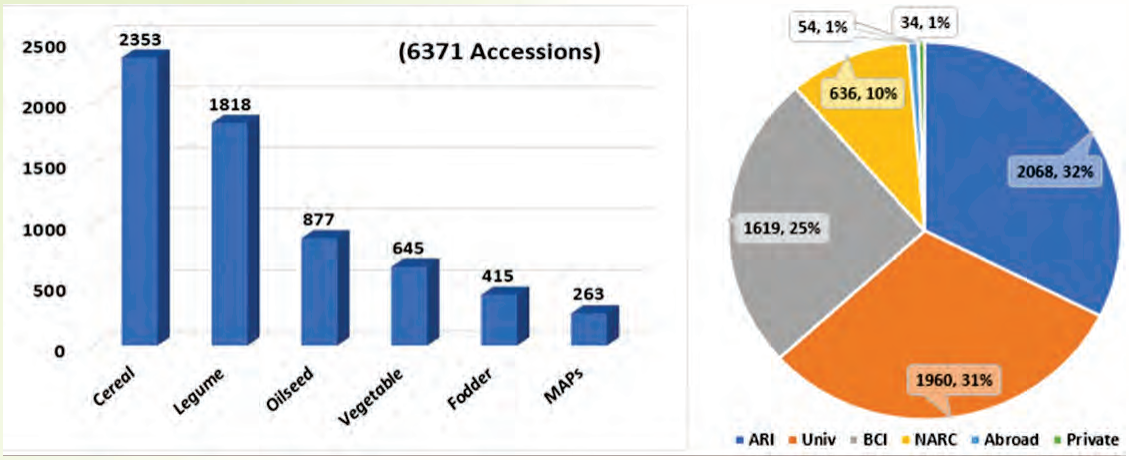
PLANT GENETIC RESOURCES

i. The mandate of the National Genebank of Pakistan (NGP) is to capture maximum crop diversity, conserve it for longer periods and make it available for research and development. The latest status of the germplasm at NGP has been reached to 42011 accessions.
ii. Germplasm acquisition: 95 entries (Cereals 43, MAPs 43, legumes 5, vegetables 2, and oilseeds 2 acquired from different sources and banked after allotting accession numbers.
iii. Germplasm distribution: 6371 accession of diverse crops provided to breeders, researchers across the country for utilization in their breeding programs. 35.5% .
iv. Distribution of crop germplasm entries to various stakeholders in the country.
v. Germplasm shared with Punjab followed by KP (22.4%), Sindh (3.4%), Balochistan (0.7%) and AJK & GB (1%).
vi. Viability testing: 3722 conserved germplasm accessions were tested for its viability.
vii. Safe-guarding breeder's material: Services were provided to various stakeholders for temporarily storing of their valuable germplasm. NUYT entries of soybean stored.
viii. Evaluation and Characterization of Germplasm: Germplasm accessions of various crops i.e. brassica oilseeds, rice, wheat, maize, lentils, Quinoa, cowpea, Soybean, mashbean, fennel, linseed, kalwanji and corriander were regenerated and characterized for traits of interest.
ix. Biochemical & Molecular Evaluation of PGRs: Biochemical evaluation using SDS-PAGE of total seed storage proteins and molecular analysis using SSR markers carried out for genetic diversity assessment and discrimination of carrot, radish, cereals and pulses.



Latest status of the germplasm at National Genebank

x. In-vitro propagation and preservation of vegetatively grown Germplasm: In vitro cultures of different varieties of potato, sweet potato and sugarcane germplasm established. Fruit germplasm of various crops, established at clonal repository.
xi. Studies on plant adaptations under local environment: Investigations have been initiated in the field on selected herbs such as Thymus vulgaris, Apium graveolus, Plectranthus sp., Aloe vera, Stevia, Coriandrum sp., Origanum vulgare, Artemisia annua, A. absenthium, Mentha arvensis



Distribution of crop germplasm entries to various stakeholders

(China), Cool mint, Mentha piperata (Japan), Lavender (Syria), Ammaranthus for adaptation under local condition.
xii. Viability testing of conserved germplasm through standard germination tests.

xiii. Native medicinal/aromatic, edible and ornamental plants and herbarium specimens were collected from Kohistan, Baltistan, Lehtrar, Havelian, Margalla hills, Nakial (Kotli, AJ & K), Bannu, Waziristan. Herbarium specimens of native flora (445 specimens) collected from different areas were accessioned.

xiv. Over 250 native plants collected from different ecologies are being maintained in the Botanical Conservatory and a similar number of exotic plants are also being maintained.

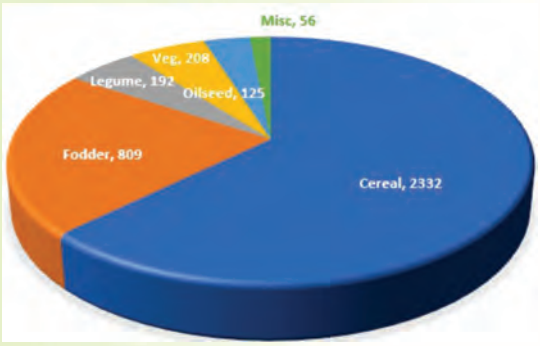
xv. Seeds of endemic monotypic genus Sulaimania otostegioides were acquired from northern Balochistan. A new species of Cicer from Zhob, Cicer appozaicum was described.

Distribution of crop germplasm entries to various stakeholders

xvi. A new species of Nepeta from Takht-e-Sulaiman, Nepeta sulaimanica was described. Glossocardia bosvallia, Anredera cordifolia, Dentella repens and Oenothera laciniata have been recorded as new to Pakistan.

xvii. Provided plant identification services to visitors, scientists, BS, MS and PhD students.

xviii. 10 research articles published in reputed journals.



Viability testing of conserved germplasm through standard germination tests

GENOMICS & BIOTECHNOLOGY

Transgenic Research

i. Transformation of cold tolerant gene (DREB1A) into 13 tomato lines/ 04 transgenic events and the resultant transgenic lines were advanced to T-8 generation.

ii. Biosafety testing trials of transgenic cold tolerant tomato on environmental and health related aspects were performed for assurance to ascertain their safety prior to commercialization.

iii. 50 crop samples tested for GMO through PCR with specific 35S and NOS primers.

iv. In Maize glutamine synthetase gene family was identified through genome wide identification of drought responsive genes and their validation was also done.

v. Tested 08 cotton pink bollworm resistant varieties through Immuno Strip Assay for the detection of CryIAc, Cry2A and CP-4/EPSPS.

vi. 25 cases of Intellectual Property Rights (IPRs) from various institutes of NARC were collected. Out of 25 cases, 11 cases fall in patent, 01 in trademark and 11 in PBRs.

vii. Genetic transformation of lectin gene in potato varieties (Asterix, Lady Roseta). Initially, GUS experiment was conducted to confirm the protocol reproducibility.

viii. Developed double haploid system in wheat having manual emasculation of wheat spikes, hybridization with fresh maize pollens, hormonal treatment, embryo rescue for production of more

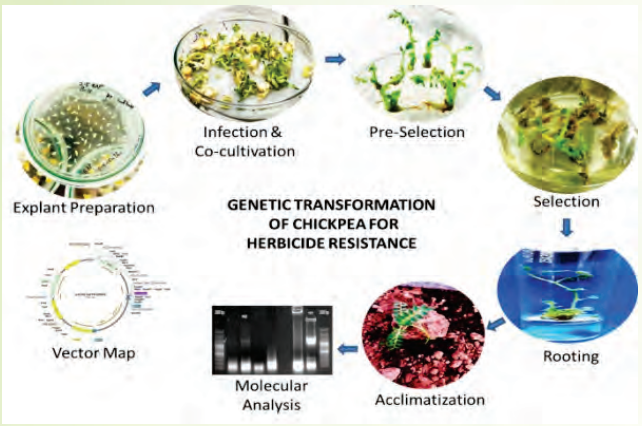
Aeroponic Potato Breeding Complex at NIGAB, NARC.

Korean Ambassador H.E Suh Songpyo being briefed by Director, NIGAB at Aeroponic Potato Seed Production Green houses at NIGAB, NARC

Aeroponic Potato Breeding Complex at NIGAB, NARC.

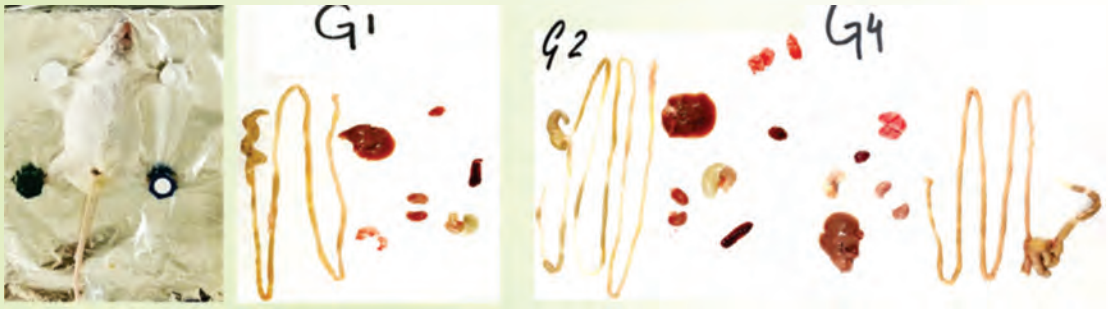
Aeroponic Potato Seed at NIGAB, NARC.

haploid plants by following the protocol of Maluszynska, 2003.



Representative diagrammatic steps of EPSPS gene transformation into Chickpea.

Biosafety testing of transgenic tomato on mice



Biosafety data of transgenic tomato (Mice Health Data)

Functional Genomics and Bioinformatics

i. Developed 18 hybrid rice combinations between Thermo-Sensitive Genic Male Sterility (TGMS) and elite GSR lines.

ii. Submission of 9 elite GSR lines to National uniform Yield Trial (NUYT) and Distinctness, Uniformity and Stability (DUS).

iii. DNA and total RNA of 06 tomato varieties were extracted, reverse transcribe the RNA, CDS and full length sHSP20 (Vis1) gene was isolated and cloned from Solanum chilense, S. lycopersicum. Positive clones were sequenced and submitted in NCBI database under accession No. OM908765.1and ON938177.

iv. Maintained the germplasm repository of 58 sugarcane varieties and lines.

v. Acquired 347 rice germplasm lines including 268 from IRRI and 79 from CAAS China. Performed experiments on gene expression under salinity and genome editing using CRISPR/Cas 9.

QR codes (Barcodes) of validated sugarcane variety specific KASP SNP genotyping markers.

vi. Evaluated and multiplied 45 rice lines including 20 Backcross population, 11 salt tolerant population, 8 grain quality and yield and 6 bacterial blight resistant lines.

vii. Acquired 96 sugarcane varieties/lines, their parents, and close relatives' samples'100K SNP. Developed protocol for designing of KASP SNP genotyping markers from array Data for DNA fingerprinting. 88 crosses of sugarcane lines acquired from China.

viii. SNP-based genome fingerprinting of 80 sugarcane varieties/lines performed.

Sugarcane fuzz growth at glasshouse as well as in the fields

ix. Genomic selection of indigenous livestock: Survey of sheep and goat production farms situated in Punjab and KPK province for genomic analysis related to the traits of economic importance. Blood collection and phenotypic data collection. Genomic DNA extraction and its analysis. SNP based genotyping / whole genome sequencing for genome wide SNPs identification related to economic traits (growth & diseases etc).

x. Acquired an ultra-high throughput DNBSEQ-T7RS NGS platform which is the biggest in South Asia. DNBSEQ-T7RS harbors wide range of applications including Whole Genome Sequencing, Whole Exome Sequencing, Transcriptome Sequencing, WGBS Agriculture, Plant and Animal Genome etc.

DNBSEQT7-RS Next generation sequencing platform

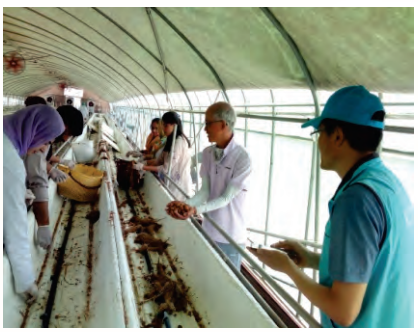
TISSUE CULTURE

i. 100 meristems of Potato variety "Lady Rosetta" were initiated after Virus indexing through ELISA for invitro multiplication. Produced 25000 in vitro plants and shifted for tuber production. Harvested 190000 mini-tubers (G0).

ii. Germplasm of 28 parent potato varieties collected from Potato Research Institute Sahiwal, Gansu Agricultural University Lanzhou, China and planted for breeding at Babusar GB. 25 Combinations of crosses among 16 potato varieties were made and 4000 seeds were harvested from mature barriers to get F1 hybrid. Total 26,343 tubers were harvested from these crosses.

iii. In micropropagation of elite ginger germplasm, seed of two ginger varieties (Chinese and Thailand) were selected for Tissue culture and field plantation. Protocols of invitro multiplication has been optimized. Rhizome sown for sprouting.

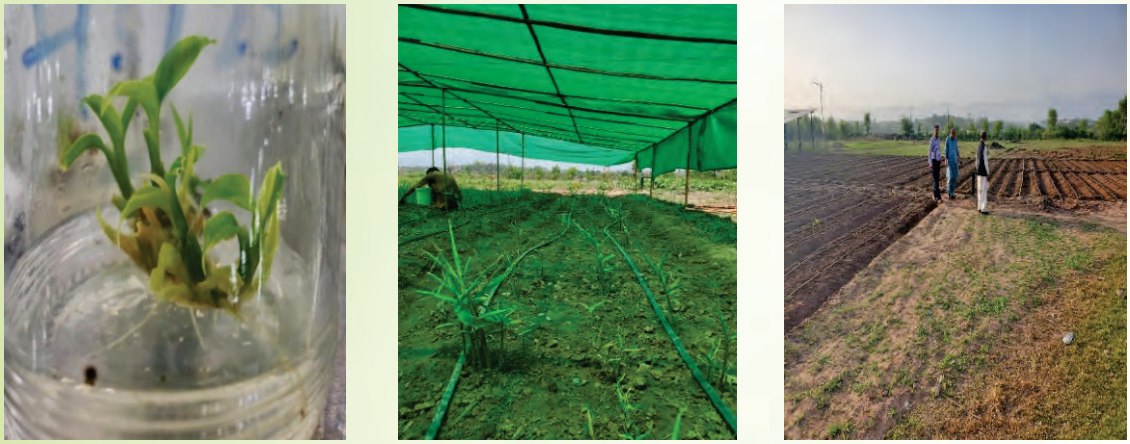
iv. In micropropagation of elite banana germplasm, four new banana varieties were introduced in Pakistan through tissue culture. Two Banana varieties NIGAB-1 and NIGAB-2 has been submitted case for Plant Breeder Rights in FSC&RD.



Zero generation potato mini-tuber

v. 10,000 in vitro plants of NIGAB-1 and NIGAB-2 are ready to transfer in the field.

vi. Tissue culture lab at NSTHRI Thatta has been strengthened and produced 34550 disease free banana plants of different varieties i.e. NIGAB-1, 2 &3, G-9 and Dhaka.



Micropropagation of ginger germplasm

MARKER ASSISTED BREEDING

i. DNA markers linked with 27 yellow rust resistance genes, 23 leaf rust resistance genes, 19 stem rust resistance genes and eleven linked DNA markers with Karnal bunt resistance are used.
ii. An advanced line with good rust resistance and low gluten content for celiac disease patients is in advanced wheat yield trials at wheat program NARC.
iii. About 210 Chinese wheat lines are crossed with CIMMYT lines. In first year's, experiments, 51 lines showed higher yield potentials. About 2000 F5 head rows are being evaluated for high yield, salt tolerance and resistance to rust disease. 89 lines showed immune reaction to yellow and leaf rust.
iv. DNA fingerprinting of following crop varieties has been done; NARC Super, Markaz-19 (Wheat), NR533 (Candidate wheat variety), NARC HG1 (Garlic), NIGAB 1 to 4 (Banana varieties).
v. 22 research articles published in reputed scientific journals.

PLANT PROTECTION

i. Three bio-pesticide products against different insect pests developed.
- Biopesticide based on molecular dsRNA targeting the silencing of Fer1HCH and Fer2HCH gene. It showed 100% mortality of BPH in laboratory trials.
- Microbial biopesticide is developed from indigenous microbes for the control Rice Leaf Folder. The isolated microbes were as effective as the Bt strain.
- Plant derived bio-pesticide has been developed from consortium of plant extracts, effective against wheat aphid, Rice Leaf folder and Brown Plant Hopper.

ii. Digital monitoring by Electric Penetration Graph (EPG) system was introduced in screening of wheat and rice germplasm against different insect pests in NYUTs. Results showed some entries susceptible to aphid infestation in wheat. 14 entries of Green Super Rice (GSR) showed resistant

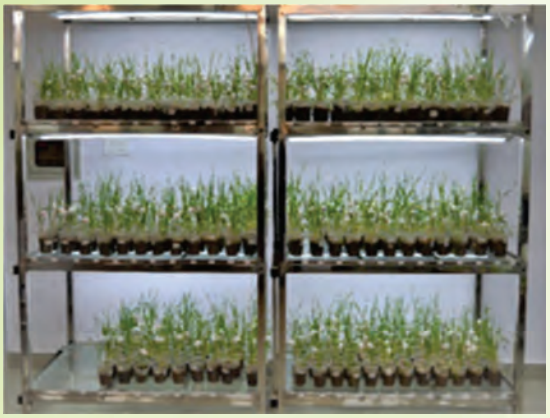
Yellow rust *Leaf rust* *Stem rust*

against Brown Plant Hopper (BPH). For rice leaf folder, 03 entries were highly resistant and 11 resistant.

iii. 759 advance wheat lines under National Wheat Disease Screening Nurseries (NWDSN) were evaluated in field against rusts at various locations of Pakistan. 225 resistant to leaf and yellow rusts, 265 resistant to leaf rust and 140 resistant to yellow rust.

iv. 70 NUWYT candidate lines were screened at various locations of Pakistan and found 6 resistant to leaf, yellow and stem rusts, 14 resistant to leaf and stripe rust, 2 to leaf and stem rusts and 3 to yellow and stem rusts.

v. Three indigenous natural enemies of FAW i.e. Trichogramma chilonis and Telenomus remus collected from field parasitizing FAW eggs & confirmed it in Lab also and Larval parasitoid



Screening of wheat for resistance of Aphid

Rice leaf folder mortality by Botanicals

Microplitis prodeniae was also recorded from the field parasitizing FAW larvae, however experiments are underway.

vi. Analyzed fruits and vegetable samples for pesticide residues and about 35% of the samples were exceeding the JMPR FAO/WHO Codex Alimentrius Commission MRLs.

vii. 128 environmentally safe PVC bait stations each consisting 100g of racumin grain bait against rats installed at different locations. 90-95% reduction in burrow activity was achieved based on pre and post-treatment number of burrows.

viii. Organized two farmers field days on "Identification of Wheat Diseases and their Management" in Sindh Province at Sakrand & Sukkur on 07-02-2022 and 12-02-2022. More than 500 researchers and 800 farmers trained.

NATURAL RESOURCES DIVISION

Management of Natural Resources is vital for food security and ecosystem services. The major challenge in terms of resources degradation is poor soil health, land degradation, desertification, climate change, ground water depletion and rapid withdrawal of water resources. The major thrust of NRD research and development agenda is focused on proper utilization and management of land, water, rangeland, agroforestry and honeybee in the country.

Effect of Larval Age on Acceptance of grafted larvae and morphometric characteristics in Apis Mellifera queens

As a result of the experiments, grafted larvae number and age did affect the queen cell acceptance rate. As indicated by Delaney (2010) that physical characteristics have a significant correlation with the fertility and reproductive success of queen bees. For future research, what are possible reasons physiological or hormonal have any effects on queen morphometric parameters might be investigated. Furthermore, from a more practical edge perception, these findings can provide

Effect of larval age on acceptance of grated larvae and morphometric characteristics in Apis Mellifera queens

guidance in efforts to improve honey bee queen quality in profitable queen rearing to resolve issues underlying the increased status of queen failures in the apiculture of Pakistan.

Honeybee Research Institute, PARC National Agricultural Research Centre, and Human Appeal Pakistan organized a one-day national-level workshop titled 'Livelihood Improvement Interventions for expansion of Quality Honey Production in the country - a way forward' is to foster the practice of honeybee farming in the country, to learn from experiences of experts in the field and to devise a plan to improve it collectively in the future.

Effect of Different Soil Fertilizing System for Seed Yield of Ispaghol (Plantago ovata Forsak)

The Ispaghol (Plantago ovata Forsak) is an important medicinal plant, valued for its seeds and husk which is used in indigenous medicine. The experiment was carried out to investigate the effects of chemical fertilizer include N and P (chemical fertilizing system), animal manure (organic fertilizing system), combined use of manure and chemical fertilizer (integrated fertilizing system) on clay loam soil of AZRI, Bahawalpur during 2021-2022. The following treatments including control (0) chemical fertilizer, C1 (30 P+50N), C2 15 (P+25N), organic matter; M1 (Cow Dung 20 t/ha), M2 (Cow Dung 10 t/ha) and integrated 1N1 (C1 10 P+20 N+20 Cow dung) and 1N2 C1 (5 P+10 N+10 Cow dung) were tested. The results showed that the highest seed yield of 500.5 kg/ha was obtained from the treatment (1N1) integrated fertilizer, followed by seed yield of 371.8 kg/ ha in treatment (IN2), whereas the lowest seed yield of 297.1 kg/ ha was obtained in control.

Another field experiment, having following treatments including (T1) 50% loam soil +50% Bhal, (T2) 100% loam + P solubilizer Bacteria and (T3) 50% sandy soil+ 50% loam + P Solubilize, showed that the highest seed yield of 618.46kg/ha was obtained from the (T3) followed by seed yield of 614.46kg/ ha in treatment (T2), whereas the lowest seed yield of 388.74 kg/ ha was obtained from T1.

Role of Foliar Nutrition of NPK on the growth & yield components on Mungbean

The field experiment was conducted at experimental farm of AZRI, Bahawalpur, during Kharif-2021,

having 04 treatments levels of NPK (20:20:20) i.e. T1=0, T2= 0.75 liter/ha T3=1.25 liter/ha, T4=2.0 liter/ha. The results showed that the T3 produced the highest seed yield of 1857.9 kg/ha, followed by T4 that produced the seed yield of 1690.1 kg/ha, while the lowest seed yield of 1130.6 kg/ha was obtained from control treatment.

Growth and yield response of different advance lines of Wheat for drought tolerance

The wheat trial comprises (5) genotypes/advance lines genotypes to test their growth and yield under the agro climatic conditions of Bahawalpur. Five (05) genotypes of wheat (screened out of CIMMYT

Field view of research trials on germplasm screening under climatic conditions of Bahawalpur

Yield Trial) has been compared during Rabi-2021-22 at AZRI, Bahawalpur. The Advance of AZRI, Bahawalpur AZ-W-08 has produced 5345.7 kg/ha, which was followed by the AZ-W-04 that produced the 4748.9 kg/ha. The Check variety Zincol-2016 produced 4576 kg/ha. While lowest seed yield of 2586.7 kg/ha was obtained in case of AZ-W-2.

New crop varieties released

BARDC Crops Sciences Research Directorate is working on breeding of field crops as well. Since the establishment of the center Crop Sciences Research Directorate has released 03 wheat, 02 barley and 01 lentil varieties. However, during the reported period BARDC released 03 new varieties (Ejaz-21

Durum wheat line

Lentil line

(durum wheat), JE-21 (barley) and Dasht-21 (lentil) from Provincial Seed Council. These varieties will be further disseminated on large scale in the province.

Establishment of Olive Orchards at BARDC, on farmer's fields and Installation of Olive Extraction Mill

BARDC is working on olives since 2013 and till 2022 about 8000 acres were brought under olive cultivation through BARDC. During the year about 100000 (for about 750 acres) olive plants were distributed to 16 districts (Quetta, Killa Saifullah, Zhob, Khuzdar, Surab, Noshki, Washuk, Musa Khel, Barkhan, Bolan, Chaghi, Duki, Kharan, Mastung, Kohlu and Punjgoor under Olive (PSDP)

Olive plantation on farmers' field at Killa Saifullah

Olive oil extraction mill at PARC-BARDC

project.

Olive oil extraction mill was installed and functionalized at BARDC under Olive PSDP project at PARC-BARDC Quetta, Honorable Governor of Balochistan (Syed Zahoor Ahmad Agha) Inaugurated Olive Oil Extraction Mill on 24th January, 2022. Worthy Chairman PARC & M.D POD were also present at the time of Inauguration. During the year 2021-22 about 10250 kg of olive fruit was processed.

Products Developed by BARDC

BARDC is working on medicinal herbs since 2004. BARDC have about 52 different medicinal herbs in its medicinal herbs garden. During the year 2021-2022 BARDC produced:

i. Seeds of crops wheat (Shalkot-2014, 550 kg; Tijaban-2010, 250 kg).

ii. Seed of barley (Sanaber-96, 300 kg and Rakhshan-10, 300 kg).

iii. Seed of Lentil (Shiraz-96, 28 kg).

iv. Demonstration block of different arid fruits (Olive, fig, pomegranate, almond and grapes) on 30 acres.

GB uniform wheat yield trial developed by NARC breeders at MARC

v. One acre of Saffron (3 varieties).

vi. Saplings of Olive (15000), Pistachio & Wild Pistachio (2000) and grapes (1000).

Performance evaluation of different exotic tomato and Chilli varieties under agro-climatic conditions of MARC Juglote

i. Seven (7) varieties of tomato were evaluated in replicated trial in MARC Juglote. The selected high

Tomato and China Chilli

yielding varieties of tomato i.e. Nagina (SAARC), Roma, Nayyab and Riogrand (28.79, 27.46, 27.06 and 24.93 t/ha) respectively.

ii. Four (4) varieties of Chili were evaluated in replicated trial at MARC Juglote. To select the high yielding varieties of chili i.e. China Red, Local, Khatmando and Kuneri, 3.90, 3.73, 3.59 and 2.77 t/ha. Respectively.

High yielding area specific wheat and Maiz varieties/entries for GB

Evaluation of GB Uniform Wheat Yield Trial developed by NARC breeders at MARC, Juglote, MARS Chillas and FCRS, Basin. The trial consists of 10 entries/lines with three replications were

GB uniform wheat yield trial developed

sown in three locations. Entry 10 (6850Kg/hac) at MARC, Juglote, Entry-5 (2845Kg/hac) at FCRS, Basin, Entry-4 (4818.3Kg/hac) at MARS, Chillas.

Evaluation of 18 maize varieties with three replication were conducted at MARC, Juglote i.e. Pharri,Azam, QPM-C, Kaptan, Jalal, Malhan, Edhi, Iqbal, Pirsabak new-1, NARC-B, Cimmyt pak, Shiwal gold, Shiwal sweet-1, Gohar-19, Haq nawaz gold, SG-2002, NARC-C and NARC-D. Produced 1100 kg seed of Maize variety (i.e. Azam 425kg, QPM 275 kg and Pahari 400 kg) and issued 1000 kg to farmers.

Coldwater Fisheries: Production of disease-free fry.

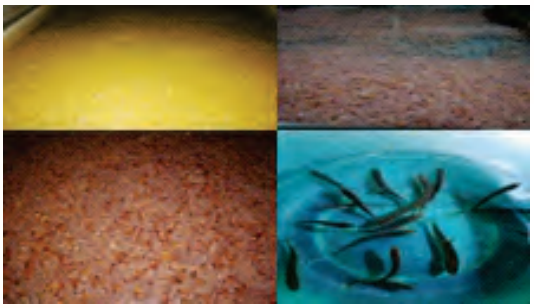
A total two hundred and twelve thousand disease free fry were produced against the target set of two hundred thousand fry production at TRMS for the year 2021-22. Out of total, two hundred and seven thousand fry have been issued to the farmers on approved subsidized rate according to their demand to promote cold-water fisheries in Gilgit-Baltistan and five thousand fry and fingerlings are kept at

S. No.	Target for the production of fry, 2021-22	Total Fry Production	Total Issued to Farmers	Existing Stock (Fry)
1	200,000	212,000	2,7000	5,000

Table: Fry production data at TRMS

TRMS for rearing and developed brood stock for the next breeding season.

A total 2000 selective brood stock of rainbow trout (Oncorhynchus mykiss) were developed at Trout Research and Multiplication Station (TRMS) according to the recommended feeding frequency for the effective production/collection of healthy eggs during the breeding season i.e. December-March. Other than these, 3000 more having various



Rainbow trout production at TRMS

size and age are also reared to develop as a brooder to enhance the fry production capacity during the coming breeding season.

Potato in vitro seed production in screen house and tissue culture labouratory activation and establishment of early walnut nursery

Tissue culturing of potato variety lady rosetta has started and produce 15000 tuber in screen house MARS Chilas. About 2500 early and 2000 normal fruiting nursery has established at MARC Chilas.

Tissue culturing of potato variety lady rosetta

Response of four buckwheat varieties/genotypes to different level of Phosphorus, 2021

The experiment was carried out in randomized complete block (RCB) design with three replications. Among these four buckwheat varieties/genotypes maximum grain yield 1.69 t/ha obtained from var. TianXiaomai at 20.00 kg ha-1.

Tr/Var.	Pl.ht cm	No. of Plant/m^2	No. of Branch/pl	No. of Cluster/pl	No. of Grain/cl.	Grain yield t/ha
V1	57.33	260.00	5.56	4.89	26.89	1.21
V2	57.50	164.50	5.50	5.44	21.34	0.81
V3	54.00	306.67	5.44	5.55	25.11	0.84
V4	67.00	278.33	5.33	5.78	27.44	1.69

Table: Among these four buckwheat varieties/genotypes maximum grain yield 1.69 t/ha obtained from var. TianXiaomai at 20.00 kg ha-1 phosphorus level

Collection, evaluation of native herbs development of Production Technologies

MARS Astore collected new species of native herbs and planted under field conditions to generate new knowledge and development of area specific crop management and production technologies for medicinal herbs in Astor valley.

Production of herbs development technologies

Urban Forestry Model (Miyawaki Model)

Fig. A view of Miyawaki Model at agro-forestry fields areaIn this model, sixteen indigenous MPTS were introduced and planted in spacing of 2x2 sq. ft. of an area of 2,720 sq. ft. The layout was laid down in such a way that contained twenty one in numbers rows horizontal and twenty lines were drawn vertically. The result revealed that among the sixteen species Eucalyptus camaldulensis attained the maximum height of 10 ft. 8 inches with diameter 1.2 inches and followed by the plant Morus alba attained the height of 10 ft. 2 inches with a diameter 1.5 inches. No mortality have been observed and maintained the experiment without any fertilizers and irrigation depending upon the saver drought.

A view of Miyawaki Model at agro-forestry fields area

New varieties of Guar, Turmeric released by AZRC D.I.Khan

AZRC-Guar released from Provincial Seed Council, KP during 2022. Which is high yielding, with potential of 20 monds acre-1, drought & heat tolerant, resistant to cercospora leaf spot disease. It is

Guar variety in AZRC field

first variety of this important guar crop in KP evolved by this center which has given best yield performance throughout the country.Fig. Guar variety in field at AZRC farmThe new Termaric variety i.e. Badar Haldi is high yielding with potential of 158 monds acre-1 and have resistance against insect / pest.

Establishment of Silage and Hay Technology at AZRC D.I.Khan

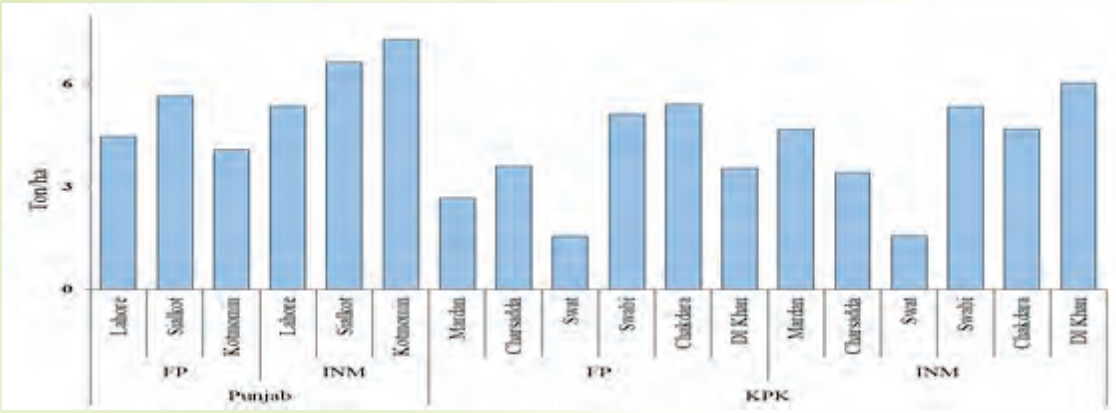
Established Silage and Hay production technology at AZRC farm for increased meat and milk production besides the objective provision of fodder during fodder scarcity period. Prepared Silage from Corn (Zea mays) and Mott grass and Hay from Barseem. Moreover, training camps (02) were organized at Centre for awareness of farming communes.

Silage and Hey technology at AZRC

Productivity Enhancement of Wheat by Integrated Nutrient Management (INM)-Components VIII

i. Integrated nutrient management comprising nutrients (N:P: K=120:90:60 kg ha-1, Zn:B=5:1 kg ha-1) along with Biozote and humic acid were applied to eleven (11) demonstrations sites on farmers' field across the country.

ii. Results indicated an average increase of 15% to 25% in wheat yield.



Response of wheat yield to integrated nutrient management

Nutrient Indexing survey of wheat growing areas of D I Khan

Nutrients indexing survey of wheat growing area of DI Khan district was carried out. Results shows that mean values of 2.69, 2.17 and 156 mg/kg for NO3-N, P and K respectively. As per generalized criteria of soil the analysis it reflects that 100% of the soil are NO3-N and P deficient. These findings emphasized the importance of integrated nutrients management in enhancing wheat productivity in DI Khan (Table 2).

	NO_3	P	K
	(mg/kg)		
Mean	2.69	2.17	158.99
se	0.10	0.09	4.16
Median	2.61	2.03	150.00
sd	1.21	1.10	50.08
Min.	1.03	0.79	26.00
Max.	9.49	9.80	340.00

Table 2: Summary statistics

Productivity Enhancement of Sugarcane component-5 "Nutrient Indexing and Explore Efficient Integrated Nutrient Package for Optimizing Sugarcane Yield and Quality"

Conducted Nutrient Indexing Survey of sugarcane growing areas (Distt.) Tendo Allah Yar Sindh. Surveyed area was found deficient in N (100%); in P (84%)and K (58 %), Zn (68%) and B (39%). Keeping in view the nutrient status of surveyed area, farmers were contacted and provided advisory services regarding nutrient management for sugarcane crop.

Survey and interviewing the farmers for their land and other agriculture related information

ANIMAL SCIENCES DIVISION

The prime objective of Animal Sciences Division (ASD) is to develop, monitor and evaluate research projects and eventually finding solutions of burning issues confronting by livestock sector to improve production potential of food animals. The broader researchable areas under ASD are livestock and poultry health, animal feeds and nutrition, animal reproduction and genetics, dairy technology, animal biotechnology and inland aquaculture and fisheries.

OBJECTIVES

The approved objectives of the ASD are as follows:

i. To set the priorities of research according to the need of provinces and relevant stakeholders.
ii. To develop, monitor and evaluate research projects being conducted at federal and provincial level.
iii. To find solutions to burning issues confronting livestock, poultry and inland fisheries sector in country.
iv. To undertake, aid, promote and coordinate livestock, poultry and fisheries research and other activities as per all PARC-mandated functions.

RESEARCH COORDINATION, MONITORING AND EVALUATION ACTIVITIES

Animal Sciences Division, PARC is involved in research coordination, monitoring and evaluation in respect to various disciplines of animal sciences. Following are the salient outputs:

S. No.	Funding sources	Completed	On-going	Total
1.	Agricultural Linkages Program	8	28	**36**
2.	International Cooperation	1	0	**1**
	Total	**9**	**28**	**37**

RESEARCH ACHIEVEMENTS

Animal Health Program (AHP)

The Animal Health Program (AHP) aims to improve animal health of livestock to achieve food safety and security in Pakistan. The theme is persuaded by research on better understanding of animal pathogens and disease mechanisms through epidemiological, conventional and molecular tools for the diagnosis and control of animal diseases. Following are the salient achievements of the program:

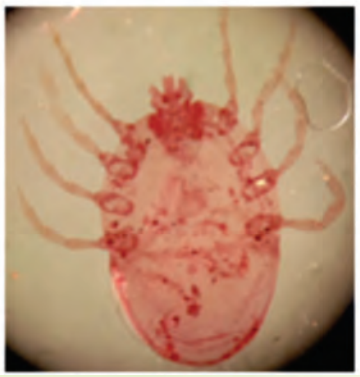
Foot and Mouth Disease (FMD): It is an infectious and sometimes fatal viral disease that affects cloven-hoofed animals. The virus causes a high fever lasting two to six days, followed by blisters inside the mouth and on the feet that may rupture and cause lameness. The FMD has very severe health implications for livestock farming, since it is highly infectious and can be spread by infected animals comparatively easily through contact. Epithelial samples (n=93) were collected from suspected FMD cases in cattle and buffaloes from various regions of Baluchistan. Among 93 samples, 70% were found positive for FMD. A total of 10 FMD viruses strains were recovered from ELISA positive epithelial samples on LFBK cell line.

Brucellosis: Brucellosis is an endemic bacterial zoonosis in Pakistan and has been identified as a priority disease for Pakistan. Brucellosis is an occupational hazard for livestock workers, veterinarians, butchers and households. A total of 14.06% milk samples (n=256) collected from cattle and buffaloes of peri urban dairy farms in Islamabad were found positive for brucellosis. Two isolates of Brucella abortus i.e., Strain-19 and RB-51 were revived from Animal Health repository and cultured.

Crimean Congo Hemorrhagic Fever (CCHF): The tick population is present round the year leading to problem of TBDs in livestock in Pakistan. The CCHF is a viral zoonotic disease and is asymptomatic in animals but fatal for humans. Its prevalence in animals is a good indicator for local virus circulation. An overall sero-conversion of 20.5% and 20.8% was observed against CCHF in small and large ruminants of Punjab, respectively. The highest sero-conversion against CCHFV was observed in cattle (26.3%) followed by sheep (23%), goats (16.7%) and buffaloes (13.6%). The

Rhipicephalus

Hyalomma



Boophilus

Ixodes

highest tick infestation was observed in cattle (41.9%) and lowest in goats (14.8%), whereas, identified tick species belonged to Rhipicephalus, Hyalomma, Boophilus and Ixodes species. The highest number of blood smears was found positive for theileria (9.4%) in cattle.

Animal Nutrition Program (ANP)

The Animal Nutrition Program (ANP) focuses mainly on nutritive evaluation of feedstuffs, economical feed development using non-conventional feed resources, development of nutritional technologies for efficient livestock production and feed safety issues including mitigation of mycotoxins problem in feeds. Following are the salient achievements of the program:

Aflatoxins in Cotton: Aflatoxins are carcinogenic in nature and commonly contaminate food and feeds. These can be transferred to milk and eggs and posing health risks to consumers. Cottonseed cake is identified as main contributor of aflatoxin residues in milk. The production and marketing chain of cottonseed cake is being studied for identifying the risk points regarding origin of aflatoxins and their progressive development. In this regard, 100 samples of soil, cottonseeds and cake were collected from different regions of Punjab and Sindh. Over 50 isolates of Aspergillus flavus were obtained from these samples and examined morphologically. Two more atoxigenic isolates have been identified with a tally of eight atoxigenic isolates up till now.

Distribution of Poultry for Poverty Alleviation: Poultry production in Pakistan is mostly dependent on exotic commercial lines. Contrarily, backyard poultry contribute 24% share to our national requirement of eggs and 9% share to meat production. However, the production potential of indigenous poultry is very low (70-80 eggs/year and 1.5-2kg body weight). This needs to be improved and can be achieved by crossing indigenous breed(s) with high producing exotic breeds and propagating these birds to rural community. In this regard, more than 600 sets (5 hens + 1 cockerel) i.e., 3,600 birds of 3 months age were handed over to Livestock and Dairy Development Board (LDDB) and distributed among farmers.

Rearing of parent stock

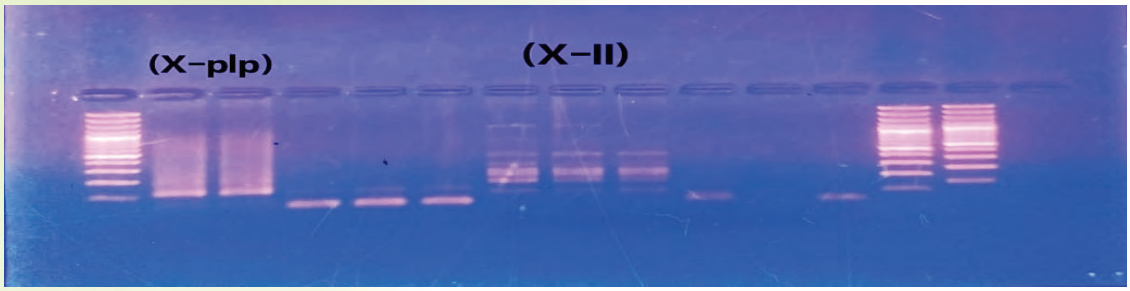
Brooding of young chicks

Animal Reproduction and Genetics Program (ARGP)

The main focus of this program is to improve reproductive efficiency and exploit genetic potential of food animals. In this regard, major reproductive tools/techniques i.e. artificial insemination (AI)/laparoscopic AI; controlled breeding, sperm sexing & cryopreservation, ultrasonography and selective breeding are being used for genetic up-gradation of local breeds of cattle, buffalo and goat. Following are the salient achievements of the program:

Laparoscopic AI in Goats: The quality of semen strongly affects the reproduction in livestock. The optimization of cryopreservation techniques is pivotal for the improvement of semen quality. The Laparoscopic AI in estrus synchronized Beetal goats during the Peak Breeding Season was recorded higher (86%) with biostimulation compared with non biostumulation (79%). Similar pattern of pregnancy rates were also found (67% and 45%) with biostimulation and non biostumulation, respectively. Trans-cervical intrauterine technique is found to be better than cervical AI technique for achieving optimum pregnancy per AI in Beetal goats during the low breeding season.

Semen Sexing: Semen having X or Y bearing sperm to produce progenies of a desired sex either female or male (with about 80-90% accuracy) is known as sexed semen. The use of sexed semen in dairy and beef farms ensures the production of animals of the desired sex, resulting in a reduction of costs. Different techniques for sperm sexing are under evaluation. The effect of different incubation tube diameter and placement angle on semen quality after sperm sexing through modified swim-up technique has been evaluated. Amplification of X-PLP gene was optimized at 54oC.



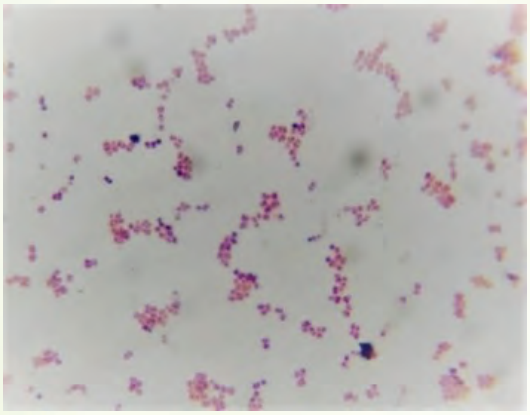
Bands at 104 bp length with first set of primers (X-plp)

Animal Product Improvement Program

Animal Sciences Institute (ASI) has carved the Animal Products Improvement Program (APIP) with a mandate of quality evaluation and value addition through improved handling and processing technologies of animal products which is the prime purpose of animal husbandry. Following are the salient achievements of the program:

Neutraceutical Yogurt: Riboflavin is an essential vitamin found in green leafy vegetables, cereals, eggs and meat but often lost during milling or cooking. Bio-fortification of Riboflavin, through utilization of synthesizing bacteria in fermented products is an economical and viable option. For bacterial isolation, 45 samples of milk and yogurt were analyzed for biochemical tests. Results

Lactobacilli bacteria



Streptococci/Lactococci

showed 30 and 35 isolates of Streptococcus and Lactococcus spp, respectively. The riboflavin concentration was found to be 6.38 mg/L, which was more than double when compared with market yogurt samples, showing its potential as riboflavin overproducer in yogurt.

Livestock Research Station

The Livestock Research Station (LRS) was established in April, 1988 with an objective to improve, preserve and supply superior breeds of cattle and buffaloes to the progressive farmers. Following are the salient achievements of the program:

Calf Feedlot Fattening: In the sub-project of PM initiative calf feedlot fattening in Pakistan under LDDB a fattening trial on buffalo calves (n=15) is underway. The adaptability period of the calves has been completed and the experimental ration is being fed. Data collection on feed offered, feed refused, feed intake and weight gain to assess the growth rate is being undertaken.

Angora Rabbitry at Gilgit: The Angora rabbit is one of the oldest types of domestic rabbit and is bred for its long fibers, known as Angora wool. Angora rabbitory has been established at Juglote and Sakardu, PARC Mountainous Research Centre (MARC). The Angora rabbits (n=5) pairs have been shifted at Juglote from NARC and their breeding is underway in order to increase the flock size. A community Workshop was also organized at Gilgit.

Aquaculture and Fisheries Program

The mandate of Aquaculture and Fisheries Program (AFP) is to undertake research on inland aquaculture to increase per unit fish production by applying modern aquaculture practices, intensive fish culture and introduction of new and high value fish in culture system. Following are the salient achievements of the program:

Rice Cum Fish Culture: This system can provide additional food and income by diversifying farm activities and increasing yields of both the rice and fish crops. A pilot study conducted at rice field (40 x 50 sqft) stocked with 100 all male tilapia fish. The average weight gain was 60g per fish in the period of three months.

Tilapia Fish in Re-circulating Aquaponics System: Re-circulating aquaculture systems that incorporate the production of plants without soil. A set up for the lettuce was also arranged below every aquarium and Fish (12 No) was stocked in each aquarium. An increase of average 32g/ month in fish growth along with increase of 22cm in size of lettuce was observed during trial as compared to control group (average growth of fish 22g and 15 cm size of lettuce).

Intensive Production Packages for High Value Fisheries: An experiment was conducted to determine the optimum stocking density for obtaining maximum net profit from the polyculture system for major carps and Chinese carps with American channel catfish. Highest growth of major Carps, Chinese Carp, American Channel catfish and Tilapia was recorded in an earthen pond having stocking density of 1800 per acre fish.

Seed Production & Rearing of High Value Fish Species: One hundred thousand fry of all male tilapia and 2000 fingerlings of American channel catfish were produced. Fingerlings of different ornamental fish species were provided to local public for home aquarium purpose.

Hapa set up for tilapia breeding

Sex reversal of tilapia to all male tilapia

National Reference Laboratory for Poultry Diseases

The National Reference Laboratory For Poultry Diseases (NRLPD) is an apex Laboratory for avian disease diagnosis and survillence. The NRLPD is designated as Regional Leading Diagnostic Laboratory (RLDL) for Highly Pathogenic Avian Influenza (HPAI) for SAARC countries by FAO. In 2014 the laboratory was accredited for ISO/IEC 17025:2017 by Pakistan National Accreditation Council (PNAC), Islamabad. This laboratory is also a reference laboratory for Anti-Microbial Resistance for poultry. Following are the salient achievements of the program:

Diagnostics to the Referral Samples from Field: Infectious diseases are imposing significant impacts on the poultry sustainability and productivity around the globe. The NRLPD has been playing role of referral lab and coordinating with provinces by providing timely diagnosis of infectious diseases since 2004. In this regard:

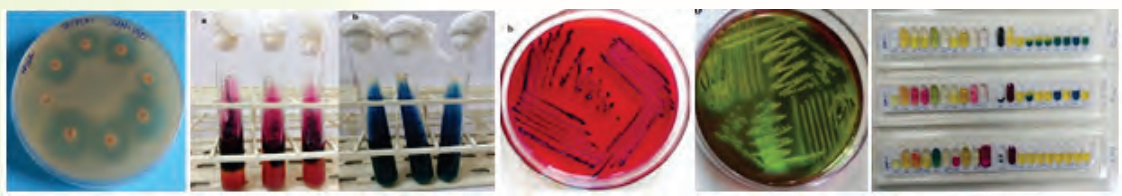
i. Under the L&DD project "PM initiative for Back yard poultry" 849 backyard poultry samples received and analyzed for Avian Influenza and Newcastle Diseases through serology, molecular diagnosis and culturing.

ii. A total of 319 different pathogens (E.coli 170; Salmonella 29; Staphylococcus 27; Pseudomonas 23; Enterococcus spp. 9; Sheigella spp. 19; Klebsiella 36; Proteus spp. 6) were recovered from 290 samples collected from diseased birds.

Antimicrobial Resistance in Poultry: AMR is an emerging public health challenge posing serious threats to human and animal health, as well as affecting food security. It threatens millions of humans and animals lives globally. In this regard:

i. E.coli (n=721), Salmonella (n=90) and Enterococcus (634) isolates were recovered from 803 samples collected from commercial broiler live bird market.

ii. Most of the isolates were resistant to Tetercyclines, Nalidixic Acid, Quinolones, Penicillins, Streptomycin, Quinopristin/Dalforistin, Erythromycin, Trimethoprim and Sulfonamides. The most sensitive antibiotics observed were Gentamycin, 3rd and 4th generation Cephalosporins, Azithromycin and Carbapenems.



Biochemical tests of Salmonella and E.coli on different culture media and AST analysis

EXTENSION, TRAININGS, PUBLICATIONS, SEMINARS, WORKSHOPS

i. Animal Nutrition Program, NARC prepared 11,400 bags of livestock feeds, 1,800 kg milk booster and 2,000 urea-molasses blocks and sold to farmers, apart from experimental feeds for different programs of ASI.

ii. A total of 130 samples of feed, fodder, silage, grasses, dung and milk from farmers, students, research organisations and industry were analysed for nutrient composition and toxins.
iii. More than 4,000 chicks of different breeds were sold to poultry farmers.
iv. One day National Training Workshop was conducted on Laparoscopic AI in Goats under ALP project at ARGP, ASI, NARC on March 16, 2022.
v. The total of 40 Livestock Assistants from North Waziristan has been trained on reproductive management and use of modern reproductive techniques in ruminants.
vi. Approximately 0.12 million liters of milk was processed (under a joint venture with PATCO). The compositional analysis of the milk showed that fat percentage varied between 3.6 – 5.8% with a mean value of 4.75% while total solids ranged between 12.11–14.80% with a mean value of 13.45%.
vii. Visit of officials from Centre of Excellence in Bovine Genetics (CEBG), Vice Chancellor (NUST), Member of National Assembly Ms. Nafeesa Khatak, Dr. Abid Suleri, Convener Agriculture Transformation Plan, Ambassadors and Senior anchor persons (media personnel).
viii. All male tilapia fish seed (100,000) was provided to local farmers.
ix. Ornamental fish (1,000) was sold to local farmers/households.

The summary of research publications, MPhil/PhD students supervised, internees trained, visitors and training (imparted/obtained) both local and international are summarized below:

Publications		**Post Graduate students**		**Internees**	**Visitors**	**Trainings**	
Research papers	***Abstracts***	***M. Phil***	***PhD***			***Imparted***	***Obtained***
30	0	8	4	125	186	1	0

SOCIAL SCIENCES DIVISION

Social Sciences Division (SSD) is one of the four technical divisions of Pakistan Agricultural Research Council (PARC), responsible for carrying out research on socio-economic and agricultural policy related aspects of Pakistan's agriculture sector. The Social Sciences Division (SSD) of PARC operates through its network of Social Sciences Research Institutes (PARC-SSRIs) at Faisalabad, Tandojam, Tarnab Peshawar, NARC and AJK. SSD also provides feedback to the Ministry of National Food Security and Research (MNFSR) on food security, impact analysis, technology adoption, trade and agricultural policy related issues. During the financial year 2021-22, the SSRIs planned more than 20 research studies falling in various research themes of the Division. In the following paragraphs, some of the completed studies with their respective themes are briefly described.

Economic Comparison of Rice Sowing Methods under PSDP Productivity Enhancement of Rice

Crop enterprise has shifted from labor-intensive practices to cost-effective mechanized crop management methods. The use of mechanized management methods vary among the crops due to varying crop cultivation practices. The sowing of rice crop has been a manual activity worldwide for extended periods. Due to labor shortages and rice productivity prospects, most rice-growing farmers have shifted to mechanical rice transplanting. Dry Sowing Rice (DSR) through drill is another option in this context. Though most of the rice-growing farmers in Pakistan are still convinced with the conventional way of rice sowing. Foreseeing the labor shortage in agricultural sector and productivity enhancement prospects, scientists and development partners under the PSDP project, Productivity Enhancement of Rice a few service providers have initiated mechanical transplantation at farmers' fields in the rice-growing area. There is a gap in socioeconomic evidence regarding the compatibility, viability, social acceptability and feasibility of different options being promoted by the public and private sectors.

A field survey of 44 mechanical and 9 DSR sowing method farmers were interviewed during Kharif season 2021 in collaboration with the project team. This study was conducted to explore the economic viability of mechanized and dry drill sowing methods vis-à-vis conventional labour intensive nursery transplanting of the crop. The survey results reveal that farmers are convinced with the advantage of mechanical transplanting of rice over other methods. Research findings indicate that mechanical transplanting increases paddy yield by nearly 4 to 5 maunds per acre compared to conventional method. Farmers are intended to increase rice area under mechanical rice transplanting in the coming season. The low labor requirement also provides a hefty advantage in the adoption of mechanized rice transplanting. However, laser leveling of the land is a prerequisite for the method's success. The limited availability of mechanized rice trans-planters and quality of nurseries raised by the service providers (mechanical rice trans-planter owners) are the concerns in the rapid, wide-scale adoption of this advantageous rice sowing method. On the contrary, conventionally transplanted crop is less risky at early stages of the crop despite more labor intensive. Farmers also have the advantage in DSR method with a little better yield and less sowing cost than conventional method. Overall, farmers are not yet convinced about the future adoption possibility of DSR, even with relatively more economic benefits over conventional rice sowing method. The emergence of weeds is a key constraining factor in the DSR method. Farmers suggest scientists should develop a complete technological package of DSR considering the critical DSR technology-relevant aspects after detailed experimentation. Government/PSDP management should further facilitate the service providers and interested farmers to enhance wide-scale adoption of the mechanical rice transplanting method.

Gender Inclusive Community Engagement: Capacity Building of Project staff and team members of the project entitled "Strengthening Vegetable Value Chains for Greater Community Livelihood Benefits (SVVCP)"

Experience of engaging men, women and youth from the small farming households especially the Strengthening Vegetable Value Chains Project (SVVCP) in Punjab and Sindh, Pakistan has shown that currently, small farming households especially women form majority of the farming community but their participation in the formal agriculture extension network is the lowest. The gender participation gap was wide in project activities during first two years and community engagement and women participation remained challenging due to limited capacity of the field staff in the gender and

community engagement. Thus, together with strengthening tomato, potato, and onion value chains, it was crucial at the same time to work on increasing women's participation and influence on decision making in the family and groups/community. Furthermore, the mid-term review report highly recommended to equip the field team especially social mobilizers and research officers with the required awareness, knowledge and skills for engaging communities. Keeping in view the importance and need of the capacity building of the project staff, the social sciences team was tasked to provide continues support on gender and community engagement.

The social sciences team of NARC has planned and provided continues support to SVVCP project team and organized four formal awareness seminars, exposure visit and training events. The major objective was to equip the project staff with practical examples of the community engagement, learnings from other successful projects such as Engro and livestock project, building networks as well as some theoretical background with the working examples in the training workshops.

The training modules were based on the experience sharing on challenges of the project teams in implementation. The training sessions were participatory and interactive where each participant was provided opportunities to participate in activity-based sessions and come up with the ideas to better implementation of the project activities.

These capacity building events has an immense impact on social mobilizers and research officers' confidence, understanding, communication and skills to engage community especially women and youth in the farmer groups. It also provided opportunities to build strong networks within the team as well as with mentors in different fields to seek advice in their professional work.

Capacity Building of NARS Scientists in Advance Analytical Techniques

On-the-job training contributes to upgrading the skills of the staff in accordance with the job specificity, specific work environment and capacity building to cope with future challenges. This project was approved to conduct training across seven sites of Pakistan namely BARDC, Quetta, NARC, Islamabad, AARI, Faisalabad, ARI, Tarnab, Peshawar, Agriculture Extension Gilgit, Agriculture Complex, Gojra, and SARC Karachi. The objectives of training were: To train agricultural scientists in various statistical, econometric methods and techniques for enhancing the quality of their research output by using various computing software such as R programming, Minitab, STATA, Statistix and SPSS and to develop training manuals for facilitating scientists in the use of statistics and econometric tools and techniques. Overall, 178 NARS scientists benefitted from the training courses. Participants were trained in the analysis of basic experimental designs, factorial experiments, multivariate analysis, regression and correlation, stability analysis, augmented design using R programming, Minitab and Statistix. Participants showed enthusiasm towards learning and applying R programming for the analysis of their experimental data. Moreover, emphasis was laid on practical sessions and interpretation of data analysis so that trainees could make their research meaningful and presentable. In the end of each training course a post evaluation of training was conducted through a well-developed evaluation proforma to assess participant's views about the training. Duration of these courses was one week. Target audience was drawn from National Agriculture Research System (NARS), and universities. Resource persons were the scientists from Social Science Research Institute, NARC. However, in some training courses, resource persons were invited from University of Balochistan Quetta, University of Agriculture Faisalabad, Pakistan Institute of Development Economics (PIDE), Islamabad, and university of AJK, Muzaffarabad. Participants acknowledged that the instructors were knowledgeable in their subject areas, also, they found course content to be relevant. Most of the participants declared that they learned everything expected and confirmed that group activities and hands on practice improved their knowledge and skills. Similarly, participants were contented with regards to the quality of training. Participants also showed enthusiasm in learning new software R programming for the analysis of data. Participants suggested to increase duration of the course from one week to two weeks and demanded to repeat such training courses in future.

Feasibility of Ginger Cultivation in Punjab-Pakistan

Ginger is an important condiment used as a spice in daily diet in Pakistan. It is produced on very small scale in Sindh province only. There is a large gap in local production and consumption in the country. The country is spending precious foreign exchange on the import of ginger in order to fulfill the supply and demand gap. The present study is mainly designed with the objective to ascertain the major factors inhibiting its production at Punjab level. It is found through Key Informant Interview (KII) and Focus Group Discussion (FGD) with various stakeholders including agricultural scientists,

extensionists, farmers and private personnel, that the major factors impeding ginger production are unfavorable climatic conditions (temperature, rainfall, humidity), inappropriate soil conditions, unavailability of suitable varieties and lack of awareness about ginger production practices among farmers etc. Further, the study reveals that net benefit per acre of ginger cultivation is about Rs. 4,75,200 if grown for market purpose. A success story of ginger cultivation is found in the area of Balaksar, Chakwal where one farmer named Abad-ur-Rehman cultivating ginger successfully at his farm for seed purpose. He cultivated it on one Kanal during year 2020 and increased the ginger area to one acre during 2021. He intercropped bitter gourd with ginger during the current season. He planned to increase its area upto 2 acres in coming year based on higher returns in the last two years. He opined that ginger can be grown successfully in the Punjab Province under semi-controlled conditions using tunnel supported with drip irrigation including intensive crop management practices as well. Many farmers of nearby areas visited his farm and shown interest in the cultivation of ginger. It is suggested that government should provide support to ginger growers in the form of production technology package and subsidized inputs.

Comparison and Efficiency Analysis of Different Sowing and Harvesting Methods of Rice in Rice-Wheat Zone of Punjab

Mechanized agriculture plays a key role in overall socio-economic development in terms of food security, value addition, employment, poverty alleviation and export earnings. Due to migration of agricultural labor in non-farm sectors and increasing climate vulnerability, it is a great challenge to keep pace of food production for population growing exponentially, especially in the developing countries. Therefore, the main aim of this study is to examine the present status and farmer's perception about new rice sowing and harvesting technologies in contrast to traditional sowing and harvesting methods. Popular rice producing districts of Hafizabad and Sheikhupura are selected for the study of aromatic rice. Comparative results regarding sowing of paddy rice shows that rice nursery and seed cost is less in mechanical transplanter while fertilizer and irrigation cost are higher in mechanical as compared to manual transplanter due to recommended plant population. Mechanical transplanter maintains sufficiently fulfills the recommended plant population of 80000 (here it is 87000) compared to traditional transplanting method (Manual) giving 40000 plants per acre. Moreover, in mechanical transplanter, yield also reported higher as 44 maunds compared to manual transplanting yielding 38 maunds per acre. Farmer's perception regarding adoption of mechanical sowing, majority of the farmers adopted this technology due to higher yield as compared to traditional transplanting, attaining target of recommended plant population, proper ventilation, saving ploughing/water costs, high straw value, labour and time saving as compared to manual transplanting of rice. Paddy harvesting technologies results show that majority of the farmers adopted paddy specialized harverster Kabota due to less post-harvest losses 5-7 maunds per acre as compared to traditional wheat harvester-based machine, higher straw value , premium price of paddy due to clean harvesting, save ploughing cost and tough working in extreme weather conditions. Despite many drawbacks, wheat- based harvester (Traditional) is still popular in rice-wheat system due to its significant features i.e. ability to harvest fallen crop, time saving in wake of fast working and easy availability in local market. Keeping in view the comparative economics and farmer's perceptions, it is concluded that mechanical transplanting and Kabota harvesting technologies are more efficient as compared to traditional methods. It is recommended that information dissemination for adoption of appropriate rice harvesting and sowing technology is urgently needed to increase the cropping intensity, crop productivity and economic emancipation through less inputs in terms of time, labor wages and other costs.

Prospects of Soybean Crop in Punjab-Pakistan

Soybean is an important oil seed crop as it contains 20 percent oil content and 40 percent protein. Although the country has suitable agro-climatic conditions for soybean cultivation but the absence of varieties with high yield potential pushed its cultivation towards the marginal areas. In Pakistan, the demand for soybean oil and meal has increased manifolds as a raw material for industry in the country. However, soybean cultivation is very low in the country and as a result precious foreign exchange is spent on its import. Pakistan is the 24th largest importer of soybean oil in the world despite possessing favorable conditions for its production.Keeping all this in view, the present study was designed to analyze the prospects of soybean cultivation in Okara/Sahiwal in Punjab because of joint venture of AARI and Nestle Company. According to the survey results, majority of the respondents sowed the soybean crop in July-August and majority harvested soybean in November-December during 2021.

Further, almost 100 percent farmers adopted ridge sowing for the soybean crop. The study revealed that only two varieties of soybean were sown by the respondents in study area. The respondents perceived that AARI-soybean variety has more yield than Faisal-soybean variety. It was estimated that benefit cost ratio with land rent was 1:1.07 while the net income was Rs. 4890.68 per acre. The respondents of the study area sold all the produce to Nestle Company at the rate of Rs.3760 per maund. No germination problem was reported by the majority of respondents (85percent).The majority of respondents (85percent) were planning to grow more soybean in future @ 4 to 5 acres in study area. For the promotion of soybean cultivation, a comprehensive and applied soybean production and procurement policy through public-private partnership should be developed and implemented to promote local supply of soybean.

Poverty Alleviation through Health Improvement of Rural Female Involved in Cotton Picking

Cotton picking is considered an important source of income generation for the women of the country. During cotton picking, females have to face many health related issues arising from direct contact with cotton sprayed fields as maturity of cotton is highly pesticides-based. Cotton picker females (girls and adults) of the country rarely use any protective measures such as gloves, caps, face mask and field shoes during cotton picking. Even the farmers don't apply pesticides judiciously as per recommendations, thus applying sprays up to 14 per acre. To find solutions to these pesticides and their after effects on female cotton pickers, current project at PARC (SSRI), Faisalabad was launched with the funding from UNESCO during year 2022. The main objectives were to create awareness among males regarding judicious use of pesticides and the females regarding use of protective measures (comprehensive kit) duly looking after their and children's personal health and hygiene while working in the cotton fields. The objectives were met through arranging informative training/meeting sessions both for the cotton farmers and female cotton pickers. Four major sites from Multan, Khanewal, Vehari and Lodhran districts among cotton belt of the Punjab were selected in consultation with relevant stakeholders including agriculture extension department. In total, 4 face-to-face trainings (one in each district) were organized at selected sites to impart awareness among farmers through brochures and visuals from various sources on cotton crop to avoid over use of pesticides. For female cotton pickers, 11 face-to-face trainings were organized at selected sites to impart awareness among cotton pickers through brochures, displaying kits and visuals from various sources on cotton crop to lessen the side effects of pesticides on females and to plan better livelihood without compromising on health and hygiene of relevant stakeholders of Punjab Province. Based on findings of Participatory Rural Appraisal (PRA) conducted by project team, concerned resource persons/trainers imparted trainings covering almost all sectors from cotton crop management for harvesting such as proper selection of insect/pest resistant cotton varieties, judicious use of pesticides, use of protective kits, eating healthy diets and kids management during cotton picking activities. To see the effectiveness of the trainings, pre and post training, cotton pickers' awareness and use of protective measures were taken. None of the female cotton pickers were using protective measures kit but almost 7 percent pickers were aware of the use and benefits of adopting protective measures. All female participants (100 percent) acknowledged the benefits of holding training for them and they showed positive attitude towards wearing protective kits in future to save their as well as kid's life from any side effects of pesticides. Even they gestured improving their eating and hygiene sustaining habits before, during and after cotton picking activities. Based on project findings, it is suggested that such type of informative trainings should remain in vogue till message reaches to large community working in the agricultural fields. Agriculture extension department should hold joint field visits with public sector nutrition experts while disseminating latest knowledge on use of pesticides as well as health and hygiene related issues in order to have more realistic application of solutions for sustained livelihood of females in the agriculture sector of the country.

Agroforestry as a Source of Rural Livelihood Improvement: Evidence from Central Khyber Pakhtunkhwa, Pakistan

Agroforestry practiced in Khyber Pakhtunkhwa province of Pakistan is as old as farming itself. However, the new concept of agroforestry was introduced during 1980s in the province with donor-assisted “Social Forestry” projects in Pakistan. This study was carried out during the year 2022 in three districts, Nowshera, Peshawar and Charsadda of Central Valley Plain of Khyber Pakhtunkhwa. A total of 102 agroforestry were interviewed with the objectives to find out the extent of livelihood

improvement and suggest measures for promotion of agroforestry in the area. Based on the study results, self-rated consumption adequacy of sampled families was; food, housing, health care, and transportation status was "less than adequate" for their family needs. Limited number of sampled farmers had fruit orchards along with fruit nurseries. Wheat, maize, sugarcane crop, fodder and vegetables like eggplant, tomato, pumpkin, bitter ground, okra and cauliflower were grown by sampled respondents. The value of tree nurseries of 1.16 years was PKR 71,511 per acre. The average number of Poplar (eucalyptus) trees on each farm was 416 numbers, age of 6.18 years with average price of PKR 4,550 per plant, sold at pre-harvest stage mainly to traders (beoparies). Agroforestry in the area was increased and intension behind agroforestry was getting additional income, no management cost, neighbor farmer plantation on the banks of farm field and high market demand. The positive role of agroforestry may differ among the economic and tenancy status of farmers while the negative impact was the decrease in productivity. Agroforestry helped the farmers in cash money and provision of emergency cash that provides safety net to farmers. It increased fuel wood that increased the energy supply. It also provides limited fodder to livestock that might decrease fodder requirement of livestock. The ownership of the trees was mainly with the owners of the farms and majority of the tenant were not given due share in the trees and viewed that crops and land productivity were decreased due to agroforestry. Perceived Advantages of agroforestry were (i) improved socioeconomic condition, (ii) improved household physical infrastructure, (iii) provision of money in emergency, (iv) increase in income, and (v) supply of fuel wood products. Attitudes of farmers towards agroforestry adoption was (i) preferring agroforestry over farming, (ii) increase area or continue agroforestry, and (iii) planting trees with agricultural crops is a good idea. Pretensions towards agroforestry of farmers was (i) increased social relationship with other communities and social organization, (ii) provision of market facilities for trees, (iii) provide protection from wind/flood and (iv) increase conflict with the neighbor. The study suggested that the Government and non-government organizations need to work in close coordination, develop sustainable agroforestry focused projects and provide scientific guidance to rural farmers through capacity building, equipping them with multipurpose tree species suitable with crops along with introduction of trial based technologies applicable according to socio-econ-psycho-and climatic conditions of the area.

Knowledge and Adoption of Climate Smart Agricultural Practices: Perception of Small-Scale Farmers of Sindh Province

The agriculture sector, particularly in developing countries, is the more victim of the impacts of climate change due to less adaptation. The low response to the adoption of climate-smart agriculture (CSA) practices raises questions about the factors influencing adaptation determinants. Therefore, this present study is planned to explore the farmers knowledge and adoption of CSA practices and the intensity, assessing through its determinants. For this purpose, 120 farmers were interviewed across three agro-ecological zones of Sindh, Pakistan. This study, contributed to the growing literature on the impact of CSA practices on farm performance, and rural household welfare by exploring climate risk management, the contribution of single or joint adaptation strategies in enhancing farm net returns, food and nutrition security, as well as poverty reduction in rural Pakistan.

Results indicate that majority of the farmers agree with opinion of climate change taking place. It shows that there was growing awareness of climate change problem among small scale farmers and emerging need for adaptation to climate change effects through adoption of climate smart practices. There was significant knowledge gap and low practice of climate smart practices, in spite of the positive outlook to climate smart practices attributed to collapse of extension services over the years. Further data shows that majority of farmers (95 percent) had an opinion of decline in cropping yield due to increase in rainfall and increased frequency and intensity in floods. Majority of farmers (80 percent) reported low milk production due to increased frequency and intensity in droughts and decline in rainfall. Results indicate that not many people were found to be familiar with farm specific nutrient management and precise fertilizer application. Only 15 percent had information about the practice, while the rest (85 percent) who constituted the majority had no idea. Awareness of green house technology among farmers was found to be low with only (18.4 percent) of respondents indicating awareness. This demonstrated the need for enhanced sensitization with regard to this practice among farmers. Responses also indicated very low percentage of knowledge (9.1 percent) among the farmers in terms of application of green house technology. Further Responses showed low (47.9 percent) awareness of crop rotation among farmers, with majority (52.1 percent) indicating lack

of awareness. In spite of the low awareness of the practice, comparatively crop rotation was among climate smart practices that were highly known among farmers. Adoption of climate smart practices was hampered mainly by dwindling farm sizes, limited knowledge of climate smart practices, limited outreach of weather and climate information, low financial capability and weak policy framework. Overall, the findings showed that CSA practices can help in reducing the adverse impacts of climate change and should therefore be promoted across the country. The policy implication is that promoting and scaling up the adoption of CSA practices could help farmers raise their incomes and reduce their exposure to crop failure and income vulnerabilities. Therefore, CSA practices should be promoted across the farmers in the country, either in isolation or in a combination of these practices. Furthermore, policies that enhance access to extension services and access to credit and education, as well as timely information on climate change would facilitate the adoption of CSA practices and contribute to improving rural farm household welfare. It is therefore recommended that, policymakers could promote effective measures to enhance farmers' access to credit and extension services. In particular, enhancing farmers' knowledge and skills through better training would help in facilitating adoption of CSA practices and raising farm incomes.

AGRICULTURAL TRAINING INSTITUTES (API)

Training Courses (T:13, P:314)

Sr.#	Training Title	Duration			No. of Participants			Prov	Collab.
		From	To	Days	Male	Female	Total		
1	Training of Agriculture Officers Batch -3 under JICA - API/NARC Project for the Capacity Development of Agriculture Extension Services in Balochistan Province	20-Sep-21	1-Oct-21	Two-Week	30	0	30	Balochistan	JICA
2	Training of Field Assistants (FAs) Batch -5 under JICA - API/NARC Project for the Capacity Development of Agriculture Extension Services in Balochistan Province	20-Oct-21	2-Nov-21	Two-Week	24	0	24	Balochistan	JICA
3	Training of Field Assistants (FAs) Batch -6 under JICA - API/NARC Project for the Capacity Development of Agriculture Extension Services in Balochistan Province	22-Nov-21	3-Dec-21	Two-Week	25	0	25	Balochistan	JICA
4	Kitchen Gardening	18-Nov-21	18-Nov-21	One-Day	0	20	20	ICT	Secours Islamique France (SIF)
5	Vegetables, Alternative Crops and Herbs (Medicinal Plants)	7-Dec-21	8-Dec-21	Two-Day	7	2	9	Punjab	Engro Foundation
6	Training of Agriculture Officers Batch -4 under JICA - API/NARC Project for the Capacity Development of Agriculture Extension Services in Balochistan Province	20-Dec-21	31-Dec-21	Two-Week	24	6	30	Balochistan	JICA
7	Exposure Visit-Cum Training on "Wheat Production"	31-Mar-22	31-Mar-22	One-Day	25	5	30	ICT	NRSP
8	Follow-Up Workshop-3 (Assembly-1) under JICA - API/NARC Project for the Capacity Development of Agriculture Extension Services in Balochistan Province	24-Mar-22	25-Mar-22	02-Day	39	0	39	Balochistan	JICA
9	Honey Testing and Exposure to Apiculture	20-Apr-22	21-Apr-22	02-Day	3	1	4	Khyber Pakhtunkhwa	Hamdard

10	Training of Field Assistants (FAs) Batch -7 under JICA - API/NARC Project for the Capacity Development of Agriculture Extension Services in Balochistan Province	16-May-22	27-May-22	Two-Week	23	0	23	Balochistan	JICA
11	Follow-Up Workshop-3 (Assembly-2) under JICA - API/NARC Project for the Capacity Development of Agriculture Extension Services in Balochistan Province	6-Jun-22	7-Jun-22	02-Day	40	0	40	Balochistan	JICA
12	Training of Field Assistants (FAs) Batch -8 under JICA - API/NARC Project for the Capacity Development of Agriculture Extension Services in Balochistan Province	13-Jun-22	24-Jun-22	Two-Week	25	0	25	Balochistan	JICA
13	Production Technology of Major Crops and Efficient Water Use	28-Jun-22	30-Jun-22	Three-Day	15	0	15	Khyber Pakhtunkhwa	IWMI
				Total	**280**	**34**	**314**		

Internship / Research Students

As part of degree requirement, 957 students from different universities were placed at different institutes of NARC. Detail is as follows:

Sr.#	Month	Internship			Research		
		Male	Female	Total	Male	Female	Total
1	July	73	64	137	2	1	3
2	August	28	34	62	3	4	7
3	September	8	17	25	3	2	5
4	October	53	17	70	3	4	7
5	November	58	12	70	3	5	8
6	December	14	20	34	4	0	4
7	January	37	48	85	2	2	4
8	February	64	36	100	3	15	18
9	March	64	52	116	3	3	6
10	April	11	19	30	3	2	5
11	May	24	10	34	5	3	8
12	June	81	33	114	0	5	5
Sub Total		**515**	**362**	**877**	**34**	**46**	**80**
Grand Total		**957**					

Exposure/Study Visits Conducted (V: 62, P:3153)

Sr.#	Date	Visiting Institute/NGO	No. of Visitors			Institutes/Programs visited
			Male	Female	Total	
01	01-11-2021	Thardeep Rural Development Program (TRDP) Tharparkar, Sindh	15	05	20	Dairy, ASI, NIGAB, BCI, HBRI HRI, CSI
02	02-11-2021	Thardeep Rural Development Program (TRDP) Tharparkar, Sindh	15	05	20	LRS, KOPIA, IPEP, CEWRI, Insectry
03	08-11-2021	Barani Institute of Management Sciences (BIMS) Rawalpindi	60	25	85	LRS, KOPIA, HBRI
04	09-11-2021	Barani Institute of Management Sciences (BIMS) Rawalpindi	60	25	85	HRI, SSRI

05	11-11-2021	University of Haripur	40	20	60	NIGAB, HBRI, HRI, IPEP
06	17-11-2021	College of Veterinary & Animal Sciences, Narowal	30	10	40	ASI, LRS
07	18-11-2021	Beachonhouse School System, Islamabad	10	10	20	BCI (NH), CDRI, IPEP
08	22-11-2021	The Islama University of Bahawalpur	06	12	18	NIGAB, BCI, FSRI, Plant Physiology
09	24-11-2021	UET, Peshawar	50	00	50	AEI, FO&S, CEWRI
10	25-11-2021	BATI, Dahgal, Rawalpindi	00	34	34	HRI, IPEP
11	30-11-2021	St. Mary's College of Education, Gujranwala	05	34	39	NIGAB
12	01-12-2021	Women University, Mardan	00	42	42	FSRI
13	07-12-2021	Virtual University of Pakistan	10	15	25	IPEP
14	07-12-2021	Engro Foundation, Lahore	01	01	02	ASI, NIGAB, BCI, HRI
15	08-12-2021	Engro Foundation, Lahore	01	01	02	HBRI, CSI, CEWRI, SSRI, FSRI, LRRI
16	08-12-2021	Iqra University, Islamabad	10	15	25	FSRI
17	09-12-2021	WWWF Pakistan	27	00	27	Wheat, LRRI, Insectry
18	09-12-2021	AHK-NCRD, Islamabad	23	02	25	CEWRI
19	13-12-2021	Govt. Post Graudate College for Women, Abbottabad	00	35	35	Fisheries, HBRI
20	15-12-2021	The University of Lahore	30	20	50	NIGAB
21	21-12-2021	Agric. Program for Improved Nutrition in Sindh (PINS-3)	44	06	50	LRS, Fisheries, HRI, CSI
22	21-12-2021	Pakistan Science Foundation	120	100	220	HRI, CSI
23	20-01-2022	AHK-NCRD, Islamabad	27	03	30	Fisheries, ASI, LRS
24	25-01-2022	PMAS-AAUR, Rawalpindi	50	25	75	LRS, HBRI
25	31-01-2022	PMAS-AAUR, Rawalpindi	40	20	60	CEWRI
26	01-02-2022	ARS, Chitral	06	00	06	NIGAB, AEI, HRI
27	02-02-2022	ARS, Chitral	06	00	06	ASI, IPEP, CDRI
28	08-02-2022	VU Pakistan	13	12	25	IPEP
29	18-02-2022	UAF, Faisalabad	90	79	161	CSI, HRI
30	21-02-2022	IIU, Islamabad	20	14	34	ASI, HBRI, HRI, CSI, IPEP
31	23-02-2022	UAF, Faisalabad	55	32	87	LRRI
32	23-02-2022	University of AJK, Muzaffarabad	20	15	35	NIGAB
33	24-02-2022	UET, Peshawar	21	00	21	CEWRI
34	28-02-2022	Agriculture Extension, Mardan	17	00	17	HRI, CSI, CEWRI
35	02-03-2022	UAF, Faisalabad	97	52	149	BCI
36	15-03-2022	ASA, Peshawar	30	00	30	HRI, CSI, CEWRI

37	16-03-2022	BATI, Dahgal, Rawalpindi	34	00	34	HRI, IPEP
38	17-03-2022	NUST, Islamabad	04	10	14	CEWRI, IPEP, LRRI
39	17-03-2022	UOS, Sargodha	25	05	30	CDRI
40	17-03-2022	MNSUAM, Multan	05	55	60	CEWRI, AEI
41	18-03-2022	UOS, Sargodha	25	05	30	CDRI Murree
42	18-03-2022	GGDC, Abbottabad	00	35	35	ASI, LRS, Fisheries, HBRI
43	31-03-2022	NRSP, Islamabad	30	00	30	API, CSI
44	05-04-2022	Headstart School, Islamabad	25	10	35	HRI, KOPIA
45	25-04-2022	Abasyn University, Islamabad	08	30	38	LRRI, IPEP
46	13-05-2022	UAF, Faisalabad	80	40	120	HRI
47	18-05-2022	UAF, Faisalabad	00	100	100	NIGAB, BCI, HRI, Insectary, IPEP
48	19-05-2022	UAF, Faisalabad	00	125	125	NIGAB, BCI, HRI, Insectary, IPEP
49	25-05-2022	ARI, Tarnab, Peshawar	25	00	25	HBRI
50	26-05-2022	UCP, Lahore	30	15	45	FSRI
51	27-05-2022	UAF, Faisalabad	60	50	110	FSRI
52	28-05-2022	CUST, Islamabad	60	40	100	ASI, NIGAB, LRRI
53	02-06-2022	UOS, Sargodha	40	20	60	IPEP, HBRI
54	02-06-2022	BATI, Dahgal, Rawalpindi	34	00	34	HRI, IPEP
55	03-06-2022	UAF, Faisalabad	90	15	105	IPEP, NIGAB, HRI
56	08-06-2022	UOS, Swabi	20	10	30	HBRI
57	13-06-2022	BU, Islamabad	06	05	11	NIGAB, CEWRI, FSRI, NIM, ERP, LRRI
58	13-06-2022	BU, Islamabad	06	16	22	LRRI, Insectary, RRI, CSI, CEWRI
59	15-06-2022	UAF, Faisalabad	50	60	110	FSRI
60	21-06-2022	KUST, Kohat	20	10	30	ASI, NIGAB, CSI
61	29-06-2022	MNSUAM, Multan	50	30	80	SSRI
62	29-06-2022	ASA, Peshawar	30	00	30	ARGP, LRS
		Total	**1806**	**1355**	**3153**	

Exhibitions

i. Set up exhibition in "Kisan Mela" at Convention Centre Islamabad on 01 July, 2021.
ii. Set up exhibition in "World Food Day" on 15 October, 2021.
iii. Set up exhibition in "World Pulses Day" on 10-02-2022.

Meetings / Seminars

i. Attended Meetings of RMC, NARC.
ii. Attended Meetings of TWG of different institutes at NARC.
iii. API TWG Meeting on 08-07-2021.
iv. Meetings with JICA-API/NARC Project stakeholders.
v. Seminar on "Seed Systems of Pakistan; Weaknesses & Opportunities for Ensuring Food Security" on 09-05-2022.

Project

I. JICA-API/NARC Project for the"Capacity Development of Agriculture Extension Services in Balochistan Province" is being implemented at API. Since its beginning, 25 ToTs, 120 Agriculture Officers and 200 Field Assistants have been trained so far.
ii. PC-I of "Professional Capacity Building and Extension in Agriculture (PCBEA)" was submitted to Ministry of National Food Security and Research (MNFS&R).

Knowledge Sharing

i. Wheat brochures (cultivation, harvesting & weeds) prepared.
ii. Cereal textbook prepared.
iii. Vegetable text book prepared.
iv. Fruit textbook prepared.
v. Fruits, Vegetable and Cereal Crops Disease & Insects Posters prepared for Balochistan.

Other(s)

i. Facilitated in preparing posters of different institutes of NARC for Kisan Mela and World Food Day.
ii. Submitted training proposal for OIC countries.
iii. Recorded Radio Program in Zarkhez Pakistan on 18-02-2.

DIRECTORATE OF SCIENTIFIC COMMUNICATIONS AND PUBLICATIONS

Directorate of Scientific Communications and Publications (DSC&P) progress report during 2021-22 is as under:

Media Activities

DSC&P is providing scientific and functional media coverage and photographic services to the scientists of PARC/NARC and its establishments. DSC&P launched YouTube channels with the title of "PARC Official" and "PARC Archive" and their links are also available at PARC website. An official Facebook page has also been created. DSC&P produced and uploaded 07 documentaries on YouTube, arranged 05 TV and news reports, 37 important functions and events were recorded. The Directorate produced two videos documenting PARC field research activities and provided 22 audio facilities for various programs. 2905 photographs were snapped for field/lab experiments, and 49 significant events were covered.

PARC Website

PARC Website was redesigned from Joomla 2.4 version to latest PHP technologies with cooperation of National Information Technology Board (NITB). Website was inaugurated by Dr. Ghulam Muhammad Ali, Chairman PARC in June, 2022. New website is dynamic, interactive and user friendly.

NARC Library

NARC library is the central information resource for scientists, researchers and students in the field of agriculture and allied subjects. Library users can find a wealth of knowledge, either in print or online. The library has collection of over 29,000 books covers a wide range of different

agricultural subjects.
Resources of HEC Digital Library and CABI information products are accessible at NARC Library and access is provided on PARC Local Area Network. Internet based Union Database of Journals (UDJ) in agricultural libraries containing information of 3034 journal/magazine titles with available volumes and issues in 36 libraries. UDJ was updated with 140 new volumes with 236 issues of NARC Library, besides its updation by participating libraries. 115 reprints were supplied to foreign agencies/scientists and 172 to local scientists during the year.

Pakistan Journal of Agricultural Research

Pakistan Journal of Agricultural Research (PJAR) is a quarterly publication of Pakistan Agricultural Research Council in the field of Agriculture. It is an HEC recognized Journal and is being indexed in Scopus, AGRIS of FAO; CAB Abstracts; Pakistan Sciences Abstract of PASTIC. PJAR is availing services of British publisher partner Smith and Franklin for promotion as well as publishing assistance to get impact factor through wide indexing of the Journal. The Journal is available on Factiva and EBSCO-affiliated international databases through Asia net Pakistan. It is being published regularly and is also available online http://researcherslinks.com/journal/Pakistan-Jouranla-of-Agricualtural-Research/24.

Annual Report

PARC Annual Report is a regular activity of DSC&P published every year and uploaded on PARC website. It can be accessed and downloaded from the Link: http://www.parc.gov.pk.

PARC Newsletter

PARC Newsletter is being published quarterly, uploaded on PARC website and widely circulated to national as well as international partners. During the year 02 issues of Volume 33 (2021) and 02 issues of 34 (2022) were published and available online on PARC website.

AGRICULTURAL ENGINEERING DIVISION

The division's key focus is to design, develop, adapt and promote energy-efficient and precision agricultural machinery with a particular focus on introduction of energy-efficient farm mechanization and postharvest technologies for cereal, fruits, vegetables and other crops. Division is also playing an important role of coordination among the stakeholders related with the promotion of agricultural mechanization in the country. The division is also exploring and utilizing solar thermal energy for drying of dates and banana value addition in production catchment areas of Sindh and Balochistan besides providing technical inputs for development of National Standards for agricultural tractors & machinery and establishing facilities for testing of agricultural machinery.
Agricultural Engineering Division has executed a number of research projects during the reported period on development, testing and commercialisation of agricultural machinery for local farmers. Some salient achievements during the reported period are given below:

Tractor-mounted maize planter

Maize is the third most important cereal crop in Pakistan after wheat and rice. Maize is cultivated on an area of 3.49 million acres with a total production of 7.24 million tonnes. Two maize crops are grown in the Punjab (spring and autumn), whereas one crop is grown in other provinces. About 97% maize is cultivated in the Punjab and Khyber Pakhtunkhwa provinces. Traditional maize varieties give an average yield of about 48 maunds per acre, whereas the hybrid maize varieties give a production of about 120 maunds per acre. About 71% maize is used in animal and poultry feed, 20% in food processing industry, 5% in human food and 4% is used for fodder and other purposes. Precision planting of maize crop is very important for getting a better yield. Hybrid maize is mainly planted by hand on ridges or beds, which is a very laborious and time-consuming practice. Available maize planting machinery does not maintain plant to plant distance, which decreases yield. Agricultural Engineering Institute (AEI) of Pakistan Agricultural Research Council (PARC), Islamabad has designed and developed manual and tractor-mounted precision maize planters that maintain the desired seed depth and plant to plant distance. Tractor-mounted precision planter saves seed, water, labour, time and increases yield. This technology gives uniform crop stand as compared

Testing and demonstration of manual and tractor-mounted maize planters

to traditional maize planting methods. The planting precision of the machines is more than 95% and can plant one acre in one hour. The planter was tested and demonstrated to farmers at Chiniot, Faisalabad, Sahiwal, Sheikhupura, Multan, Khanewal and Vehari districts. The operating cost of the machine is Rs. 946 per acre, whereas the manual planting cost is Rs. 2,700 per acre. Therefore, the net economic benefit to farmers by using this technology is Rs. 1,754 per acre.

Groundnut Digger-Inverter

Groundnut is an important summer cash crop grown on well-drained sandy or sandy loam soils in Pakistan's marginal lands. It is a good source of edible oil as it contains about 50% oil of good quality. Groundnut oil is one of the best cooking oils due to its high smoking point and is desirable for use in ghee, margarine, shortening and salad oil. Groundnut is also an excellent source of vitamins and other essential nutrients. The major groundnut growing areas in Pakistan are Chakwal, Attock and Jhelum in Punjab; Karak and Swabi in KPK; and Sanghar in Sindh. Groundnut crop has large yield gap in Pakistan which is mainly attributed to uncertain weather conditions, inadequate application of farm

inputs, and persistent cultivation of conventional varieties and unavailability of proper harvesting machinery.

In Pakistan, more than 95% farmers use digging blade to harvest the groundnut crop and after digging the crop, labour is required to invert the crop manually. Almost 5-6 persons are involved for picking, shaking and inverting the crop in 3-4 hours per acre. This is a very labour-intensive and time-consuming operation, also high cost is paid due to non-availability/shortage of labour. The inefficient


Testing of groundnut digger-inverter

digging of groundnut crop also results in financial loss to farmers as 30-40% pods remained underneath the soil. Lack of appropriate technology and efficient harvesting are the factors resulting in lower productivity and high labour cost, ultimately reducing the profit of farmers. Agricultural Engineering Institute, NARC has addressed the issue of harvesting the groundnut crop and introduced a tractor-mounted groundnut digger-inverter in 2020 to reduce the pod losses and reduce the labor requirements. This machine performs four functions simultaneously i.e. digging, shaking, conveying and inverting. The new machine was extensively tested at farmer's field for its performance evaluation and different field days / seminars were arranged at different groundnut growing areas to demonstrate this technology to farmers. The machine is being commercialized through local machinery manufacturers. The economic impact of this machine is very significant as it reduces digging losses up to 20% and increases yield up to 10%.

Ispaghol processing machinery

In Pakistan, tradition methods are used to separate husk from ispaghol seed. Due to traditional methods of threshing, cleaning, and de-husking, a lot of wastage occurs and the quality of product is often poor. The capacity of husk production using traditional methods is very low. Furthermore, this method is very dusty and contaminate environment with dust pollution. Laborers engaged in husk


Ispaghol processing machinery developed by AEI, NARC, Islamabad

production often get asthma and other respiratory diseases due to dusty environment. Due to unavailability of modern processing facilities, farmers and merchants do not get due profit that could only be realized if modern processing facilities are available. Due to poor quality husk production in Pakistan, multi-national companies import husk form India. There is a great potential for export of ispaghol husk. About 64 families own traditional ispaghol processing units in Hasilpur. These families can process about 10 tons ispaghol seed per day. Normally, ispaghol processing time-span is 3 months (i.e. from April to June). Ispaghol processing capacity using traditional methods is far less

than its market demand. In traditional methods the labor requirement is very high. One person is required to operate one de-husker for 12 hours shift and can only process 20 kg seed per shift.
Agricultural Engineering Institute has designed and developed indigenous ispaghol cleaning, de-bearding, de-husking and classifying machines. The small processing unit (4 dehsukers) is installed at NARC. Its seed processing capacity is around 250-300 kg per day. The processing cost and income of complete ispaghol plant (16 dehuskers) is Rs. 9,965 and Rs. 10,827, respectively with a net profit of Rs. 862 for 40 kg seed. The net profit for one day (10 h) shift is Rs. 32,311, when 1.5 tonnes of ispaghol seed is processed daily.

Rice residue management machinery

The rice-wheat growing areas in Pakistan are primarily situated in central Punjab (main districts include Gujranwala, Sheikhupura, Narowal and Sialkot) followed by Sindh. In the system, rice is traditionally grown by transplanting 25-35 days old seedlings in well-puddled and continuous flooded field. This method of rice establishment is a time-consuming, tedious and inhuman and involves high cost of labour, water, and land preparation. Wheat sowing after the paddy harvest is delayed, resulting in poor crop stand and low grain yield. Wheat crop is also badly affected by flood irrigation due to poor drainage of paddy soils. Consequently, the productivity of the system remains far below the potential yield levels of modern cultivars.



Pak Seeder, Combine Seeder and other rice residue management machinery

For sowing of wheat in combine harvested paddy fields is a challenge due to handling of heavy rice residue to avoid delay in crop sowing. Agricultural Engineering Institute (AEI) has developed rice residue management technologies called as Pak Seeder and Combine Seeder that can plant wheat crop directly in combine-harvested paddy straw. These technologies not only improve soil biological and physical health, but also increase wheat and rice yield. These resource conservation technologies can enhance crop yield up to 10%, reduce nutrients loss of the soil and save environment form smoke pollution. These technologies will help in mitigating the SMOG problem in the country.

Onion Seed Planter

Onion (Allium cepa L) is one of the important condiments widely used in all households throughout the year. Onions may be eaten raw, fried and pickled. There are two cropping season of onion in Pakistan i.e., spring and autumn. Various methods prevail in the country to sow onion crop in a field. In spring cropping, first nursery of onion is sown, then this nursery is transplanted in field and on maturity crop is harvested in the month of June. For off season/autumn crop nursery raising is too difficult due to hot month of June.
This off season/autumn crop had some limitations. The most important one of the limitation is nursery raising for this off season crop during hot month of June, July, and August. Normally farmers brought onion seedlings from Sindh province causing 40-50% mortality during transportation.



Testing and demonstration of onion seed planter

Therefore by raising onion seedlings under these hard conditions farmers would be able to get onion seedlings at their farms inspite of importing from Sindh. In case nursery raising is not successful

under hot summer conditions, a better substitute to seedlings are onion sets.
In Balochistan, onion cultivation is done by broadcast direct seeding method. All these methods, nursery sowing, set sowing and broadcast method are manual. These manual onion seed planting methods are laborious and more time consuming practice which results in a lower plant density and low yield. Improper seeding depth arises germination losses whereas improper plant to plant distance increases competition between adjacent plants for available air, sunlight, nutrients, and water which ultimately effects plant growth and decreases yield. More distance between plant to plant results in yield decreases. Manual seed sowing for onion set production or nursery raising especially on mass scale is very much time consuming and labour intensive work.
To address this problem Agricultural Engineering Institute (AEI), NARC has developed a tractor operated onion seed planter attached with bed shaper will sow onion seeds on beds using unique cavity type seeding mechanism. This machine has disk type furrow openers for proper seed placement with a roller to cover the seed with soil. The machine sows seed simultaneously in 10 rows with row spacing of 2 inches having two beds of same size. The field capacity of the machine is around one acre per one hour. The machine is being commercialized with the collaboration of private machinery manufacturer.

Postharvest Processing of Peach

Peach occupy the most important place in the stone fruits and is temperate in nature. Swat and Peshawar valleys enjoy the central position in KPK in supplying peach fruit of high quality and grade. Peach produced in NWFP is marketed immediately after harvesting. High temperature and humidity, however, cause high postharvest losses. Estimates suggest that losses are ranged 20 -30%. Peach supplied to various cities of the country by the growers themselves and through Beoparies (middlemen).
The rapid cooling of peach after harvest is very important to remove field heat of the produce. Currently in Pakistan, the peach is marketed without any washing. Agricultural Engineering Institute has imported postharvest processing machinery for peach, which will be tested and demonstrated in the fruit growing clusters in the Khyber Pakhtunkhwa province. About 10-15 % losses of the peach fruit would be reduced and the shelf life of fruit will be increased.

Machinery for Postharvest Processing of fruit and vegetables

Rice Mechanisation

Pakistan is the world's 10th largest producer of rice. Pakistan's exports make up more than 8% of world's total rice trade. It is an important crop in the agriculture economy of the country. In Pakistan, rice is grown manually by sowing rice seedlings and then transplanted manually in the puddled soil

Field testing of improved DSR drill, nursery raising machine and rice transplanter

using labour force. The plant population achieved by manual transplanting is around 35,000-40,000 plants per acre while recommended plant population is around 80,000-85,000 plants per acre. This difference is plant population results in low productivity of rice crop in Pakistan.

Agricultural Engineering Institute (AEI) has field tested and evaluated the direct seed rice (DSR) drill to identify the problems in the drill. The design modifications in the drill to improve its performance were enlisted. Technical assistance was provided to private manufacturer to modify the DSR drill for its performance improvement and service providers of rice transplanters. Training and awareness were provided to farmers about benefits of using DSR drill and mechanical rice transplanting technology. The mechanized planting of rice will enhance the productivity of rice up to 20%. The issues of labour shortage and low production of rice due to less plant population of rice and grain loss due to the use of improper combine harvester will be significantly reduced.

Regenerative Agriculture

The climate-smart production system that requires significantly less cost outlay and far less inputs is applied to regenerative agricultural practices. This production system is based on natural process of soil fertility. Main elements of this production system include growing crops on raised beds, zero or far less tilling, sowing of crops with precision planter and mulching of sown crop. The system is well known and has been practiced globally for decades, but individually and sporadically. For proper application of regenerative agricultural practices, all these cultural practices should be integrated in the field in a sequence by using proper mechanisation and implements. This production system has already been practiced by many individual farmers in the country and have reported impressive results in higher yields, significantly reduced use of irrigation water and virtually no application of chemicals. However, the one of public sector research and development institutions has experimented this system. Agricultural Engineering Institute with active support of Ministry of National Food Security and Research and Planning Commission of Pakistan has conducted a trial on wheat crop and found encouraging results. The bottlenecks in implementation of regenerative agriculture system is the availability of customised agriculture machinery suited to this system from planting to harvesting. Regenerative agricultural machinery will help to enhance the soil organic matter, reduction in chemical fertilizer and weedicide application and 10-15 % improved yield of the crops.

Field testing of regenerative agricultural machinery

PLANNING AND DEVELOPMENT DIVISION

AGRICULTURAL LINKAGES PROGRAM

During the year 2021-22, two meetings of Board of Directors were convened in which 40 projects were approved for funding.

I. In year 2021-22, one hundred and thirty eight (138) projects are on-going under ALP with approved total cost of Rs.737.499 million, in disciplines of Plant Sciences, Natural Resources, Animal Sciences, Agricultural Engineering and Social Sciences (Table-I).

Table-I: Discipline-wise On-going Projects under ALP During 2021-22

Sr#	Discipline	No. of Projects	Total Cost (Rs. million)
i.	Plant Sciences	76	369.381
ii.	Animal Sciences	31	181.500
iii.	Natural Resources	22	128.850
iv.	Social Sciences	02	5.840
v.	Agri. Engineering	07	51.928
	Total	**138**	**737.499**

ii.Under ALP fifty five (55) projects have been completed amounting Rs.294.971 million in year 2021-22 of National Agricultural Research System in disciplines of Plant Sciences, Natural Resources, Animal Sciences and Agricultural Engineering (Table-II).

Table-II: Discipline-wise Completed Projects under ALP during 2021-22

Sr#	Discipline	No. of Projects	Total Cost (Rs. million)
i.	Plant Sciences	24	105.23
ii.	Animal Sciences	08	38.573
iii.	Natural Resources	12	70.922
iv.	Agri. Engineering	11	80.246
	Total	**55**	**294.971**

PUBLIC SECTOR DEVELOPMENT PROGRAM

i. One project was completed titled, "Up-gradation of Arid Zone Research Institute (AZRI) D.I Khan" during FY. 2021-22 under PSDP funding.
ii. Twelve (12) new project proposals were submitted to M/o NFS&R for approval of competent forum (DDWP, CDWP, ECNEC). However, the administrative approval of the project titled "Mainstreaming of Mountain Agricultural Research Centre (MARC) for the Promotion of High Value Agriculture in Gilgit-Baltistan" has been issued by M/o NFS&R.
iii. Prepared/approved online Cash Plans & Work Plans of nine (9) On-going PSDP funded projects.
iv. Conducted five (05) Steering Committee and four (4) Technical Committee Meetings during FY 2021-22.

RESEARCH AGREEMENT (MOU TYPE) PROJECTS

Overall nineteen (19) research agreement projects (MoU type) were ongoing during the 2021-22. The MoU section of PM&E has processed and revised administrative approvals of eighteen (18) projects for revision/re-appropriation of budget breakup and extended the project duration of different MoU projects for smooth implementation of projects. In which some of the major contributing donors were

Australian Center for International Agriculture Research (ACIAR), International Development Research Center (IDRC), Global Crop Diversity Germany through ICARDA, Royal Botanical Garden (RBG) Kew UK, CABI-Pakistan, International Atomic Energy Agency (IAEA), Punjab Agricultural Research Board (PARB), NSLP (PSF) etc.

List of MoU type Projects implemented during 2021-22

Plant Sciences	Animal Sciences	Natural Resources	Social Sciences	Agricultural Engineering	Total
12	02	01	04	0	19

The MoU section has also processed 30 project proposals and concept papers to the different local and international donors like FAO-Turkey, JICA, NSLP (PSF), German Academic Exchange Service (DAAD) KOICA, D-8 Turkey etc. As the Council has privilege to compete for financial assistance from the local and international donors. Therefore, scientists of the Council have won different projects from national and international donors. Some of the research agreements with international organization are underway for implementation in the future.

COORDINATION AND MONITORING DIVISION

The Coordination and Monitoring Division's (C&MD) role is to coordinate and facilitate agricultural research at national and international levels, and for this purpose, a mechanism of interaction by entering into Memorandum of Understandings and formation of different forums at National level has been devised. This mechanism of national and international coordination has facilitated in dissemination of innovative technologies to stakeholders, distribution of new germplasm, and minimizing duplication/ overlap of research activities in the National Agricultural Research System (NARS). The Division is involved in organizing MoU signing ceremonies, national and international conferences, seminars and meetings. Additionally, it also organized national level meetings, wherein the senior management of provincial agricultural research and extension, and Vice Chancellor of universities were invited. The C&MD also deals in capacity building of manpower in terms of Post-Doc., Ph.D. and M.Sc. levels besides other long/ short term trainings, visits for meetings/ symposia etc. Besides this, C&MD is also involved in dissemination of agricultural education through PIASA, which is an affiliated body involved in awarding higher level degrees M.Phil and Ph.D. in agricultural sciences. During the year, 22 M.Phil and 05 Ph.D students of PIASA passed their degrees in their respective fields.

The Coordination and Monitoring Division (C&MD) has also played a key role for the establishment of Korea Program on International Agriculture (KOPIA) Center in PARC-National Agricultural Research Center, Islamabad. Through this Center, Pakistan and Korea are collaborating for transfer of latest agricultural technologies to Pakistan with the aim to modernize our agriculture sector and increase incomes of smallholding farmers, through self sufficiency of virus-free potato seed multiplication by Aeroponic technique; establishment of production technology of major fodder crops in Pakistan; and Chili production and postharvest management technology development in Pakistan.

The C&MD, PARC has been involved in exploring the new avenues of cooperation with National Agricultural Research System (NARS) of friendly countries including China, Hungary, Korea and Turkey. This Division has facilitated the Ministry of National Food Security and Research, Government of Pakistan in organizing meetings of Pak-China Joint Working Group (JWG) on Agriculture, and Pak-Chinese Joint Working Group (JWG) on Socio Economic development. During these high level meetings between the Pakistani and Chinese Governments, the areas for bilateral cooperation, to uplift the agriculture sector of Pakistan have been identified, and Action Plan has been discussed. The agreed areas for cooperation include: (1) Capacity Building; (2) Germplasm Resources; (3) Agricultural Product Processing; (4) Technology Extension; (5) Fisheries; (6) Establishment of FMD Free Zones in Pakistan; and (7) Market Information and Agricultural Trade.

FINANCE DIVISION

PARC BUDGET

Highlights

The funds of the Council consist of the following as per article 18 of PARC Ordinance:

i. Grants made by the Federal government and the Provincial governments.
ii. Grants, donations, endowments, contributions, aid and assistance given by other organizations.
iii. Foreign aid and loans obtained or rose with the approval of the Federal Government.
iv. Receipts from other sources.

The annual accounts of the Council are audited by independent Chartered Accountants as well as the Auditor General of Pakistan under the PARC Ordinance 1981. Expenditures are examined and pre-audited on the basis of transparency, efficiency, effectiveness and economy.

AN OVERVIEW OF PARC'S BUDGET

(Rs. in million)

Budget Head/Funding Source	2020-21 Actual Exp	2021-22		
		Budget	Revised Budget	Actual Exp
Current Expenditure (GoP Grant)	2558.938	2976.000	2976.000	2976.000
Employee Related Benefits	1406.848	990.000	1229.450	1229.450
Total :	**3965.786**	**3966.000**	**4205.450**	**4205.450**
Development Expenditure (PSDP)	1926.763	2481.556	1409.448	1404.396
Agricultural Linkage Program (ALP)	185.214	306.400	306.400	306.400
Memorandum of Understanding (MoU's)	24.517	61.591	40.003	40.003

Current Expenditure

(Rs. in million)

Objects	2020-21 Actual Exp	2021-22		
		Budget	Revised Budget	Actual Exp
Establishment Expenses	2327.993	2650.000	2650.000	2650.000
Operational Expenses	230.945	326.000	326.000	326.000
Employee Related Benefits	1406.848	990.000	1229.450	1229.450
Total :	**3965.786**	**3966.000**	**4205.450**	**4205.450**

Development Expenditure Budget

Development Expenditure budget of Rs.2,481.556 million was allocated for the following on-going PSDP Projects for the year 2021-22 which was subsequently revised to Rs.1,409.448 million. The detail of projects is as under:

On-going Projects:

(Rs. in million)

Sl. No.	Title of the Projects	Approval Date/Forum	Total Cost	Budget 2021-22	Revised Budget 2021-22	Expenditure 2021-22
1.	Strengthening/Up-Gradation of Agriculture and Livestock Research System of (AZRI) Umerkot, Sindh	DDWP 03-05-2017	528.592	225.786	102.739	98.759
2.	Productivity Enhancement of Wheat	ECNEC 29-08-2019	5,632.774	900.000	557.572	557.556
3.	Productivity Enhancement of Rice	ECNEC 29-08-2019	3,750.660	527.421	435.481	435.301
4.	Productivity Enhancement of Sugarcane	ECNEC 29-08-2019	1,003.773	107.278	69.012	68.978
5.	Pulses Project	ECNEC 29-11-2019	1,437.358	261.843	162.342	161.840
6.	Commercialization of Potato Tissue Culture Technology in Pakistan	DDWP/17-04-05-2020	158.830	33.170	20.065	20.014
7.	Sino-Pak Agricultural Breeding Innovation Project for Rapid Yield Enhancement	DDWP/15-24-02-2020	433.936	68.890	42.712	42.466
8.	Upgradation of Agro-Ecological Zones for Pakistan through Satellite and in-situ Data Mapping	DDWP/05-24-02-2020	64.450	33.050	19.525	19.482
9.	Strengthening/Up-Gradation & Accreditation of National Lab		1554.000	324.118	-	-
	TOTAL			**2481.556**	**1409.448**	**1404.396**

Agricultural Linkage Programme (ALP) Budget 2021-22

Keeping the principal amount Rs.1300.000 million of the Endowment Fund intact, the funds generated through income from such investments are used to finance the research activities/program under ALP. The Provinces-wise allocation of projects and position of utilization of ALP funds has been tabulated hereunder:

(Rs. in million)

Sr. No.	Location	Budget 2021-22		Revised Budget 2021-22*		Actual Exp 2021-22	
		Total Number of Project Executed	Total Amount	Total Number of Project Executed	Total Amount	Total Number of Project Executed	Total Amount
1	Federal	63	80.046	63	130.566	63	130.566
2	Punjab	42	34.166	42	61.534	42	61.534
3	KPK	29	29.364	29	43.592	29	43.592
4	Sindh	07	8.076	07	8.076	07	8.076
5	Balochistan	03	0.472	03	1.135	03	1.135
7	AJK	04	2.776	04	5.303	04	5.303
6	PARC, H.Qtr.	01	48.268	01	48.268	01	48.268
8	Block Allocation	Block Allocation	101.732	-	0.086	-	0.086
9	Sponsoring of Short Term Exchange of Agri. and Scientist and Experts		0.000	-	0.000		-
10	Scientist Award		1.500	-	1.500		1.500
11	Membership Fee to Foreign Agencies		0.000	-	6.340		6.340
	Total :-	**149**	**306.400**	**149**	**306.400**	**149**	**306.400**

**As on 26-08-2022*

MOUs

A total of 14 projects at a total budget of Rs.61.519 million were approved under MoU's with different National and International organizations for the Financial year 2020-21. An overview of MoU's is as follows:

(Rs. in million)

Objects	2020-21 Actual	2021-22		
		Budget	R.B.	Actual Exp.
Budget	24.517	61.519	40.003	40.003
No. of Projects	10	14	14	14

An Overview of PARC's Budget

(Rs. in million)

Budget Head/Funding Source	Revised Budget 2021-22
Current Expenditure (GoP Grant)	4205.450
Development Expenditure (PSDP)	1404.396
Agricultural Linkage Programme (ALP)	306.400
Memorandum of Understanding (MoU's)	40.003
Total :-	**5956.249**

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