

ANNUAL REPORT

2020-2021



Pakistan Agricultural Research Council

PARC

Annual Report

2020-21



PARC

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FOREWORD FROM THE CHAIRMAN

Scientific Research and development in agricultural sector is significant determinant for hunger reduction and ensuring food security. The developed countries of the world, where most of the Research and Development work is done, put their efforts in introducing modern techniques to revolutionize the agriculture sector. In contrast to developed world, our food consumption is increasing day by day yet, our resources and food production is limited which needs proportional increase as compared to the population. The agricultural research and development on modern lines is the only solution which can lead to enhanced agricultural productivity on sustainable basis and reduce pressure on natural resources. Population explosion, rapid urbanization and climate change are leading challenges towards natural resource degradation, deforestation, low productivity, energy and water crises in agriculture.

In this backdrop Pakistan Agricultural Research Council (PARC) is entrusted with the task of identifying sustainable scientific solutions for the existing issues of agricultural section in Pakistan. It is not only working on food secure Pakistan through bringing sustainable improvement in productivity and quality of crop but also carrying out research on resource conservation technologies, genetic diversity, socio-economic and agriculture policy related aspects in agriculture sector.

Plant Science Division (PSD) of PARC is focusing on improvement in productivity and quality of crops to reduce input costs and produce high yielding, disease resistant crop varieties that increase productivity. So, our aim is to transform Pakistan from food importing to food exporting country.

Significant activities which accomplished included; high yielding Groundnut variety NARC-GN20 and Sesame high yielding variety NARC-Til recommended for cultivation in Pakistan, two disease resistant, high yielding banana varieties NIGAB-1 and NIGAB-2 approved by Sindh Seed Council for commercial cultivation, Initiated potato breeding for variety development and up-grading the infrastructure for nucleus potato tuber production upto 500,000 annually, In vitro multiplication of Lilium & ginger and produced 2500 & 500 plants respectively, Garlic variety i.e. NARC H Garlic-1 approved from Punjab and KP seed councils. Five fruit varieties of Avocado and lime i.e., NARC-Avo-H.05, NARC-Avo-H.06, NARCAvo-Fuerte, NARC-Avo-Cyclon Purple and NARC Mexican Lime have been developed and approved by the Khyber Pakhtunkhwa Seed Council in its 40th meeting held on 07-04-2021 for general cultivation in their respective ecologies. For value addition Soymilk, Multigrain Bakery Products, Banana Bread and Soybean Supplemented Bakery Products have been developed at FSRI.

PARC acquired 552 Green Super Rice advance lines from Chinese Academy of Agricultural Sciences (CAAS), China for seed multiplication, evaluation and genomic selection, participated in seed deposition ceremony at Global Seed Vault, Svalbard-Norway and deposited 310 accessions of different crops.

PARC persisted in its efforts to create a revenue stream via innovative research product marketing company, PATCO Display Centers. According to PARC performance reports PATCO- in its third phase of up scaling in PPP mode- recorded a significant boost in business growth of 463.6 million gross revenue in 2020 as compared to 95.6 million in 2019, which increased by approximately 15% from the previous year. I am pleased to say that we expect this revenue generation to be doubled in 2021.

The Natural Resources Division (NRD) has generated knowledge and developed technologies to conserve soil, water and climate. Potential utilization of available water through installation and integration of High Efficiency Irrigation Systems (HEIS) with solar technologies. PARC introduced solar desalination of brackish water for drinking and kitchen gardening which can provide clean water 18-20 liters in eight hours. Now this technology is being widely adopted in Thar. Further the analytical techniques of Geographic Information Systems (GIS) and remote sensing coupled with hydrological methods and field surveys were utilized for water resource assessment, availability and potential for storages in Himalayan and sub-Himalayan regions. Silvo-pastoral Model was developed for sustainable land use and carbon sequestration. High

yielding, disease resistant variety of wheat (AZRC Dera), Chickpea "Indus-2019" and Lentil "Lentil-2019", Termaric "Dera Haldi" and AZRC Guar were introduced while wheat candidate variety "AZRC 84" is under process for approval. Introduced Integrated Nutrient Management along with Biozote-Max and Humi-NARC which resulted in maximum wheat yield i.e., 4.9 t/ha. Biogas is produced from anaerobic digestion of biodegradable organic wastes. Established advanced Honeybee Research Lab at NARC for quality queen production. Seven new perennial grass varieties (03 Chloris gayana, 03 Lolium multiflorum, 01 Panicum maximum) from Australia and Thailand imported by private companies were tested for adaptability in Pakistan.

The Animal Science Division is involved in research coordination, monitoring and evaluation in the disciplines of animal production, animal health and aquaculture.

The National Reference Laboratory Poultry Disease is working in the field of avian disease diagnosis and research and is also designated as Regional Leading Diagnostic Laboratory (RLDL) for High Pathogenic Avian Influenza (HPA1) for SAARC countries by FAO is successfully upgraded to ISO-17025/IEC-2017 by PNAC for next three years from 2021-2023. To preserve the local breeds and make them productive in terms of milk, meat and dairy products, introduced modern technologies like, Laparoscopic Artificial Insemination techniques in small ruminants. Besides this, in aquaculture and fisheries, intensive farming of high value fish species carried out to hit the global market for fish export and established first ever Public Sector Hatchery for all Male Tilapia Seed Production.

Moreover, Agricultural Engineering Division of PARC put special focus on technological transformation of agriculture in Pakistan. Development, demonstration, provision, evaluation, and maintenance of modern and reliable machinery took place under the head of AED. In this respect farmer's trainings and demonstration were held to make them aware of new technologies and introduced them to modern machineries such as Groundnut Digger Inverter, Pak-seeder, Direct Seeded Rice Drill, Ispaghول Processing Machinery, Onion Seed Planter etc.

The Social Science Division carried out research on socio-economic and agricultural policy related aspects of Pakistan's agriculture sector. Beside this, the division also provided feed back to the Ministry of National Food Security and Research (MNFSR) on food security, impact analysis, technology adoption, trade and agricultural policy.

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, promoting 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.

COORDINATION ACTIVITIES

Germplasm Acquisition and Distribution

Following germplasm was acquired from various international sources for their evaluation and utilization in national breeding programs of various commodities:

Crop	Acquired	Distributed
Wheat	2599	2599
Rice	486	486
Maize (2020 by CIMMYT)	122	122
Sugarcane	99	40
Lentil	36	09

Meetings/ Onsite Monitoring

- i. Meetings of Variety Evaluation Committee VEC on oilseed crops held on August 18, 2020 in which potential candidate lines evaluated and those found promising [Sunflower (3 hybrids), Canola (1 hybrid), Rapeseed (1 Variety), Mustard (1 hybrid), Groundnut (1 variety), and Sesame (1 variety)] were recommended to be released for commercial cultivation.
- ii. Two meetings of VEC on Maize, Sorghum, Millet, Fodder & other cereals were conducted during 2020-21, 8th VEC meeting held on October 08, 2020 in which potential candidate hybrid/varieties evaluated and those found promising [Maize (55 hybrids), Pearl Millet (1 variety) and Sorghum Sudan Grass (8 hybrids)], while in 9th VEC meeting held on April 09, 2021 in which potential candidate hybrid/varieties evaluated and those found promising [Maize (63 hybrids), Pearl Millet (7 varieties) and Sorghum (2 varieties)] were recommended to be released for commercial cultivation.
- iii. Annual Wheat Planning meeting 2021 was organized by Wheat Coordination Plant Sciences Division (PSD) at Ayub Agricultural Research Institute (AARI), Faisalabad on 27-28 September, 2021.
- iv. Meeting of VEC on Rice held on November 24, 2020 in which six rice hybrids were recommended for commercial cultivation in Pakistan.
- v. Organized Travelling Sugarcane Seminar 2021 that covered potential sugarcane growing areas, sugar mills and Research Institutes of Punjab, Sindh and Kyber Pakhtunkhwa.
- vi. Organized Travelling Wheat Seminar (TWS) 2021. First part was commenced on March 10, 2021 from D.I khan. Travelled through Pulses, Cotton, Sugarcane and Rice Zones. It was concluded in NARC Islamabad on 19th March 2021. Second part was started on 4th April, 2021 and covered Potohar, and KP Districts of Wheat areas and ended on 8th April, 2021 at CCRI Pirsabak Peshawar.
- vii. Travelling Seminars for Kharif (31st August, 2020 – 7th September, 2020) and Rabi (15th March, 2021 – 31st March, 2021) Pulses 2020-21 (chickpea and lentil) were conducted involving pulses scientists from all over the country. During Kharif, only Punjab and Khyber Pakhtunkhwa provinces were visited, while during Rabi, the research and extension departments working under the project in all the four provinces were visited.
- viii. Visited National Uniform Yield Trials for onsite-monitoring and data recording of wheat, rice, sugarcane, pulses, maize, oilseeds and potato.

National Uniform Yield Trials (NUYT)

NUYT of following crops were conducted to find out the suitable entries and to move forward with their commercialization:

Crops	Entries	Locations
Wheat	70	48
Rice (Hybrids / Coarse / Fine)	104/19/26	12/14/15
Maize	390	33
Sorghum	16	9
Sorghum (Fodder)	9	14
Millet	31	10
Millet (Fodder)	10	14
Sugarcane	23	7
Lentil	16	16
Chickpea (Desi)	17	18
Chickpea (Kabuli)	15	16
Mung	23	15
Mash	09	12
Rapeseed & Canola/Mustard	32/60	16
Sunflower	26	14
Soybean	13	16
Sesame	16	10
Groundnut	11	09
Taramira	03	16

CROPSCIENCES INSTITUTE

i. Crop Sciences Institute developed and contributed a total of 45 advance lines / hybrids for national testing that included Bread Wheat (06) and Durum Wheat (03), Mung bean (02), Mash bean (05), Chickpea (02), Lentil (04), Sunflower hybrids (02), Soybean (02), Groundnut (05), Oat (04), Vetch (05) and Millet (05).

ii. Under the PSDP- Productivity Enhancement of Wheat Project, Speed Breeding Facility (Greenhouse) has been constructed at NARC which will be helpful in the rapid development of wheat varieties.



Speed Breeding Facility

iii. 392 tons of quality seed of various crops that includes 148 ton of wheat, 18 ton of pulses, 132 ton of Oilseeds, 90 ton of Fodder and 4 ton of maize to seed companies and farmers. In addition, 0.3 million cuttings of Mott grass were also supplied to farmers in Balochistan to enhance fodder production in the province.

iv. Variety Evaluation Committee (VEC) in 2020 recommended Groundnut variety NARC-GN20 (high yielding, bold seeded) and Sesame high yielding variety NARC - Til for cultivation in Pakistan.

v. During 2020-21, 19 field days / training were conducted for 1800 farmer / agriculture staff to disseminate improved crop production techniques. High yielding wheat and pulses varieties and improved production techniques were also demonstrated on more than 215 farmer fields.



Farmers' Field Day



Wheat Research Field Area

BIO-RESOURCE CONSERVATION INSTITUTE

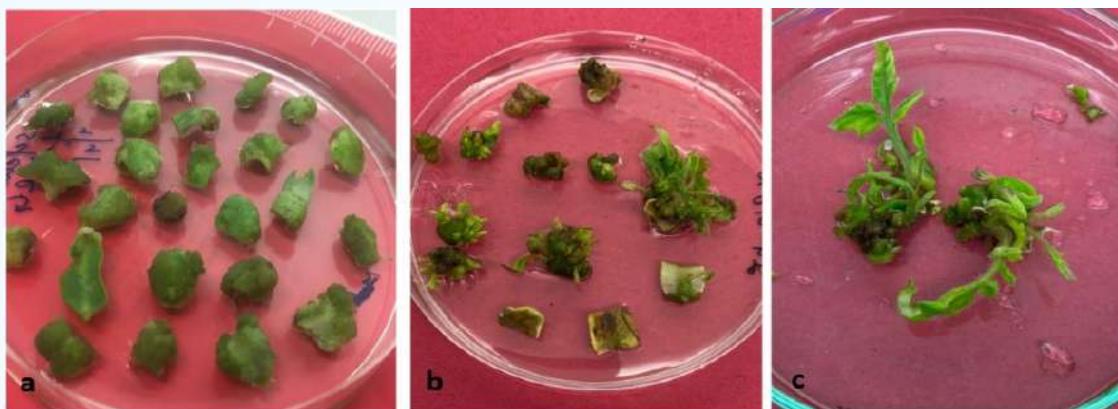
- i. Genebank acquired 261 entries including fruits & vegetables, MAPS, CWRs and cereals and banked 454 accessions after allotting accession numbers and now final germplasm inventory in the genebank reached to 41000 accessions.
- ii. Received 158 seed requests from different institutions and provided 5442 accession's samples of diverse crops. The major crop groups requested were cereals (37.8%) followed by oilseeds (21.6%), legumes (19.3%) & vegetables (15.4%).
- iii. 448 accessions were tested for viability, including the 49 samples tested for PATCO.
- iv. Participated in seed deposition ceremony at Global Seed Vault in Svalbard-Norway and deposited 310 accessions of different crops.
- v. Collected Crop Wild Relatives (CWRs) 203 accessions representing 30 species from different parts of the country.
- vi. Genetic diversity assessment and discrimination of carrot, radish, rice, wheat, maize, barely, lentils, and mungbean germplasm was carried out.
- vii. Local and exotic plants that are being maintained in the home pharmacy area at NARC such as *Thymus vulgaris*, *Apium graveolus*, *Plectranthus* sp., *Aloe vera*, *Stevia* sp., *Coriandrum* sp., *Origanum vulgare*, *Artemisia annua*, *A. absinthium*, *Mentha arvensis* (China), Cool mint, *Mentha piperata* (Japan), Lavender (Syria) and *Ammaranthus* sp were multiplied and distributed to various stakeholders.
- viii. Different combinations of herbs were evaluated and handed over to Institute of Agricultural Engineering (AEI), NARC for herbal tea processing.
- ix. 233 strains were collected and isolated from different ecological zones of the country and preserved in National Microbial Culture Collection of Pakistan (NCCP), NARC.
- x. 155 halotolerant strains were isolated from marine and mangroves forest soil and screened for NaCl tolerance for plant growth promoting activities.
- xi. 52 multi-drug resistant bacteria isolated and identified from fecal ecology of neonatal calf diarrhea (NCD) animal having potential risk for zoonotic diseases.
- xii. 26 pure bacterial strains were isolated and identified from yogurt and pickle samples for Probiotics traits evaluation.
- xiii. 16 strains were distributed to Scientific Community for R&D through SMTA.
- xiv. More than 600 specimens of medicinal/aromatic, wild edible and wild ornamental plants were collected from different areas of Pakistan, were accessioned.
- xv. About 250 native plant species are being maintained in Botanical Conservatory at NARC.
- xvi. Provided plant identification services to visitors, scientists, MS and PhD students.

NATIONAL INSTITUTE FOR GENOMICS & ADVANCED BIOTECHNOLOGY

- i. *Genetic transformation in chickpea for herbicide resistance:* Optimized all tissue culture protocols for regeneration and transformation of chickpea. Establishment of genetic transformation system using GUS/GFP gene was completed. Developed two events against herbicide resistant gene in chickpea Molecular confirmation of transgenic chickpea events.
- ii. Developed transgenic cold tolerant tomato and patent filed (Application #: IPO-68/2021).

Biofortified tomato with precursor of Vitamin A is also in final stage of development. Also Isolated Lycopene β cyclase(β -Lcy) gene from Tomato.

iii. Screened drought tolerant maize cultivar based on morpho-physiological data. Finding of glutamine synthetase gene in maize and their expression analysis under drought stress condition.



Regeneration and shoot induction from transformed cotyledonary leaves a: Transformed cotyledonary leaves; b: Shoot induction from transformed cotyledonary leaves on selection media; c: shoot elongation on selection media.

iv. *Double haploid system in wheat:* Six wheat varieties (Borloug-16, Pakistan-13 and Markaz-19, Zincol-2016, Akbar-19 and Anaj-17), six maize genotypes (Haq Nawaz Gold, CZP-132011, OPV-2, OPV-3, NARC Pops and Sargoda-2002) and one maize hybrid (QPM-200) were sown with different time intervals in order to synchronize with maize tasseling. Wheat spikes 500+ emasculated and crossed with maize fresh pollens to produce haploid embryos. After 48 hours to pollinate, hormone treatment (100 ppm 2-4, D) applied. 400+ spikes were sterilized, rescued and cultured in test tubes and petri dishes in MS, B5 media containing 2,4-D hormone after 14 days of emasculation. Post culture techniques (dark and cold treatment) were also practiced to germinate the haploid embryos. Embryos were regenerated in MS and B5 media to produce haploid plant.

v. *Genetic Transformation of potato with lectin gene:* Potato variety (Kuroda) was multiplied on MS media for explant source. Internodal parts of Potato ((Kuroda variety) used as explant and 400+ explants infected and used for genetic transformation. 30+ plants were obtained after selection pressure and the transgenic plants confirmation is in process.

vi. Seed samples from various sectors have been successfully tested for GM testing through ELISA and PCR.

vii. *Green Super Rice (GSR) in Pakistan:* Phenotypic evaluation of 552 Green Super Rice and selected 14 elite GSR lines out of 552 based on early maturity, grain yield, seed length under drought, salt, cold and heat conditions. Physical, Milling, Chemical & Cooking Quality Tests of selected 14 GSR lines. SSR marker genotyping of 14 elite GSR lines for grain quality traits. Submission of 5 elite GSR lines to National uniform yield trial (NYUT) and Distinctness, Uniformity and Stability (DUS) trial.



Double haploid system in wheat

viii. *Translational genomics and genome editing approaches to enhance wheat yield:* Protocol was optimized for generation of CRISPR-cas9 constructs in monocot by Gibson assembly. CRISPR-Cas9 expression constructs were generated for targeting FT and Ppd1 genes in wheat to improve the yield. Successfully transferred the constructs in *Agrobacterium tumefaciens*. *Agrobacterium* mediated transformation of wheat to knock-out the FT and Ppd1 genes is in progress.

ix. *NGS-based identification of sugarcane varieties and hybrids:* Identified the candidate genes (Invertase, Pyrophosphate Phosphotransferase) involved in sucrose metabolism for CRISPR/Cas9-based genome editing experiment. Expression pattern of Sugarcane *Sucrose synthase* gene family of CPF251 and CPF252 cultivars.

x. *Sino-Pak Productivity enhancement of Wheat:* Multiple wheat trials including Historical germplasm (327lines), Diverse association panel (470lines/ cultivars), Pakistan's wheat association panel (250 cultivars), Mapping population F₇ (620lines), CIMMYT-ICARDA (48 lines), Advanced lines BZU (16) and root experiment of 40 lines. Conduct root phenomic experiment under control, drought, salt and phosphorus efficient of forty lines in PVC pipes. DNA sampling from wheat field experiment including Historical germplasm (327lines), Diverse association panel (470lines/ cultivars), Pakistan's wheat association panel (250 cultivars), Mapping population F₇ (620lines), CIMMYT-ICARDA (48 lines), Advanced lines BZU (16) and root experiment of 40 lines. Expression analysis of selected short, long and dense rooting varieties under normal and drought condition.

xi. *Plant Tissue Culture Program:* Two banana varieties NIGAB-1 and NIGAB-2 approved by Sindh Seed Council for commercial cultivation. In vitro multiplication of high yielding banana varieties and produced 5000 virus free banana plants. Initiated potato breeding for variety development and up-gradating the infrastructure for nucleus potato tuber production upto 500,000 annually.

xii. In vitro multiplication of Lilium & ginger and produced 2500 & 500 plants respectively.



Inauguration of potato tissue culture lab at Chillas GB

HORTICULTURE RESEARCH INSTITUTE

i. Five fruit varieties (four Avocado and one Mexican Lime) i.e. NARC-Avo-H.05, NARC-Avo-H.06, NARC-Avo-Fuerte, NARC-Avo-Cyclon Purple and NARC Mexican Lime have been developed and approved by the Khyber Pakhtunkhwa Seed Council in its 40th meeting held on 07-4-2021 for general cultivation in their respective ecologies.

ii. Evaluated 11 open pollinated varieties of local winter flowers annuals for seeds production.

iii. Developed production technology for selected cutflowers eg: Stock, Anthirrinum, China Aster, Campanula, Lisianthus, Limonium & Sunflower.

iv. Morphological Characterization of three cultivars of Dutch Iris Wedgewood (white), Pride of Holland (yellow) and Prof. Blaauw (blue) for two years.

v. Developed two potato clones, the seed of these clones have been increased for further evaluation in NUYT and other experiments i.e. NARC Potato IV (280 kg seed produced) and NARC Potato III (210 kg seed produced). Three sweet potato clones i.e. Exotic Sweet Potato-1, Exotic Sweet Potato-2

*New varieties of fruits*

(Handorus) and Exotic Sweet Potato-3 (Portugal) planted on farmer field for evaluation and multiplication

vi. Garlic variety i.e. NARCH Garlic-1 approved from Punjab and KP seed councils. DUS for NARC Onion-05 by FSC&RD completed. Submitted four advance lines of chillies viz; NARC-14/9, NARC-15/5, NARC-16/4 & NARC-16/5 for registration with FSC&RD.

vii. Provided 2000 Seed kits & 500,000 seedlings of summer and winter vegetables to Kitchen Gardeners.

*Seed sowing of winter vegetables**Germination stage of winter vegetables*

FOOD SCIENCE RESEARCH INSTITUTE

i. Protocol for determination of Folic acid in wheat samples standardized. Physical quality analysis methodologies (Test weight, Thousand Kernel weight etc) are also standardized.

ii. More than 200 wheat samples for 558 tests evaluated for proximate profile (Ash, moisture and protein determination), minerals determination (Zn, Fe, Cu, Mn), gluten content and Falling number.

iii. 382 rice samples received from different institutions of Pakistan and analyzed for their physical, cooking and chemical properties.

iv. 264 bacterial species were phenotypically characterized based on color, elevation, margin, light transmission, texture, and colony shape. 136 bacterial strains were tested for presence/ absence of catalase enzyme. 136 strains were tested to get their optimum NaCl growth range and their upper tolerance limit. 128 pure isolates were tested using gram staining. Out of 128 isolates, 65 were found gram positive. Antimicrobial activities of 128 purely isolated strains were tested against *E. coli*, *Bacillus cereus*, *Staphylococcus aureus*, and *Staphylococcus pyogenes* by well diffusion method. Out of 128 total isolates, 90 isolates showed antimicrobial properties against any food pathogen.

v. For value addition Soymilk, Multigrain Bakery Products, Banana Bread and Soybean Supplemented Bakery Products have been developed at FSRI.

INSTITUTE OF PLANT AND ENVIRONMENTAL PROTECTION

i. The climatic and storage condition of Pakistan favors pest infestation that causes about 30% losses in agriculture sector. The overall objective of Institute is to protect the agriculture produce keeping in view sanctity of the environment and obligations of international trade.

- ii. The Insect Pest Management Program has been devising environment friendly alternative pest control measures in wheat, rice, sugarcane and horticulture crops under PSDP Productivity Enhancement Program and Area Wide Integrated Pest Management (AW-IPM) of fruit flies under ALP. Laboratory facilities have been established for assessment of host plant resistance by inducing artificial infestation of insect pests, bioassays, development of biological control agents and biopesticides (botanicals and microbial).
- iii. The genetic sexing strain of fruit fly *Bactrocera dorsalis* (Diptera: Tephritidae) for Sterile Insect Technique (SIT) application in field has been evaluated. The sterile males of GSS only can be released for the effective control of fruit flies in the field.
- iv. The control of sugarcane pests has successfully been demonstrated at farmer's fields (08 locations) by incorporating the bio-control agents *Trichogramma* with granular insecticides. The efficacy of botanical insecticide developed in this lab is at par of the contemporary synthetic ones.
- v. Ecotoxicology Research Program established National Pesticide Residues Monitoring System in Pakistan. Two federal and four provincial labs in agricultural research institutes have been established/strengthened in terms of buildings renovation, trained human resource and state of the art analytical instruments. NARC lab also got ISO-17025 accreditation from PNAC. These Labs are ready to cater the country need in the field of pesticide residues analysis in food, feed and environmental samples.
- vi. The National Insect Museum Program has established Molecular Lab for the DNA based identification and characterization of insect fauna.
- vii. The Vertebrate Pest Management Program has developed a new zinc phosphide bait from broken rice, millet and maize in combination with peanut butter to mask the peculiar phosphine smell for the control of field rats. Similarly for wild boar control Racumin (slow poison) has been formulated with improved bait palatability by incorporating shakkar and cooking oil in broken maize.



Pesticide Residues monitoring activity



Screening of wheat entries against aphid by artificial infestation

CROP DISEASES RESEARCH INSTITUTE

- i. CDRI coordinated in release of five (05) wheat varieties i.e. MH-20, Dilkash-20, Subhani-20, MA-20, Bhakkar-20 in the National Agricultural Research System (NARS) of Pakistan.
- ii. 750 advance lines of National Wheat Disease Screening Nurseries (NWDSN), 70 lines of NUYT were evaluated against rusts of wheat (295 lines resistant to leaf and yellow rusts, 155 resistant to leaf rust and 111 resistant to yellow rust). 70 lines of NUWYT also screened for karnal bunt (47 lines found positive for karnal bunt by visual test and 56 positive for karnal bunt by filter wash test).
- iii. Karnal bunt surveillance made at 47 locations of Pakistan. Collected 703 samples and its prevalence was calculated as 34.51%, incidence 0.2% and severity: 0-4, while total 47 isolates on wheat agar and 20 isolates on PDA were purified.
- iv. 180 commercial wheat varieties were included in NDWSN 2020-21. Dominant wheat varieties Galaxy-13, Faisalabad-08, TD-1, TJ-83 and Seher-06 were found totally ineffective for stripe rust. Wheat varieties Shahkar-13, Pirsaq-13, Pakistan-13, NIA-Sarang, Zincol, Boroloug-16, Fatehjang-16, Wardan-17, Pasina-17, Khaista-17, Anaj-17, Akbar-2019, Bhakkar Star, Fakhr-e-Bhakkar

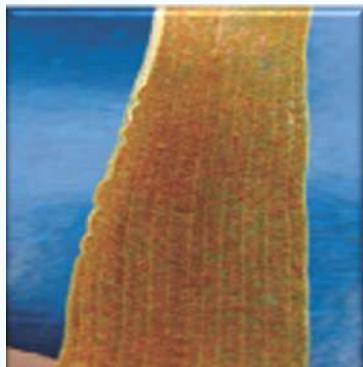
Gulzar-19, Pirsbaq-19 found resistant against rusts.

v. Trap nurseries: No stem rust was observed in the trap nurseries. Yellow rust resistant gene *Yr5*, *Yr10*, *Yr15* and *YrSp* found effective in Pakistan. No virulence was observed on leaf rust resistant gene *Lr 3Ka*, *Lr19*, *Lr10,27+31* and *Lr28*.

vi. 180 entries screened for spot blotch of wheat, out of which 10 entries found highly resistant and 71 entries highly susceptible. 70 NUWYT and 750 NWDSN entries screened for Powdery mildew of wheat. Total 31 entries found highly resistant and 105 entries highly susceptible.



Yellow rust



Leaf rust



Stem rust

vii. Upgraded and renovated CDRI labs & greenhouse at NARC, Murree and SARC Karachi.

viii. Screened rice germplasm (149 entries) against Bacterial Blight and Brown Leaf spots of Rice. Out of 26 OP lines, 11 were found resistant while among 19 coarse lines, 15 were found resistant. Among 104 hybrids 85 were observed resistant. For Brown Leaf Spot 04 fine lines were found resistant, while 17 coarse lines and 85 hybrids were found resistant.

ix. Screened Mung and Mash against *Cercospora* leaf spot, Chickpea against *Ascochyta* blight, Lentil against Stem rot. Five (05) Mungbean, 03 Mashbean, 14 Chickpea and 06 Lentil lines were found resistant.

x. Identified mycoviruses and atoxigenic strains from *Aspergillus flavus* results indicated that 101 colonies were atoxigenic as compared to 142 toxigenic.

xi. Survey for prevalence and incidence of different sugarcane diseases: 560 Sugarcane leaf samples were collected, 100 % prevalence of SCMV with 20-70% incidence confirmed. Prevalence of SCWLD (32.56 %), Leaf Scald (14.28 %), SCYLV (3.57 %), Red Stripe (5.35 %), Red Rot (62.5 %), Wilt (12.5 %) and Rust (5.35 %) was recorded.

xii. Screened elite sugarcane germplasm (NUYT Entries) for resistance against major diseases of sugarcane (mosaic, red rot, smut, Fusarium): Eleven (11) isolates of *Fusarium* sp. and 37 isolates of *Colletotrichum* sp. from stem and leaves were obtained. Three (03) isolates of *Ustilago scitaminae* and 04 isolates of *Bipolaris* sp. were also isolated from different locations of Pakistan.



In-Vivo Cultures of Sugarcane Mosaic Complex Collected from Sindh and Punjab Provinces



In-Vivo Cultures of Sugarcane white Leaf Phyto Plasma Collected from Sindh and Punjab Provinces



Sugarcane Rust samples collected from Sindh provinces and preserved for further studies

xiii. Designed & fabricated Hot Water Treatment Machine for disease free sugarcane seeds. Six experiments on use of hot water and/or fungicide seed treatment for managing SMC /Fungal diseases conducted at farmers' fields in Faisalabad, Lodhran, Rahimyar Khan, Nawab Shah and Harnai districts of Punjab, Sindh and Baluchistan.



Hot Water Treatment Plant Fabricated under PSDP PESC at Gourmet Sugar Mills Farm



Raising Hot Water Treated sugarcane chip Buds for Growing Disease Free sugarcane nurseries



sugarcane Hot Water Treatment trials at CDRI Screen House

xiv. Diagnostic services provided to Public and Private Sectors including Deptt. of Plant Protection, MNFS&R, Pepsi Cola, Fauji Freez & Fresh, etc. and total 15800 samples of Potato Citrus Chilli Sugarcane were analysed.

PARC-Southern-Zone Agricultural Research Center (SARC), Karachi

- i. CDRI Karachi managed trials of National Wheat Diseases Screening Nursery at four locations i.e. SARC Karachi, NIA Tandojam, WRI Sakrand and Farmer Fields at Kunri and Thatta, where 750 lines were evaluated. Wheat rusts surveillance activities were also carried out in 95 locations of 23 districts of Sindh.
- ii. IPI Karachi maintained existing germplasm of Coconut, Tamarind, Ber, Sapodilla (Chiku), jojoba and Moringa. Ground layering of 50 Sapodilla (chiku) plants has been prepared and shifted to main field. Selected (healthy matured coconut) nuts (Srilankan green tall variety) for germination and further propagation. Curry Patta (*Murraya koenigii*) has been planted on half acre using saline ground water at IPI (10x15feet) under furrow irrigation mode. Water application efficiency of *Murraya koenigii* was found 68% under furrow irrigation with 5 % mortality. Introduced new plants including Grapes, Fig (Black Sawari), lemon, (Red Beauty), grape fruit, Pepino (*Solanum muricatum*), Avocado (*Persia americana*), Custard apple (*Annona reticulata*), Litchi and thirteen varieties of dragon fruit have been shifted in field for evaluation and introduction in the area.
- iii. PMRI Karachi rearing *Acerophagus papayae* an effective parasitoid of papaya mealy bug (PMB) and has potential to produce as many as 100,000 to 250,000 per month. Due to continuous release of this parasitoid over the last few years the problem of papaya mealy bug has considerably resolved and hardly any spray is carried out for control of this pest in district Malir Karachi. The monitoring of fruit flies using methyl eugenol is also a regular activity. Four fruit fly species viz, *Bactrocera zonata*, *Bactrocera cucurbitae*, *Bactrocera correcta* and *Bactrocera dorsalis* trapped throughout the year.
- iv. VPCI evaluated different poisonous baits against *Rattus rattus*. 1% dose of Vecar powder caused 20% mortality after 3 days; 2% dose caused 60% mortality in 2 days and 3% dose triggered 100% mortality after 1 day. Temik on fresh apple also proved very successful against *Rattus rattus* by showing 100% mortality after 24 hours. 5% dose of Recumin powder against *Rattusnorvegicus* caused 100% mortality within 2 days.
- v. FQSRI conducted antimicrobial activity of medicinal plants against food borne microbes i.e. *E. coli*, *S. aureus*, *B. subtilis*, *V. parahaemolyticus*&*V. cholera* by using different solvent extraction. *Ocimum basilicum*, *M. koenigii* and *Saracaasoca* plants have an excellent anti-bacterial activity by means of well diffusion method. Methanol showed maximum inhibition zones against food borne microbe. Food products including dehydrated ginger, garlic, jujube, powder of banana, onion, ginger and garlic, jam of jujube, moringa seed powder, date syrup etc. have been formulated and optimized. A protocol for multiplication and rooting of orchids was developed by using nutrient media contained MS (Murashige&Skoog) with different concentrations (0, 0.5, 1.0, 2.0, 3.0 and 4.0 mg L⁻¹) of BAP and IAA.

PARC-NATIONAL SUGAR & TROPICAL HORTICULTURE RESEARCH INSTITUTE (NSTHRI), THATTA

- i. The promising line YTTh-1705 on account of its better performance in terms of cane yield, sugar recovery and other characters of commercial worth was selected for further study in NUYT (2021-)



Sugarcane Fuzz Collection activities at Thatta

2023). The seed of YTTh-1705 sent to six different sugarcane institutes for further multiplication and evaluation.

ii. Local fuzz weighing 9.5 kg collected from coastal areas of Thatta and Badin and dried and distributed to different sugarcane research institutes of Pakistan.

iii. 13 crosses of matching flowering behaving sugarcane lines near Keti Bander for the purpose of quality fuzz production under field conditions. The varieties are in good growth condition with mean cane height of 180.44-210.50 cm and 8-10 internodes per plant.

iv. 71705 healthy and disease free seedlings of six commercial varieties developed.

v. 12 promising sugarcane genotypes namely Th-1412, Th-1504, Th-1629, Th-1631, Th-1643, SLTh-1510, YTTh-7101, YTTh-1705, YTTh-1707, YTTh-1710, YTTh-1730 and Thatta-10 were screened against different diseases and insect pests i.e. whip smut, borers and whitefly.

vi. Developed 5887 tissue culture banana shoots and 2933 rooted plants. Total 10045 tissue culture plants shifted on hardening, out of which 7633 plants survived.



Banana Tissue Culture activities at NSTRU-PARC, Thatta

PARC-NATIONAL TEA AND HIGH VALUE CROPS RESEARCH INSTITUTE (NTHRI), SHINKIARI

i. FSC&RD certified fruit plant nursery disbursement healthy and disease free plants to farmers.



Tea Garden at Shinkiari

ii. Processed and produced more than four tons green tea and two tons black tea.

iii. Produced budded/grafted 42000 plants of various fruits species i.e. apricot (5000 plants), peach



Plum (Cv. Red beaute)



Plum (Cv. Wixon)



Kiwifruit

(24000plants), plum (6000 plants), almond (5000 plants), cherry (500 plants), pear (1000) apple (500 plants) for disbursement among the farming communities.

iv. Maintained Mother Fruit Orchard comprising of 14 different fruits species for further evaluation and screening of fruits cultivars and to get the bud/graft wood.



Value added products of NTHRI (Food Processing Jam & Squashes)

v. Produced more than 1100 true-to-type kiwi plants of 8 cultivars and 3000 kiwi seedling root stock from kiwifruit seeds. Further planted 6000 kiwifruit shoot cuttings for the production of true to type plants. Managed the kiwifruit orchard in the main Mother block comprising 51 kiwi plants (6 years old) of *Hayward* variety. 2 kg kiwi seed produced.

vi. Planted olive on 160 acres area in Hazara Division. Registered more than 500 olive growers throughout Hazara Division. Established Olive Nursery for the production of more than 0.08 million plants. 422 liters of Extra Virgin Olive oil was extracted in the season from 2.3 tons of olive fruit.

vii. Processed pulp of Peach (220 kg), Plum (300 kg) and Apricot (70 kg) and other neglected fruits like persimmon. Produced jam of different fruits i.e Peach (300 bottles), Plum (300 bottles) & Apricot (50 bottles). Produced squashes of Peach (200 bottles) & Plum (100 bottles).



Tea leaves Plucking to Processing

PARC RESEARCH & TRAINING STATION (PRTS), MULTAN

i. *Trichogramma* eggs cards (13341 in number) were prepared and 9805 cards were distributed to the farmers of local area and the students of agriculture B.Z. University, Multan. Regarding the rearing of *Chrysoperla carnea*, 2640 no. of egg sheet cards were produced and 1722 number of eggs sheet cards was disseminated to farmers of local area and the students of agriculture B.Z. University, Multan.

ii. Conducted NUYTs of Mustard, Rapeseed,



Natural enemies' augmentation Lab PRTS Multan

Taramira and Sesame and other trials on Mungbean, cluster bean and sunflower at PRTS Multan where BZU students and faculty frequently visited the trials for their learning.



National Uniform Yield trials at Field

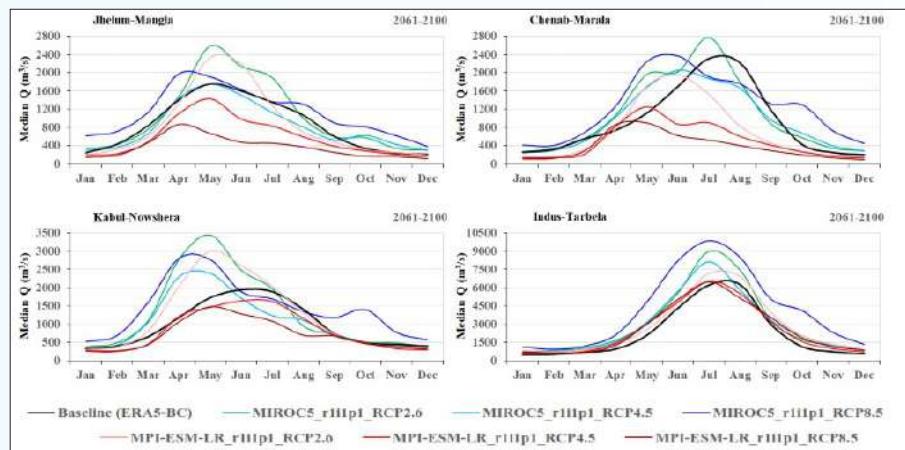
NATURAL RESOURCES DIVISION

The Natural Resources Division (NRD) of PARC has been focusing on enhancement of agricultural productivity through best management of land, water, rangelands, forests and honeybees. The NRD addressed the issues related to agriculture in the arid and mountain environments. The knowledge and innovative technologies generated as a result of research endeavors made towards increasing the land fertility with balanced application of fertilizers, use of bio-fertilizer, management and utilization of scarce water resources and improving the productivity of salt affected and waterlogged areas will substantively enhance agricultural production and productivity in various ecologies. The development and dissemination of honeybee management technologies have turned Pakistan into a honey exporting country. The high yielding, disease resistant and drought-tolerant crop varieties have been selected for arid and cold environments of Balochistan and Northern Areas. Promising forage species have been identified for different agro-ecological zones and agro-forestry models have been developed for rehabilitation of degraded mountain areas. Dissemination of technology packages for trout farming and medicinal plants and distribution of improved horticultural varieties developed for upland areas will provide additional income generating opportunities for the poor farmers of the mountainous region.

CLIMATE ENERGY AND WATER RESEARCH INSTITUTE, NARC

Hydrological Implications of Climate Change in the Upper Indus Basin

Hydrological modeling study conducted by PARC shows unprecedented and contrasting signals of climate change impacts across high-altitude upper Indus basin. Karakoram, Northwest Himalayan and Northern Hindukush (Indus River upstream of Tarbela Dam and Chitral River) regions are projected to experience slight gains in river flows while western Himalayan basins (Jhelum and Chenab rivers) may experience considerably reduced river inflows during the 2nd half of 21st century. Three to four weeks earlier onset of peak flows is anticipated for all river gauging stations. Frequency, intensity and duration of floods and droughts are also projected to increase in future.

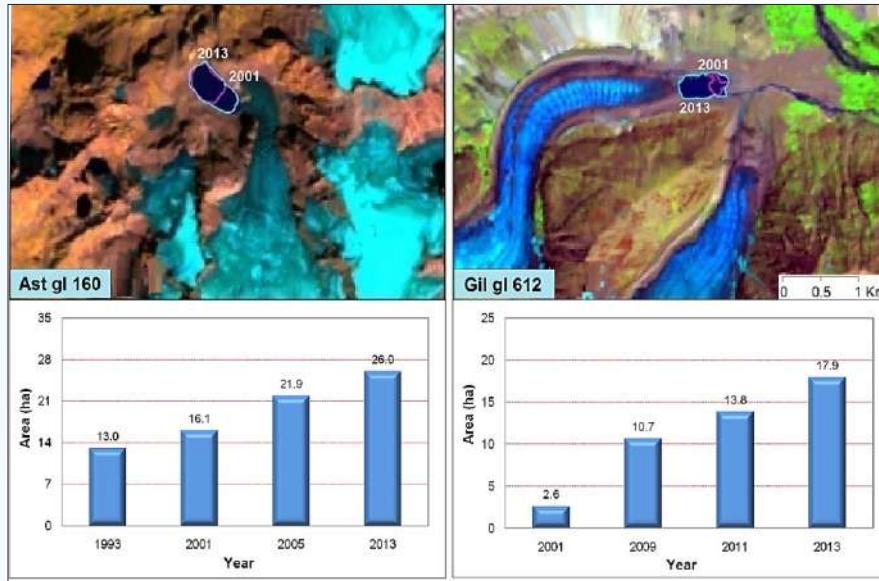


Shifts in seasonality and annual cycle of hydrological peaks in main rivers

Risk Assessment of Glacial Lake Outburst Floods (GLOFs)

The overarching effect of increased warming in HKH region relates to increase in glacial melting and subsequent expansion of glacial lakes. The indigenous kuhl irrigation system serving as lifeline for mountain agriculture in Pakistan is highly vulnerable to climate change impacts like glacier retreat, glacial lake outburst floods, snow avalanches and landslides. In this study, the risks of glacier depletion, glacial lake outburst floods, snow avalanches and landslides in the 10 river basins of the UIB are analyzed using multi-hazard indexing approach. High risk of glacier depletion was observed in the Astore and Swat river basins probably due to combined effects of reduced snowfall and rising temperatures. The risk of expansion in aggregate lake area was high in the Indus sub-basin, moderate

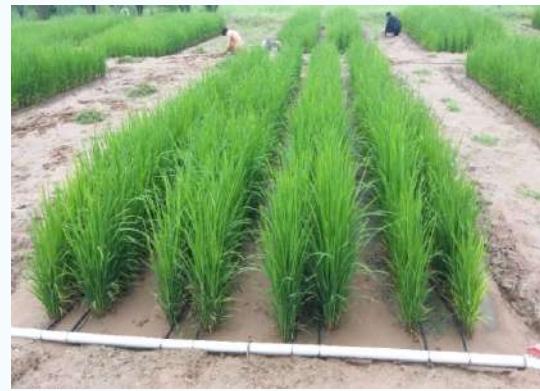
in Hunza, Shigar, Shyok, Shingo and Astore basin, and low in Swat, Chitral, Gilgit and Jhelum basin. More than 2% areas of Hunza and Shigar basins in the Karakoram range exhibited high risk of snow avalanche and landslide (SAL) hazard, while moderate SAL hazard was found in >40% areas of Chitral, Gilgit, Hunza and Shigar river basins. An effective early warning mechanism and provision of adequate resources for preparedness are essential to withstand the negative impacts of climate change on water and agriculture in this region.



Temporal variations in lake area in Astore (Left) and in Gilgit river basin (Right)

Water Management Technologies for Improving Water Productivity of Rice Crop

Declining freshwater availability along with low water productivity are threatening to sustainable rice production in Pakistan. Therefore, development of alternative solutions to improve water productivity of rice crop is essential. This study assessed the water saving and productivity benefits of direct seeded rice on raised bed compared to transplanted rice on flat. The two treatments for transplanted rice were Conventional Flooding (CF) and Alternate Wetting and Drying (AWD) and for direct seeded rice were furrow irrigated Wide Bed (WB: 130cm, 5 rows) and drip irrigated Narrow Bed (NB: 65cm, 2 rows). The interim results for the 1st season indicate significant savings in irrigation water and yield increases for drip irrigated narrow bed and alternate wetting and drying irrigation methods respectively.

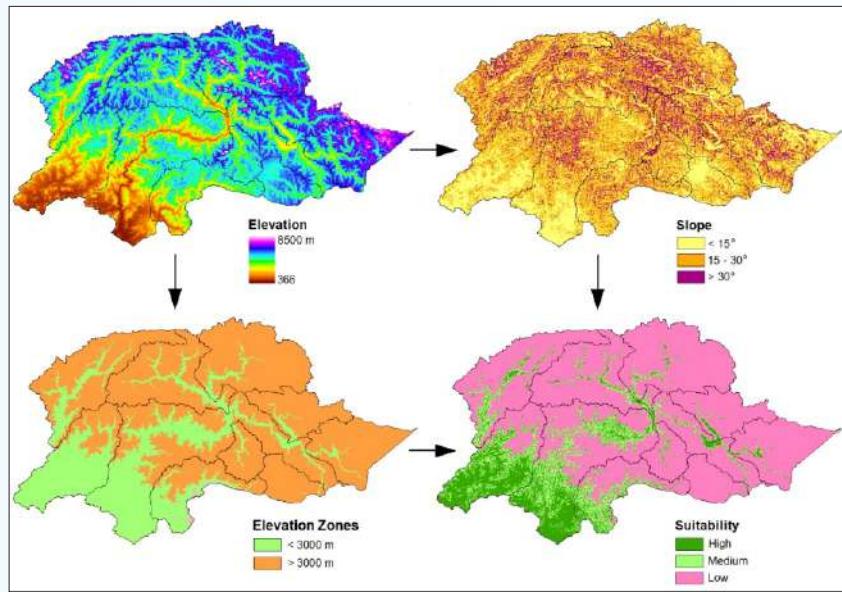


Research on water management technologies for rice at CEWRI Field Station at NARC Islamabad

Prospects of Kuhl Irrigation System in Pakistan

Changing cryosphere and growing population have raised the importance of extending agriculture and improving the livelihoods of local communities in the Upper Indus Basin (UIB). This study investigated the prospects of cryosphere-fed irrigation through adopting topographic suitability and water availability indexing approach to broaden the base of agriculture and socio-economic activities

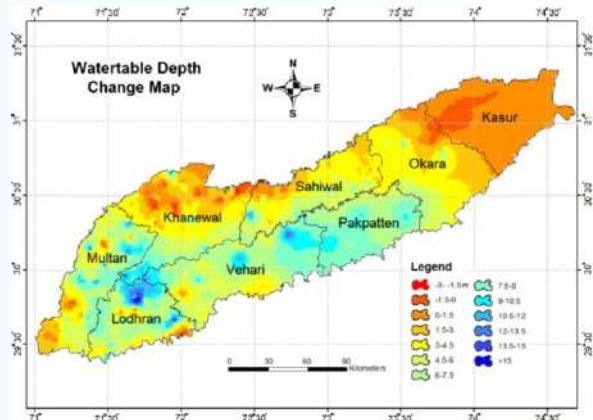
in the area. Topographic suitability for crop cultivation was found high (<15° slope below 3000 m) over 47.8% area of the Swat, 23.6% of the Indus, 16.6% of the Jhelum basin and 14.6% of the combined UIB. This land can be developed through indigenous kuhl irrigation systems subject to availability of sufficient water resources. The glacier-melt was found >8.0 lps/ha in the Karakoram region (Hunza, Shigar and Shyok river basins) and within 4.0 – 8.0 lps/ha in the Chitral and Astore river basins. The scarcity of land and water was found (one at a time or both at once) at certain locations which may affect agricultural production in the region. In places with limited land for farming opportunities, the basis of livelihoods can be broadened through diversifying income sources.



Topographic suitability for crop farming in the UIB

Impact of Floods on Water table in Bari Doab

Groundwater resources of the Indus basin are seriously stressed by its over-exploitation and Bari doab is not an exception. Direct precipitation, floods and irrigation losses are the primary sources of groundwater recharge. Water table fluctuations in response to 2010 and 2014 floods in Bari Doab were studied in using geospatial techniques. Rise in watertable due to flood condition was evident from the increase in coverage of <1.5 m water table depth from 169.5 km² in 2005-2010 to 215.5 km² in 2010-2015. Similarly, the coverage of 1.5-3.0 m was increased from 264.1 km² to 4126.2 km² for the same periods owing to the flooding effect. The effect of 2014 flood was evident from the rising behavior of watertable in Multan, Khanewal and Lodhran districts during post-flood period condition of 2015.



Spatial distribution of change in watertable depth between 2005-2010 and 2010-2015 in Bari Doab

Precision Laser Land Levelling (PLL) and grading as a Climate-Smart Agricultural (CSA) tool and its impacts on irrigation water saving at basin scale

Flood irrigation generally results in poor irrigation efficiencies and low water productivity. Higher irrigation efficiencies and better crop yields can be obtained by precise levelling of crop fields. A field experiment comparing precision laser land levelling and conventional levelling showed improvement in application efficiency (Ae) by 17 %, distribution uniformity (Du) by 32 %, water

productivity in farm context (W_{pf}) by 18 %, water productivity in basin context (W_{pb}) by 11% and adequacy (Ad) of irrigation by 27 % of laser levelled field compared to conventionally fields. The efficacy of precisely levelled sloping plots is further investigated to determine ultimate savings in applied irrigation water. The winSRFR, a surface irrigation evaluation model, is used for evaluation and validation of flood irrigation events. The simulation results showed improvements in all indicators for irrigation in sloping laser levelled fields.

LAND RESOURCES RESEARCH INSTITUTE, NARC

i. Nutrients indexing survey of wheat growing area of Mardan district shows that all soil samples of the surveyed areas 100% in NO₃; 75% in P and 47% in B deficient emphasizes the need of INM based fertilizer management in the area. Integrated Nutrient Management comprising N:P:K:Zn:B (@120:60:90:5:1 kg ha⁻¹) along with Biozote-Max and Humi-NARC resulted increase of wheat yield from 15 to 25 % at eleven farmers fields across the country. Maximum wheat yield with INM was 4.9 t ha⁻¹.

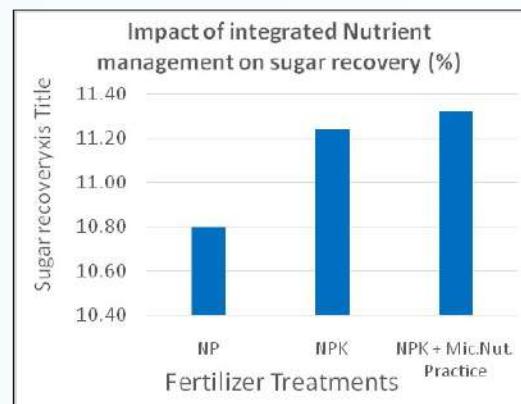


Comparison of INM and FP sites

ii. Nutrient Indexing survey of major sugarcane growing districts of Pakistan (Rahimyar khan, Sargodha, Shaheed BenazirAbad, Mardan, Dera Ismail Khan, Charsadda) was carried out. All the soils of the surveyed areas are deficient in nitrogen, 90% in phosphorous and 32-40% in potash. Micronutrient disorder was variable; Zinc deficiency in soils was 40%, iron deficiency ranged from 40-50% and boron deficiency was 35%. Increase in sugarcane yield due to potash use over NP (farmers' practice) was 83mds/acre and with INM practice (NPK+Zn+B) it was 103.4 mds/acre. The quality parameters (Brix, polarity, sugar recovery) were also improved.

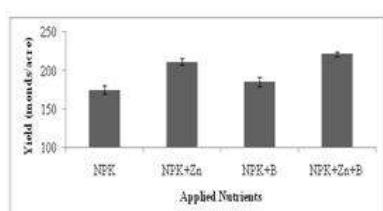


Field experiment in collaboration with Shakarganj Sugar Mill Ltd. Research Farm Jhang



Sugar recovery with Potash use over NP = 5.5% on overall basis of trials conducted all over the country

iii. For diagnosing mineral nutrient status and its management for enhancing citrus productivity and fruit quality 270 soil samples were collected from three Tehsiles of District Sargodha (Kot Momin, Bhalwal, Sargodha). Results indicated that 100, 78 and 76% of surveyed areas was deficient in plant



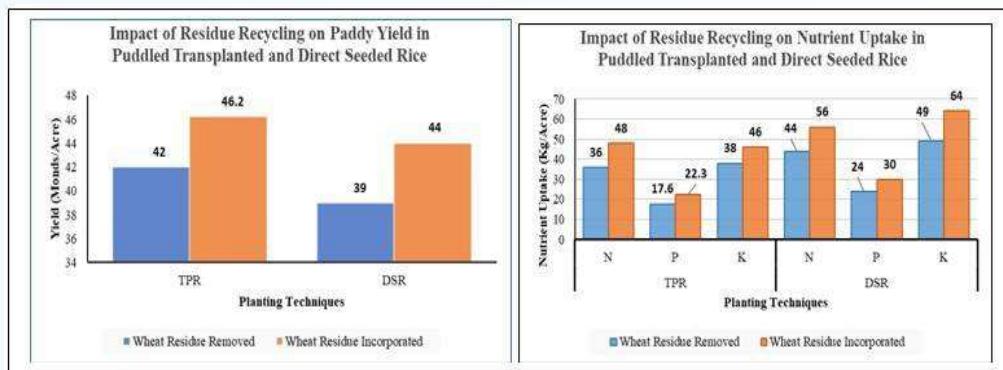
Kinnow yield (mds/acre) as affected by applied treatments

Farmer Practice (NPK)	Micronutrient Management (NPK+ Zn & B)
Net Income Return (Rs. 000)	Net Income Return (Rs. 000)
71,740	103,284
Benefit Cost Ratio	10.70

available $\text{NO}_3\text{-N}$, P and Zn content. After generation of digital maps, field trials in six orchards for Zinc and Boron management were conducted. Micronutrients Zn (5 g tree^{-1}) and B (5 g tree^{-1}) along with NPK resulted 6, 20 and 26.5 % increase in citrus yield as compared with farmers' practice (NPK, @ 1000:500: 700 g tree $^{-1}$).

iv. Field experiment was conducted in Pindi Bhattian. Interactive impact of Humi-NARC and nursery enrichment with zinc sulphate was evaluated at farmer field in Pindi Bhattian (Hafiz Abad). Rice variety "Kainat" was sown. HumiNARC and zinc enrichment increased the paddy yield upto 8%, 16%, 44% and 29% increase in N, P & K respectively was recorded for Humi NARC and Z.E nursery treatment as compared to farmer practice.

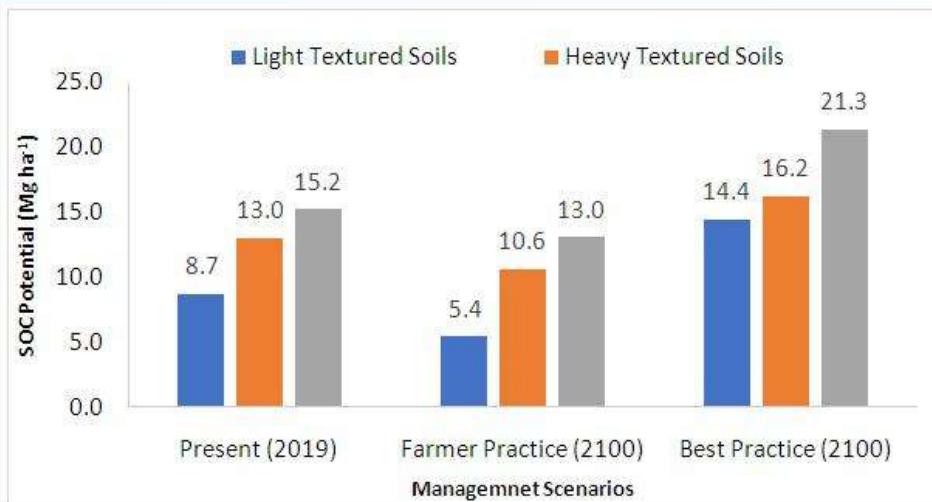
v. Experiments were conducted at 02 farmer fields. The impact of crop residue management (Incorporation) was evaluated in direct seeded (DSR) and puddled transplanted (PTR) rice in farmer fields (DSR in Sialkot and PTR in Mangowal-Gujrat). Wheat residue @ of 1.6 tons/acre in Sialkot and 1.8 tons/acre in Mangowal was incorporated. At all sites, rice variety "Super Basmati" was sown.



Crop residue incorporation increased paddy yield by 10% in DSR and 13% in PTR as compared to farmer practice while increase in nutrient (N,P,K) uptake in residue managed plots in DSR was 33%, 26% and 21% for N,P and K respectively. On the other side nutrient (N, P, K) uptake in residue managed plots in PTR was 27%, 25% and 30% for N, P and K respectively when compared to farmer practice.

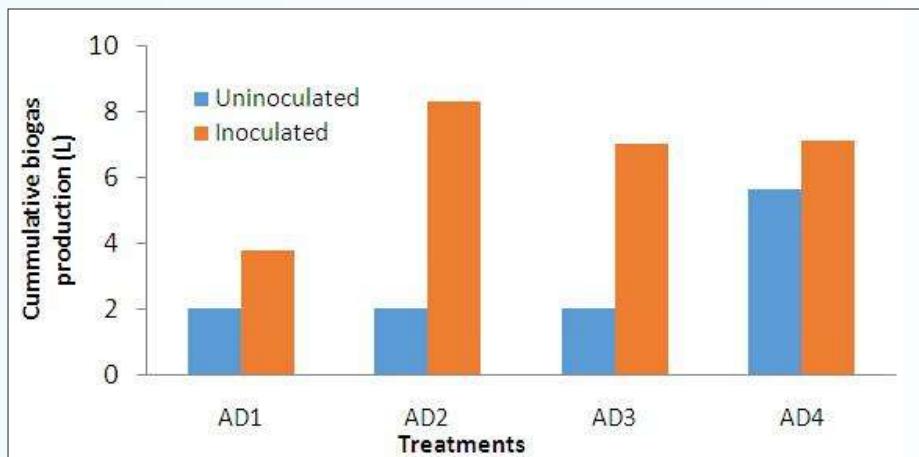
vi. Samples of rhizosphere of Okra and Chilli were collected from Khanewal, Shorkot and Islamabad. Total 92 bacterial isolates were collected from Chilli and 104 from Okra. The isolates were characterized for different growth promoting traits. 81 potential rhizobacteria (Chilli: 22, Okra: 59) were added in the gene bank for further evaluation. DNA of 12 potential isolates of Okra and Chilli was extracted for identification. Nine potential PSB and PGPR of Okra were tested utilizing chemical fertilizer and enriched vermicompost. PSB strain (ORSS1e) followed by PGPR strain (ORPS1c) showed best results. Nine potential PSB and PGPR of Chilli were tested utilizing chemical fertilizer and enriched vermicompost. Bacterial strains CRP4(PSB), CRS34 (IAA), CRO19 (PSB+EPS) and CRP9 (PGPR) presented best results. Consortia of PSB and EPS presented better response regarding plant growth of Chilli. The PSB strains ORSS1e followed by consortia of PSB and PGPR i.e ORSS1e+ORPS1c produced best pod yield of Okra, under field conditions utilizing chemical fertilizer integrated with vermicompost.

vii. In order to explore the carbon sequestration potential of different textured benchmark soils in Punjab, a most widely used CENTURY model was employed. Firstly, the model was calibrated and then used to assess the impact of two scenarios a) best management practice (BP) i.e., residue application while maintaining CNPS stoichiometry (b) prevailing farmer practices (FP). The benchmark soils were categorized among light, medium and heavy textured soils. It was evident from the simulated data that the maximum carbon sequestration potential (21.3 Mg ha^{-1}) was observed in heavy textured benchmark soils under best management practice scenario compared to their current SOC content in farmers practice. Whilst, the lowest potential (5.4 Mg ha^{-1}) was found in light textured soils under farmer practices. The order of carbon sequestration potential in the benchmark soils was in the order of heavy textured>medium textured>light textured soils. The results indicated that carbon sequestration potential was associated with soil texture and management practices. The heavy textured soils showed higher soil carbon sequestration potential under best management practice scenario.



Carbon sequestration potential of differently textured benchmark soils of Punjab, Pakistan under FP and BP scenarios as simulated using CENTURY Model

viii. Biogas is produced from anaerobic digestion of biodegradable organic wastes. Enhancing biogas production through biodegrading microbe inoculation, on various organic wastes in suitable ratio is a recent approach. Different combinations of cow dung and maize residues were incubated in static bioreactors under lab condition, and biogas production was studied for 40 days. The results of cumulative biogas production for 40 days revealed that 3:5 corn: cow dung ratio (AD2) produced maximum (8.3 L) followed by 5:5 corn: cow dung ratio (AD4); 4:5 corn: cow dung ratio (AD3) i.e. 7.1 and 7 L respectively which is statistically similar. Least 3.75 L was produced by 2:5 corn: cow dung ratio (AD1). It was concluded that inoculated treatments were superior to un-inoculated ones.



Cumulative biogas production from different mixtures of cow dung and maize

HONEYBEE RESEARCH INSTITUTE, NARC

i. Established advanced Honeybee Research Lab at NARC for quality queen production, produced 375 quality queen through Cup Grafting Technique, Artificial Queen Insemination and Supercedure cells also distributed among progressive bee keepers. Distributed 200 Modern Turkish bee hives along with Beekeeping Kits to the Bee keepers for testing.

ii. Five treatments were tested under Integrated Pest Management (IPM) of Honeybee Parasitic Mites in (*Apis Mellifera*) colonies. Highest honey yield (6.0 kg/colony) was



recorded in (garlic oil + formic acid) treatment. Trained 130 beekeepers from Swat, Peshawar and Islamabad.



Inauguration of Honeybee Modern Turkish Lab at HBRI, NARC

RANGELAND RESEARCH INSTITUTE, NARC

- Seven new perennial grass varieties (03 *Chloris gayana*, 03 *Lolium multiflorium*, 01 *Panicum maximum*) from Australia and Thailand imported by private companies were tested for adaptability in Pakistan. Rhodes grass varieties produced fresh biomass 10 t h^{-1} (Sultan), 12 t h^{-1} (Diana), and Rye grass varieties produced fresh biomass 19.1 t h^{-1} (Coaster), 15.4 t h^{-1} (Ascend), 18 t h^{-1} (Lemnos). Mombasa grass produced 24 t ha^{-1} . As a result of adaptability trials, *Chloris gayana* has been cultivated over 23000 acres in Punjab, Sindh, Balochistan for forage/fodder production. Similarly *Lolium multiflorum* has been cultivated over an area of 3500 acres in various provinces of Pakistan including Gilgit-Baltistan.
- Established Silvo-Pastoral System: A model for sustainable land-use and Carbon Sequestration in Potohar with the combination of perennial grasses and legume trees on three community lands. Best forage grasses (*Panicum maximum*, *Chloris gayana*, *Pennisetum purporium*) were identified. With these interventions one acre of pastoral land can support nine large ruminants and 27-30 small ruminants round the year for grazing.



Established Pasture at Potohar



*Growth of Hybrid Robinia at field area
RRI, NARC*

- Evaluated fast growing hybrids of (Salix and Robinia) introduced from Hungary. In nursery the survival rate of willow and Robinia was 96 % and 92% respectively. Whereas after transplantation in filed the survival rate of willow and Robinia was recorded 85% and 94% respectively.

PARC-Balochistan Agriculture Research and Development Center, Quetta

- Establishment of Olive Orchards at BARDC and on farmers' fields in Balochistan: Eighty five thousand (for 850 acres) olive plants distributed in 16 districts under Olive (PSDP) project. Up till

now 4,500 acres were brought under olive cultivation. Expanded and established a progeny orchard of Olives on 30 acres on high efficiency irrigation (Drip) system at BARDC, farm, Quetta.

ii. High Efficiency Irrigation (Drip) System installed on 150 acres for olive orchards in Balochistan.

iii. Introduced pistachio plantation on drip irrigation system on one acre at BARDC, Quetta.

iv. Submitted case to FSCRD for approval to release three new varieties (Durum wheat, barley, and lentil).

v. Promoted lentil cultivation in rainfed areas of Balochistan (32 acres in Mastung, 39 acres in Surab, 33 acres in Khuzdar, 2 acres in Kharan, 2 acres in Taftan) with an average seed yield of 400 kg/acres.

vi. Seed production of 15600 kg for further multiplication in the province. Introduced high yielding and disease resistant chickpea varieties (Bittle-16, Fakhare-Thal, DG-92) in Jaffarabad.



Olive plantation on farmer's field in Kila Saifulla



Lentil trials at Mastung

PARC – Mountain Agricultural Research Center, Gilgit

i. Five thousands (5000) true to type plants of (apricot, cherry, almond, pear, peach, grapes, fig and apple) were provided to farmers, NGOs, Government organization at Subsidized rates.

ii. Planted 13845 Olive Plants on farmers field and Defense Land in Gilgit Baltistan.



Deciduous and other fruit plants at MARC

iii. Propagated 13000 deciduous fruit plants (Apricot, Apple, Cherry, Peach and Plum) through budding / grafting. KIWI variety (Hayward), Black berry (Boysen and strawberry variety (Sea Scape & Tribute) showing good performance and these varieties will further be propagated for up scaling in Gilgit Baltistan.

iv. Evaluated 8 varieties of Tomato, 4 varieties of Brinjal, 4 varieties of chilies and 3 varieties of Radish and selected Tomato variety of SAARC Nagina, (28.71 t ha^{-1}), Brinjal variety of Padagoda



SAARC Tomatoes and China Radish at MARC

(29 t ha^{-1}), Chili variety of China Red (3.8 t ha^{-1}) and Radish variety of China red (33 t ha^{-1}) for further promotion in the region.

v. Tested four varieties of Soybean and three varieties (NARC-16, NARC-11 & Rawal-1) selected on the basis of high yielding (1210 kg ha^{-1} , 1100 kg ha^{-1} & 1000 kg ha^{-1} respectively) in agro-ecological condition of GB. Seed 1200 kg produced and provided to Agriculture Extension Department Skardu for further propagation in Baltistan Division.

vi. The exotic improved buckwheat variety introduced by PARC in GB was tested at five localities, Tormik Roundu, Gumba Skardu, Olding Kharman Doghoni Ganche and Teesar Shigar valley of Baltistan to compare the yield potential with Local variety "Jawas" during summar 2020. Variety Mancan performed better than local var. Jawas at five localities giving average higher grain yield 1.86 t ha^{-1} as compared to 1.35 t ha^{-1} average grain yield produced by local variety.



Buckwheat var. Mancan at PARC, Station, Skardu

vii. Ryegrass variety Vertex and Diamond provided by RRI, NARC Islamabad was tested at MARC and at farmer's field at two different locations for biomass testing and seed increase. Total biomass from three cuttings i.e. 1st, 2nd and 3rd cutting was $24, 21$ and 14 t ha^{-1} respectively obtained in variety vertex and $20, 18, 13 \text{ t ha}^{-1}$ was recorded in Diamond variety.

PARC-ARID Zone Research Center, D.I. Khan

i. Diversifying cropping pattern to adapt climate changes in spate irrigated areas of KP was evaluated. New cropping pattern was formulated for spate-irrigated areas of district D.I. Khan and Tank. Rabi crops cultivated according to newly formulated cropping pattern on farmer's field. Newly high yielding and disease resistant variety of wheat (AZRC Dera), Chickpea "Indus-2019" and Lentil



Lentil at AZRC farm, D.I. Khan

“Lentil-2019” were introduced among 20 progressive growers of D.I. Khan and Tank in Gomal Zam command areas.

ii. Farm Productivity Enhancement through adoption of multiple cropping system and introduction of high value crops in rainfed and riverine areas of Southern Khyber Pakhtoon khwa. First time planted summer crops in rainfed ecology in Lakki Marwat and Pezu area. Mung bean variety “Inqalab Mung” superseded in yield among the tested varieties on farmers field. Similarly, Arooj variety of mash bean remained top in yield as compared to other varieties. Introduce 2 varieties of turmeric (Mehak & AZRC-T-DK-1) in riverine area of D.I. Khan.



Inqalab Mung Variety at AZRC farm

iii. Wheat candidate variety “AZRC 84” was tested in various sites in rodkohi/rainfed areas and under process for approval. Drought tolerant and high yielding Guar variety “AZRC GUAR” is also under process for release from provincial seed council. 5200 kg certified seed of AZRC Dera wheat variety, 2500 kg chick pea Indus-2019, 700 kg Mung bean Inqalab and 600 kg of lentil-2019 seed has been produced at AZRC Farm.

iv. Soil sample for physical and chemical analysis were collected from selected farmer's fields in different villages. The soil pH varied from 7.8 to 8.2 and the EC 0.25-0.56 dsm⁻¹ and organic matter ranged 0.54-0.88. This shows that the soils are poor in organic matter and show marginal sodicity.

v. Assessed number of tube wells and water quality in spate irrigated and rainfed areas. Six tubewells in Daraban with varied depth from 100 m to 140 m. The total dissolved solids (TDS) of the water varied from 1010 to 1330 ppm. Eight tubewells in Lalokot and their depth varied 90 m to 140 m. The TDS of the water varied from 1010 to 1455 ppm. In Musazai village, 10 tubewells and their depth varied from 80 m to 180 m. The TDS of the water varied from 977 to 1330 ppm. In Chaudwan village, seven tubewells and water depth varied from 75 m to 153 m. The TDS of the water varied from 745 to 1189 ppm.



Wheat AZRC 84 Variety

PAR CARID ZONE RESEARCH INSTITUTE, UMERKOT

- i. Post harvest technologies (solar tunnel dryer, solar-cum-gas fired dryers) for drying of chilies, dates, onion, spinach, cluster bean, musk melon, Moringa leaves were introduced in Thar area and recorded 50% reduction in drying time with 80% reduction in aflatoxin.



Solar tunnel dryer and one solar-cum-gas fired dryers

- ii. Established 40 acres of arid orchards (Chiku, Lemon, Guava, Date palm and Ber) using brackish groundwater with 3500 ppm through solar powered drip irrigation system.
- iii. Seed production of improved varieties of cluster bean (3000 kg), Mustard (4000 Kg) and Mung bean (60 Kg) for further scaling up in the area.
- iv. Cultivated 2 acres of elite Longi/ Dandicut chilies at farmer's fields and produced seed for 300 acres. Crosses between elite genotypes made to acquire resistant and better yielding chilies. Provided training on nursery management, improved production methods, safe drying and post harvest of chilies to 150 farmers.



Grafted ber on drip irrigation

v. Propagated 5000 saplings of medicinal plants (Gugral, Alo vera, Imli, Jungle julibi and Khavi) and distributed among farmers. Value added products of Moringa (leaf powder, tea bags, energy bars), Alo vera gel, Khumbhat gum, Gugral gum were prepared.



Moringa olifera and medicinal plants

PARCARID ZONE RESEARCH INSTITUTE, BAHAWALPUR

- i. Evaluated 58 genotypes of Ispaghul under agro-climatic conditions of Cholistan desert. Different trials on sowing time, sowing method, seed rate and fertilizers were carried out.
- ii. National uniform yield trials of Lentil, Mung bean, Wheat, Chickpea, Berseem, Groundnut and Rapeseed were conducted to evaluate and select high yielding, drought and disease resistant genotypes.
- iii. Native grasses and trees of Cholistan desert were conserved for seed multiplication and greening of desert.



Field view of germplasm screening trial at Cholistan Farm of PARC AZRI, Bahawalpur

ANIMAL SCIENCES DIVISION

The objective of this division is to set need based national research priorities and monitor research activities being conducted at the Federal and Provincial level. The researchable areas addressed by this division are related to livestock and poultry health, animal feeds and nutrition, animal reproduction and genetics, dairy technology, animal biotechnology and inland aquaculture and fisheries.

RESEARCH PLANNING, MONITORING AND COORDINATION

The ASD is involved in research coordination, monitoring and evaluation in the disciplines of animal production, animal health and aquaculture. The research planning, monitoring and coordination activities under this division are summarized below:

S. No	Funding Sources	Completed	On-going	Total
01	Agricultural Linkages Program	13	33	46
02	Public Sector Development Program	02	0	02
03	International Cooperation	01	03	04
	Total	16	36	52

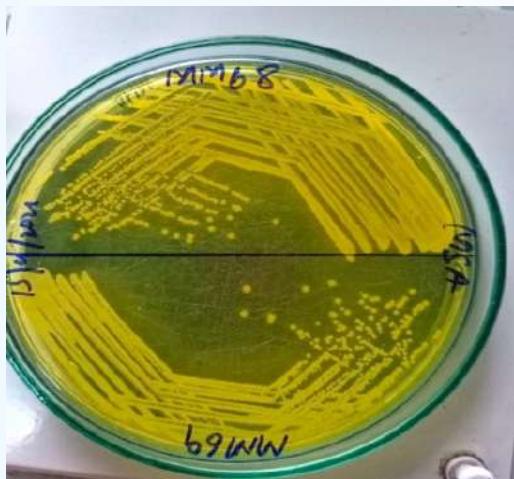
RESEARCH ACHIEVEMENTS

Animal Health Program

The program aims to improve animal health among livestock in Pakistan. This is persuaded by research on better understanding of animal pathogens and disease mechanisms through using epidemiological, conventional and molecular tools for the diagnosis and control of animal diseases. Following are the salient research achievements of this program:

Aerosol Hemorrhagic Septicemia (HS) Vaccine: It is an acute and fatal disease of cattle and buffaloes. Pakistan ranks HS as of considerable economic importance and 34.1% of all deaths in animals are caused by HS. The prophylactic vaccination is the principal mean of controlling the disease. A live aerosol heterotypic HS vaccine has been developed and found it safe and efficacious in cattle and buffalo calves.

Brucellosis-An Occupational Hazard: 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. The national herd prevalence of brucellosis was investigated and determined at 16.32%. A herd with a history of abortion during the last six months was a significant indicator for brucellosis.



Salmonella aureus colonies



Processing of milk samples in the lab

Prevalence of Congo Virus: Tick borne diseases (TBDs) are production limiting factor of livestock industry. Ticks are present round the year leading to problem of TBDs in livestock. Crimean Congo Hemorrhagic Fever (CCHF) is a viral zoonotic disease and is asymptomatic in animals but fatal to humans. Its prevalence in animals is a good indicator for local virus circulation. The sero-conversion of CCHF has been investigated and 19.3% and 18.75% was observed in ruminants of Punjab and Baluchistan, respectively, which is an indication of the virus activity. In Baluchistan, the overall prevalence of tick infestation in domestic animals was 47.2% and the most commonly observed tick was Hyalomma.

Antimicrobial Resistance: The inflammation of mammary glands of cattle and buffalo (Bovine mastitis) is economically the most important disease of dairy animals and the most importantly *Staphylococcus aureus* is associated with it. The *S. aureus* isolates (23) were recovered from milk samples (105) collected from Rawalpindi and Islamabad. These isolates exhibited highest resistance toward lincomycin (100%), cefixime (90%) and ampicillin (80%). The prevalence of *mecA* gene was 70% among *S. aureus* positive isolates and indicates high prevalence of zoonotic Methicillin-resistant *Staphylococcus aureus* (MRSA) in slaughtered animals and workers.

COVID-19 in Pets: The SARS-CoV-2 virus, associated with COVID-19 pandemic, is zoonotic in nature. It has been reported to be transmitted from humans to other animals and within animal species. It is needful to investigate how it affects animals, possible spread to humans and other potential roles in epidemiology. A sero-survey has been planned in twin cities to determine sero-prevalence of COVID-19 in pets (dogs and cats). A 7.23% sero-prevalence of COVID-19 among the pets was found in Islamabad. Animal in families with a history of COVID-19 among owners were more likely to be sero-positive for SARS-CoV-2.

Animal Nutrition Program

The mandate of this program is to conduct research on livestock and poultry nutrition and to develop and validate feed production technologies for industry and farmers. Animal feeding is recognized as the most important component of livestock production systems, forming up to 70% of the cost of production. The current supply and demand gap for dry matter, crude protein and metabolizable energy are 19.4%, 37.2% and 38.0%, respectively. Following are the salient research achievements of this program:

Distribution of Poultry for Poverty Alleviation: Commercial poultry production in Pakistan is mostly dependent on exotic 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). The production performance of backyard poultry can be improved by crossing local breed(s) with high producing exotic breeds and propagating these birds to rural community. A total of 3,780 birds of three months age were provided to Livestock and Dairy Development Board (LDDB) for distribution among farmers.



Rearing of backyard poultry



Distribution of 3 months old bird units

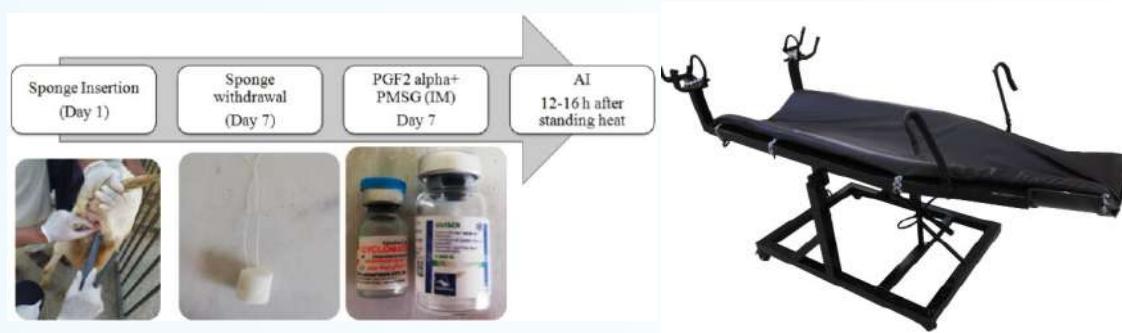
Bio-control of Aflatoxins: Aflatoxins are carcinogenic in nature and contaminate food and feed resources. These toxins can be transferred to milk and eggs and posing health risks to consumers. Cottonseed cake is one of the major protein sources in dairy feeding and a main contributor of aflatoxin residues in milk. Over 300 isolates of *Aspergillus flavus* were obtained from cotton samples and examined morphologically, and subjected to aspergillic acid and aflatoxin production tests. Five atoxigenic isolates have been identified and characterized using PCR.

Provision of Animal Feed: This prepared 117,700 bags (37kg) of livestock feeds, 2,200 kg milk booster and 2,500 urea-molasses blocks and sold to farmers, apart from experimental feeds for different programs.

Animal Reproduction and Genetics Program

The focus of this program is to improve reproductive efficiency and genetic potential of food animals. In this regard, major reproductive tools i.e. artificial insemination, estrus synchronization, semen cryopreservation and other assisted reproductive techniques are being investigated in local livestock breeds.

Improvement of Semen Quality in Buck and Buffalo: The optimization of cryopreservation techniques is important for the improvement in semen quality. The improvement in buck and buffalo



Timeline of estrus induction and AI in beetel goats.

PGF2 alpha= Prostaglandin F2 alpha,

PMSG=Pregnant Mare Serum Gonadotrophin,

IM=Intramuscular, AI= Artificial Insemination

Laparoscopic AI Cradle for goats was developed indigenously and applied for patent

sperm cryopreservation was studied using biocompatible nanoparticles and Kisspeptin-10. In the post-thaw evaluation, the sperm treated with either 400 μ M of manganese oxide nanoparticles or 15 μ M Kisspeptin-10 was found better in terms of quality parameters.



Ultrasound scan of pregnancy, fetal fluid with fetus is visible at 50 days post LAI



DG, NARC examining the kids born through LAI

Optimization of Artificial Insemination Technique in Goats: Beetal goats detected in heat were artificially inseminated by using laparoscopic AI (LAI) technique. The LAI technique was optimized. The pregnancy was confirmed through trans-abdominal ultrasonography 50 days post-AI. The recorded estrus rate was 83.33% (40/48) and the estrus interval after sponge removal ranged from 24-60 hours (43.8 ± 1.99 h). The pregnancy per AI tended to be higher in goats inseminated through laparoscopic method by using spermatozoa of beetal bucks. The number of kids born through LAI and cervical AI are 11 and 5, respectively. The Laparoscopic AI Cradle for goats has been developed indigenously and applied for patent.

Animal Production Improvement Program -Dairy Technology Section

This program is focusing on smallholders and processors to develop better alternates of indigenous technologies and practices and make them more efficient and organize result-oriented trainings thereby generating better economic opportunities.

Enhancement of Shelf Life of Cheese: Natamycin is a naturally occurring antifungal agent isolated from soil and made by fermentation of the bacterium *Streptomyces natalensis*. This trial was conducted to study the effect of natural antifungal agent (natamycin) on the shelf life of white cheese at 4°C. The results indicated the efficacy of natamycin added chitosan film, where no fungal growth was observed up to 49 days and even after.

Neutraceutical Yogurt: Riboflavin (vitamin B2) is an essential vitamin found in green leafy vegetables, cereals, eggs and meat but often lost during milling or cooking. Bio-fortification of vitamin B2 in preparation of fermented products is an economical and viable option. In this study, B2 contents of milk and yoghurt samples collected locally were estimated. The results revealed the riboflavin contents in milk samples with a mean value of 2.55 ± 0.57 mg/L, while in yogurt samples with a mean value of 2.52 ± 0.66 mg/L. The Lactic Acid Bacterial strains were isolated from milk and yogurt samples and characterized for B2 producing potential. The results showed that 59 isolates, out of 100, with promising results.

Livestock Research Station

This station is serving as a demonstration site as well as it supports the research activities of the Animal Sciences Institute. Care and management, feeding, breeding, vaccination, deworming, spraying, treatment of animals and fodder production are the farm management practices being carried out at LRS routinely.

Total Mixed Fermented Ration (TMFR): Pakistan is producing huge quantities of agro-industrial wastes like corn steep liquor, citrus pulp and beet pulp etc. Its use in animal feed is limited due to high moisture contents, handling transportation and storage issues. This study was therefore, designed to evaluate nutritional profile and fermentation characteristics of TMFR based agro-industrial waste, crop residues and concentrates. The fattening trial on buffalo calves (n=20) showed



Ensiling and preservation of agro-industrial wastes at LRS



Buffalo calf fattening at LRS

maximum weight gain (856 g/day) fed on 60% sugar beet while lowest weight (681 g/day) in calves fed on 60% mixed fodder grain.

Angora Rabbitry at Gilgit: The Angora rabbit is one of the oldest types of domestic rabbit. It is bred for its long fibers, known as Angora wool. Angora rabbitry will be established at Juglot and Sakardu, PARC Mountainous Research Centre (MARC) through ALP funding as a source of livelihood for poor farmers especially women.



The angora rabbitry at Juglot, MARC was inaugurated by Special Advisor to Prime Minister on Food Security and Research, Mr. Jamshed Iqbal Cheema on June 10, 2021

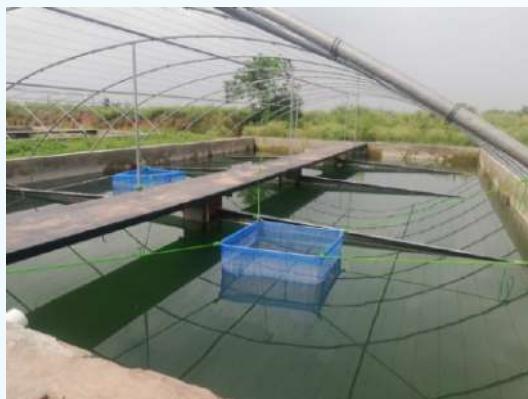
Aquaculture and Fisheries Program

This program was set up with the vision to develop inland aquaculture on modern lines to meet national and international requirements. The mandate of program is to undertake strategic research on inland aquaculture to increase per unit fish production.

Tilapia Fish Hatchery and Production: Tilapia are among the easiest and most profitable fish to farm due to their omnivorous diet, mode of reproduction, tolerance of high stocking density, and rapid growth. In this regard the temperature control tilapia hatchery is utilized for the production of 50,000 fries of All Male Tilapia annually. The effect of different dietary protein levels on growth performance of all male Tilapia showed best growth performance at 30% protein with 23.3 gram monthly weight gain.

Floating Feed in Talapia Culture: This study was designed to investigate the growth performance of Genetically Improved Farm Tilapia (GIFT) Tilapia and all male Tilapia by feeding floating feed. The sex reversed Tilapia (all male) showed better growth performance as compared to GIFT on floating feed (sex reversed fish gained average 500g weight in 5-6 months).

Probiotic Feeding to Tilapia: The aquaculture intensification and inter-regional transfer of new fish species are the factors that accelerate emergence of pathogenic microorganisms. The use of



Hapa set up for tilapia breeding



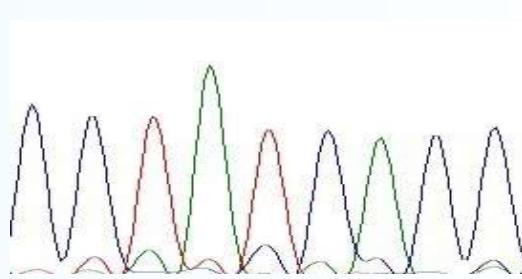
Sex reversal of tilapia to all male tilapia

antibiotics and other chemical compounds had shown the development of antibiotic resistance and environmental pollution. This led to the use of alternates like probiotics. In this study, bacteria (*Lactococcus lactis* sub sp. *lactis* 3FT) was tested in tilapia feeding. This probiotics enhance the immune system of tilapia and provide resistant against infections against Vibrio specie.

American Channel Catfish Production: American channel catfish has high consumer preference due to fewer spines (bones) and good quality meat. For induced breeding of channel catfish to ensure regular supply of fish seed throughout the year, a catfish hatchery has been established at NARC. Fifth brood stock of American channel catfish has been developed and 2,000 fingerlings were stocked in earthen ponds.

Animal Biotechnology Program

Genetic improvement of indigenous livestock breeds is inevitable to meet the dietary requirements of increasing population in the country. This program is conducting research on selection of higher production genome.



Genomic analysis of Kappa-casein gene in Nili-Ravi and Kundi buffaloes

Kappa-Casein Genes in Nili-Ravi, Kundi buffalo and Sahiwal Cattle: The modern cattle breeding strategies involve the identification of milk, meat and disease resistance genes that can be incorporated into selection programs. Kappa-casein gene is one of the important milk protein involved in the processing properties of milk and breed characterization etc. Genotyping of milk protein genes has been established in Nili-Ravi and Kundi Buffaloes and Sahiwal cattle. Nili-Ravi and Kundi buffaloes were found homozygous for BB genotype of Kappa-casein gene while in Sahiwal cattle, genotypes AA and AB were observed. Multiple sequence analysis of amplified Kappa-casein (κ -CN) gene in Nili-Ravi buffaloes has shown two SNPs with reference sequence of Nili-Ravi breed (FJ770200) at 102 and 111 positions as C>G and C>A respectively.

National Reference Laboratory for Poultry Diseases

The NRLPD is working in the field of avian disease diagnosis and research and is also designated as Regional Leading Diagnostic Laboratory (RLDL) for Highly Pathogenic Avian Influenza (HPAI) for SAARC countries by FAO of United Nations. In 2014 the laboratory was internationally accredited for ISO/IEC 17025:2017 by Pakistan National Accreditation Council (PNAC), Islamabad.

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. In this regard;

- i. A total of 12,911 samples were analyzed for avian pathogens and surveillance of Avian Influenza and Newcastle Disease Viruses.
- ii. For molecular diagnostics, 1,492 reactions were carried out.
- iii. Differential diagnosis was provided for IBV, Avian Reo-virus, CAV, ALV, AAV, ILTV, ORT, APV, MG, MS, Pasteurella, E. coli, Salmonella, Staphylococcus species, Klebsiella, Porteous species and Marek's Disease.
- iv. A total of 334 postmortems were conducted.
- v. A total of 883 samples were analyzed, for AMR surveillance, from healthy chicken. The E.coli, Salmonella and Staphylococcus were recovered from these samples.

Biological and molecular characterization of avian pathogens: For the biological and molecular characterization of avian pathogens, following activities were performed:

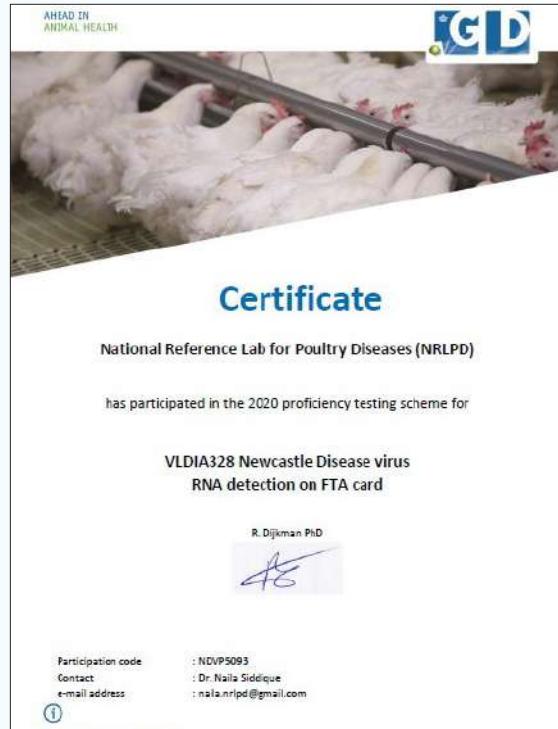
- i. Phylogenetic and sequence analysis was performed to find out mutations and evolutionary status of field isolates. It includes identification of HPAI (H5N8, H5N1) first time from poultry and wild birds in Pakistan.
- ii. The selected H5N8 isolates were subjected to sequencing. Sequence and phylogenetic analysis of HA gene was performed, which showed close similarity with Indian H5N8 belonging to clade 2.3.4.4 isolated from zoo during 2016.
- iii. Cartography analysis was performed using HI test for the H5N8.

Up gradation of NRLPD: Successful up gradation of NRLPD to ISO-17025/IEC-2017 by PNAC for next three years from 2021-2023.

Extension, Training, Publications, Seminars, Workshops

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
20	0	6	5	80	468	5	0



Certificate of proficiency testing - 2020

SOCIAL SCIENCES DIVISION

Social Science 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. Beside this, the division also provides feedback to the Ministry of National Food Security and Research (MNFSR) on food security, impact analysis, technology adoption, trade and agricultural policy.

The Social Sciences Division (SSD) had established its network of social sciences research in 1984 by establishing Agricultural Economics Research Units (now upgraded as Social Sciences Research Institutes) at provincial and federal levels and one at Azad Jammu & Kashmir. The main objective of these institutes is to carry out research on socio-economic aspects of farmers at grass root level in Pakistan. Moreover, PARC also extends a helping arm to provincial agricultural research systems. This has not only bridged the information gap on micro-level issues of farming and technology adoption but also resulted into development of new crop, livestock and farm machinery related technologies in the country.

During the financial year 2020-21, SSRIs carried out different research studies and projects in accordance with the research themes of the Division. Some of the completed studies of national importance are briefly described below.

Impact of COVID-19 on Mango Supply Chain in Pakistan

Mango is an important fruit in tropical and subtropical regions of the world. Asia accounts for the major proportion (74.3 percent) of production in the World followed by America, Africa and Oceania. Mangoes in Pakistan are grown mainly in Punjab and Sindh provinces and are known around the globe for its flavour and sweetness. The current study was conducted in mango producing area of Punjab to assess the impact of covid-19 on mango supply chain. For this purpose, whole supply chain was studied starting from producer to the end consumer. Total 110 sample respondents were personally interviewed using structured questionnaire. The sample comprised of 50 producers, 25 contractors, 10 wholesalers, 10 retailers and 10 exporters.

The findings of the study show that total cost of production for mango producer was Rs. 97952 per acre with total revenue of Rs. 110303 per acre. Gross margin of mango producers was Rs. 50350 per acre while net profit was Rs. 12350 per acre. About 86 percent of the farmers sold mango to pre-harvest contractors, 5 percent to processor and 9 percent farmers sold in wholesale markets through commission agents. Contract is done on stamp paper or simple paper. During the year 2020-21 there was an uncertainty because of COVID-19 so most of the farmers sold their orchards to pre-harvest contractors at an early stage, at relatively lower prices (25 -30 thousand rupees per acre) than previous years. Farmers reported shortage of some inputs like fertilizer, especially DAP and NPK this year because of COVID-19. On average 17.6 percent loss is reported by mango producer during the production cycle. Main reasons reported for this loss were fruit fly and disease attack on mango crop. Mango contractors reported 2-5 percent loss during the harvesting time because of poor handling.

Contractors mostly sell mangoes at wholesale markets, because of their commitments, as they have received advance payments from the commission agents. Some proportion of the produce is also sold to exporters especially, late varieties. Mango is usually transported in trucks and pickups to wholesale markets. Mango supply chain was badly affected this year because of lockdown in the wake of Covid 19 pandemic. This also resulted in 25-30 percent increase in transportation charges. Sindhri and Chaunsa are the major varieties which are exported to Iran, Middle East, UK, Malaysia, and Russia. Mangoes are exported in specialized packing with weight varying between 4-8 kgs, depending upon the demand of foreign markets. Farmers are shifting towards late maturing varieties of mango particularly for enhancing exports. There is a need to explore new markets to avoid the excessive mango supply and low export prices in existing markets. In future, Egypt could be a potential market for late varieties.

Production, Post-Harvest Management and Marketing Issues of Peach in Khyber Pakhtunkhwa

In Pakistan peach is produced in Malakand, Peshawar and Hazara divisions of Khyber Pakhtunkhwa province. Peach is produced on an area of 14350 hectares in Pakistan with 72536 tons of production. Out of this, 9013 hectares (63 percent) are grown in the province of Khyber Pakhtunkhwa with 56776 tons (78 percent) of production. Peach growers face various production and marketing problems.

Being highly perishable in nature, peach is sold and consumed in a relatively very short period of time. Seasonal production, perishability, price fluctuations and high post-harvest losses are the major threats for competitiveness of peach producers. Keeping in view the importance of peach crop and issues in production, and marking of this commodity, the present study was conducted to explore the cost of production, profitability analysis, and production, post-harvest and marketing issues of peach growers. Data was collected from 60 Peach producers/contractors from Swat, Mardan and Peshawar districts of the province.

The study results indicate that overall yield was 235.68 maunds per acre. It was almost same for producers as well as pre-harvest contractors with minor differences. Net return was Rs.168258, quite higher for contractor (Rs 243530.24) while lower (Rs. 177486.13) at producers farm. BCR ratio was 1.41:1 it was higher (1.57:1) for contractors while lower (1.44:1) for producer. It is concluded that peach was a profitable crop for both the contractors and producers in the study area. The main destinations for selling peach produce included wholesale markets at Islamabad, Lahore, Faisalabad, Gujranwala, Sargodha, and Karachi. Some proportion of the produce is also sold at the local assembly markets. Farmers face the issues of disease attack, fruit fly attack, high input prices, lack of modern machinery, shortage of canal water, and expensive labour. Producers as well as contractors have to market the fresh produce as soon as possible because of absence of cold storage facilities and no value addition at local level. In scenario of increase in supply of peach, value addition at local level is needed to be encouraged while avenues for export need to be explored.

Exploring Sustainability in Cotton Production in Southern Punjab

Cotton production supports Pakistan's largest industrial sector i.e. the textile sector. Cotton and cotton products have 10 percent contribution in agricultural GDP and 55 percent of the total export earnings in term of foreign exchange. Present research is based on primary data to assess economic sustainability in cotton production in Southern Punjab, Pakistan. The analysis revealed that there was a decreasing trend in area and yield of cotton. The overall decrease in area and yield during 2018 to 2020 was reported to the tune of 34.6 percent and 44.1 percent, respectively. A higher decrease in area and yield was reported by the large farms 41.9 percent and 46.3 percent, followed by medium farms 22 percent and 44 percent, respectively during 2018 to 2020. Small farmers reported a decrease in area and yield to the tune of 10.3 and 43.4 percent, respectively during the same period. Respondents intentions regarding cotton area for the year 2021 revealed that there was an overall 56.5 percent decrease in the planned area as compared to the 2020. A higher intended decrease in area is reported by large farmers (60.7 percent) followed by small (59.6 percent) and medium farmers (45.7 percent) as compared to the allocated area during the year 2020. This shows an alarming situation in sustainability of cotton production in Pakistan.

Information on area under different cotton varieties show that on overall 94.7 percent cotton area was under BT-cotton and only 5.3 percent cotton area was under conventional cotton varieties. Variety wise area allocation analysis revealed that SS-32 variety was the major choice of cotton growers and overall 53.4 percent area remained under this variety. Large farms had higher percentage of SS-32 variety (58.3 percent) followed by medium farms (46.7 percent) and small farms 44.6 percent. Other common varieties adopted by the farmers were IUB, J-5, Z-33 etc.

Cotton yield is reported very low and remained 11.15 maunds per acre on overall basis during 2020. Cotton yield was a bit higher for small farm category (11.46 maunds per acre) and lowest for medium farms (10.57 maunds per acre). Main reasons for low productivity and decreasing area are non-availability of quality seeds and more disease infestations. Total cost of cotton production Rs.67,149 per acre while gross revenue was estimated at Rs. 43,379 per acre on over all basis. Net profit after deducting land rent was negative. The estimated benefit cost ratio was 0.70 which was higher for small (0.77), followed by medium (0.72) and large (0.60) farmers. The analysis revealed that cotton production in the study area is economically not viable across all farm categories. The BCR analysis revealed that farmers received Rs. 0.70 against investment of Rs.1. The results revealed that with the prevailing technology, prices of inputs and outputs, and policy environment, the cotton growers are in loss. Therefore, farmers were shifting to maize, sugarcane and rice crops. Availability of certified seed, measures to reduce the cost of production and provision of the minimum support price of cotton are needed to sustain cotton crop in Pakistan.

A Comparison of Statistical Methods to Study Genotype by Environment Interaction and yield Stability in National Uniform Maize Yield Trials

A multi-environment yield trial in maize crop is very important for evaluation of genotype by environment interaction and identification of stable genotype in the final selection phases. Genotype adaptability across diverse environments is usually tested by its interaction with different environments. It is believed that the genotype is more stable or adapted if it has a high mean yield and low variability in yield across diverse environments. The present study was conducted in collaboration with National Maize, Sorghum, Millet and Fodder Coordinated Program, Pakistan Agricultural Research Council (PARC), Islamabad. The main objectives were to compare various statistical methods of stability analysis to evaluate genotype performance under multi-location trials and to identify the promising maize genotypes for their adaptability and stability under different agro-climatic conditions in Pakistan. Sixty-four (64) maize hybrids were evaluated in national uniform maize hybrid yield trials under randomized complete block design with three replications. These trials were conducted at seven locations of Pakistan including Ayub Agricultural Research Institute Faisalabad, Cereal Crops Research Institute Pirsabak, Nowshera, Maize and Millet Research Institute Dadu, Data Agro Khanewal, Petal Mardan, Pioneer Swabi and Pioneer Nowshera having different agro-climatic conditions. Results of combined analysis of variance for 64 maize entries showed highly significant differences for genotypes (G), environments/location (E) and G x E interaction. The presence of significant genotype by environment interaction indicated the inconsistency in performance of maize hybrids across environments. The significant G x E permits the stability analysis to be performed. Comparison of various statistical methods of stability analysis showed that Eberhart and Russell deviation from regression (S_{2di}), Wricke's ecovalence (Wi2), Coefficient of determination (Ri2) and Shukla's stability variance () were the most suitable techniques to evaluate genotype performance under multi-location trials. Spearman's coefficient of rank correlation indicates that highly significant correlation was observed among deviation from regression, Wricke's ecovalence, coefficient of determination and Shukla's stability variance. This indicates that the ranking order of the entries by these parameters is significantly correlated. It was concluded from the results that entry number 28 was considered the most stable maize hybrid across the environments and it can be released as a new commercial hybrid on the basis of stability analysis. This situation suggests that maximum statistical measures for yield stability should be adopted to maximize the confidence level before making final decision for the hybrid to be released as a commercial variety.

Climate and Non-Climate Risks and Coping Strategies of Smallholder Vegetable Farmers in Central Khyber Pakhtunkhwa, Pakistan

Khyber Pakhtunkhwa province of Pakistan has diversified agro-climatic conditions that make possible the production of a variety of horticultural crops. These crops are exposed to climate and non-climate risks like production risk, institutional risk, financial risk, market risk and human risk. The available resources at farm and external factors shaped the farm's adaptive capacity. This study was established to seek the perceptions of risk sources and coping strategies of vegetable growers in central Khyber Pakhtunkhwa. Based on the results of this study, vegetable growers were found to be quite young, majority of them were educated with an average vegetable farming experience of 24 years. Income from vegetables production shared more than three-fifth in the total household income. About two-fifth of the surveyed vegetable growers had their own landholding while majority had either shared-in or rented-in land. Vegetables grown in the study area were bell pepper, bitter gourd, bottle gourd, cauliflower, chilli, colocasia/ arvi, cucumber, green peas, garlic, leaf vegetable, onion, potato, round gourd, smooth gourd, tomato and turnip.

This study identified the institutional risk (minimal access to government programs and inadequate extension services); financial risk; market risk (fluctuation in input prices, market competition and high market price in the previous growing season); and human risk (migration of family members and difficulties in finding labor). The small holder vegetable growers in the study area adopted the coping strategies including weather forecast for adjusting production practices, adoption of new technology and production diversity as production strategies; maintaining good relationship with friends/relatives and market actors as institutional strategies; sale of perennial crops and sale of livestock as financial strategies; leasing inputs, market monitoring and switching to other markets for higher prices as market strategies; and engaging on off-farm employment for income generation and reducing hiring of labor for farm activities as human strategies. This study recommends to devise and ensure strict implementation regarding use of agricultural land for other purposes. This study also recommend introduction of trial based vegetable technologies, digitalization for timely provision of

climate and price information and identification of new business opportunities to cope with the climatic and non-climatic risks faced by the smallholder vegetable growers.

Cost of Production of Lentil in Rice-Wheat Cropping System of Punjab

Pakistan imports large quantities of pulses to meet the ever increasing gap between the domestic production and requirements. In Pakistan, lentil crop was grown on 13.5 thousand hectares with a production of 6.3 thousand tones during 2018-19. The yield was 467 kg per hectare. Punjab is the leading province in lentils which contributes 46.7 percent and 42.8 percent in respect of area and production respectively. Major lentil producing belt in Punjab is the Barani tract. However, it is also cultivated in the Narowal district of the rice-wheat cropping system. Yield as well as area of lentils has decreased from 1998 onward. According to literature, cultivation of low yielding local varieties, old lentil production technology, climate changes (for example untimely rains) and weeds are the main reasons for declining trend of lentils. The present study was planned to work out the cost of production of lentils in Narowal district to see whether it is a viable enterprise.

The average land holding in the area was 16.26 acres with domination of owner-cum-tenant operated farms. After wheat, lentil was the second major crop of Rabi season by occupying more than 13 percent of total cropped area. Desi lentils with more than 69 percent area of lentils were among the major varieties. Masoor-93 was the only recommended variety planted by growers on about one fourth of the area of lentils. The average yield of lentils was 6.79 maunds per acre. Total cost of production for an acre of lentil was Rs. 21,883 with gross revenue of Rs. 25,299 per acre. The farmers of the area were earning Rs. 3,416 and Rs. 15,416 as net income with and without land rent, respectively. Majority of the respondents (71.7 percent) reported a decline in area under lentils during the last 5 years. Farmers reported that lower yield of lentils followed by higher profitability of wheat crop were the main reasons for decline in area of lentil. Harvesting and marketing issues were other reasons for decline in area. Promotion of use of certified seed of recommended varieties and modern production technology is suggested for enhancing lentil production. Moreover, provision of interest free loan to lentil farmers for use of full package of recommended technologies is suggested for increasing yield of lentil. The growers of lentils can get better output prices provided processing plant in the lentil producing area are promoted. Establishment of warehouses and storage facilities under public-private partnership may also increase the local viability of the lentils in the country.

A Critical Appraisal of Livestock Markets in Punjab: Evidence from Faisalabad

Market is a cardinal link in marketing channel connecting production area to consumption area of both villages and cities. Livestock is either traded at village level or in urban markets. Both small and large ruminants are bought and sold in the same market. However at some places, buffalo, cattle, sheep and goats are traded separately. At some places (bakkar mandi), only small ruminants are traded. Small or primary markets are present in the rural interior and generally held at some fixed day, whereas, the large or secondary markets are organized near the urban centres or on the main roads. This research study was designed to investigate the ownership, management and operation of newly established livestock market in Faisalabad (235 RB). Thirty buyers and sellers who traded animals in this market were selected randomly for the present study. Data from two market officials were also collected. Data were analyzed by employing descriptive statistics.

The newly constructed Faisalabad cattle market started its operation in August 2016 in village 235 RB (Niamuana) on an area of 46 acres. Necessary infrastructure including internal approach roads, auction platforms, sheds and amenities like water supply, sewerage, electricity, telephone facilities etc. were provided in the market. About 60 percent of cows and 34 percent of buffaloes were traded in the market. Small ruminants (goat and sheep) were basically traded by small farmers for their daily needs. Main buyers in the market were beoparies (50 percent) followed by butchers (43 percent). About 40 percent used motorcycle rickshaws for bringing the animals in the market followed by 37 percent Mazda (mini truck) and 17 percent were using trucks. Punjab government issued to each market administration a list and scale of fee / commission and other charges to be received from market intermediaries. The market managing authority charged Rs 500 for larger animals' sale and Rs 100 for small animals' sale (Goats and Sheep).

The respondents were inquired about the performance of the market managing and operating authority in discharging various duties assigned to them. Almost 30 percent of the respondents in Faisalabad market considered that managing authority ensured fair trade practices in the market. However, market infrastructure was incomplete and there was no facility of bank, post office, police

station and firefighting. Similarly, there were serious problems of cleanliness and hygiene, sanitation, congestion and encroachments within the market. On the basis of results, it is suggested that management authority should ensure fair trade practices in the market. Similarly, cleanliness and hygiene, sanitation, congestion and encroachments within the market need to be improved. Moreover, facility of bank, post office, police station and firefighting should be provided in the market.

Health Issues of Women Cotton Pickers in Multan Division: An Empirical Study

Women play an important role in agriculture in Pakistan, contributing almost 67 percent of share in agriculture, forestry, and fishing. Cotton picking is an important source of employment for rural women, providing supplementary income to rural farm and non-farm households. In Pakistan, women are involved in cotton cultivation from cotton sowing to cotton picking, with manual cotton picking being their major activity. Mostly non-farm household females are illiterate and cotton sowing and picking is their major activity. Cotton pickers in Pakistan face some serious health related problems due to heavy use of pesticides on cotton crop. Cotton pickers do not use personal protective measures and hence face serious health problems because of unawareness of pesticide risks and poor knowledge of personal protection. The present study was designed to investigate the health issues and other social problems faced by women cotton pickers. The study used cross-sectional data collected from Vehari and Multan districts during the cotton season 2020. Face-to-face interviews were conducted with randomly selected respondents (160).

Results reveal that majority of the women (56 percent) had no education, while 44 percent had primary education. Considering cotton picking experience, 41 percent women were involved in cotton picking for the last 10 years while (59 percent) women were involved in cotton picking for more than 15 years. More than three-fourth cotton pickers reported one episode of illness during cotton picking season. More than 23 percent cotton pickers reported falling ill over three times during cotton picking season. Majority of the respondents (55 percent) were not using any protective measures during cotton picking activities. Some cotton pickers (22 percent) reported the use of muffler/scarf/cloth as a personal protective measure for covering their face, 12 percent were wearing shoes, and 11 percent were using gloves during cotton picking.

As reported by the cotton pickers, health issues in descending order are eye irritation, skin infection/rashes, headache, flue/fever, cough, abdominal pain and sleeplessness etc. The use of protective measures was positively correlated ($P < 0.05$) with education and years of experience in cotton picking. Increasing formal education and implementing training programs for the use of personal protective measures are recommended to reduce health risk and health cost among female cotton pickers.

DIRECTORATE OF SCIENTIFIC COMMUNICATIONS AND PUBLICATIONS

Directorate of Scientific Communications and Publications (DSC&P) progress report during 2020-21 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 provided the facility of Video recording for different crops under PSDP, PM Emergency Program (Wheat, Rice and Pulses), Canola, Garlic, Horticulture, Poultry, Fisheries and Livestock at NARC. DSC&P produced 26 documentaries related to agriculture technologies, arranged 15 TV talk shows/news reports for the projection of PARC achievements, video recording to PARC field research activities from sowing to harvesting of 5 crops and video recording, editing and audio facility for more than 32 important function, events, meetings, training sessions, exhibition, important visits of dignitaries at National Agricultural Research Centre. 4455 photographs were snapped for field/lab experiments, and 77 significant events were covered.

PARC Website

PARC Website is being maintained and updated regularly. The website is updated based on the information provided by different Centres, Institutes, Directorates, Programs of PARC and Directorate of Public Relations & Protocol.

NARC Library

NARC library serves as the primary source of knowledge for scientists, researchers and students in

the field of agriculture and allied subjects. During the year sixty-three new books/documents and 107 journal issues were added to library stock. 549 books/documents were added to the digital library. Thirty-one books/documents were issued to library members. Six hundred and fifty-three users visited the library during the reported period. 1277 reprints were provided to scientists and students. Union Database of Journals was updated 182 new volumes and 258 issues, besides its updation by participating Libraries. Moreover, Information of 1311 Pakistani published agricultural research articles/documents were shared with the international scientific community by sending input to FAO AGRIS database.

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. The Journal is regularly published and accessible online.

PARC Annual Report

PARC Annual Report is a regular activity of DSC&P that is published and uploaded on the PARC website, which can be viewed and downloaded at the given URL: <http://www.parc.gov.pk>.

PARC Newsletter

PARC Newsletter is published quarterly, uploaded on the PARC website and widely circulated to national as well as international partners. During the year 02 issues of Vol. 32 (3-4), 2020 and 02 issues of Vol. 33 (1-2), 2021 were published and available online on the PARC website.

AGRICULTURAL ENGINEERING DIVISION

ON-GOING DEVELOPMENT PROJECTS

Tractor-mounted maize planters

Maize is the third most important cereal crop of the country after wheat and rice. Maize crop is now mainly grown on beds or ridges. Bed/ridge sowing not only improves the irrigation efficiency, but also develops a good root structure of crop. In the Punjab, planting of grain maize is accomplished by hands on prepared ridges for which extensive labour force (women labour) is employed. Manual dibbling is an expensive planting method and gives uneven planting depth and spacing. The yield of crop is affected due to labour shortage in the season. All these factors contribute to a decreased productivity and a low profit of the farmer.

Objective: The objective of this project was to develop, adapt and introduce manual and tractor-mounted precision maize planters in maize growing areas of the country.

Achievements: In this regard, one manual maize planter was designed and developed at AEI. Three manual planters were identified and procured from the international market. Based on the performance of manual planters, a tractor-mounted precision maize planter was developed and field tested. The row to row distance was about 60 cm and plant to plant distance was 15 cm. The machine can plant one acre in one hour. The sowing depth was 2-5 cm. The planter was tested at Chiniot, Faisalabad, Sahiwal, Sheikhupura, Multan, Khanewal and Vehari districts. The planter was demonstrated to maize growers at Vehari district. The tractor-mounted bed planter can plant one acre per hour and its precision is more than 95%. The crop stand planted with this machine is very uniform and gives more yield than manually planted crop.

Impact: 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.



Testing and demonstration of manual and tractor-mounted maize planters

Groundnut Digger-Inverter

In Pakistan, traditional methods are used to harvest the groundnut crop when 75 % pods are matured. Mostly, the crop is dug manually using a khurpa, kasola or a spade and pods are collected manually from the soil as much as possible. This is a very labour-intensive and time-consuming operation. Furthermore, financial loss occurs due to ineffective digging because a significant amount of crop remains in the soil. A groundnut digger was also introduced by AEI, PARC, but a massive labour is needed to invert the crop manually. Lack of appropriate technology and efficient harvesting are the factors resulting in a lower groundnut crop productivity.

Objective: The objective of this project was to adapt a groundnut digger-inverter according to our local groundnut farming conditions and available tractor size.

Achievements: The imported machine was extensively field tested in the groundnut growing areas



Testing of groundnut digger-inverter

of the Pothohar region and the performance was demonstrated to end users. The machine was modified to accustom it according to our local available tractor size, as the machine is mounted-type, which needs extra front load on tractor as well as needs transportation tyres. The machine performs crop digging, shaking and inverting in one go.

Impact: The economic impact of this machine is very significant. It reduces digging losses up to 20% and increases yield up to 10%. Similarly, the income of farmer is also increased by 10%.

Ispaghul processing machinery

Ispaghul or psyllium (*Plantago ovata*) crop is cultivated in Thar Parkar and Cholistan areas of Sindh and the Punjab provinces of the country. The crop is threshed using manual beating and winnowing in the air. The average yield of the crop is about 8-10 maunds per acre. Threshed seed contains lot of impurities like dust, straws, stones and weeds. The raw seed is cleaned by passing it through different sieves. The seed is de-husked using "Chakkis" to detach husk from seed. The mixture of detached husk and seed is separated through winnowing method using a pedestal fan.

Objective: The objective of this project was to mechanise ispaghul processing using innovative machinery that can process high quality ispaghul husk.

Achievements: To achieve this objective, Agricultural Engineering Institute designed and developed indigenous ispaghul cleaning, de-bearding, de-husking and classifying machines. The performance of machines was tested at NARC. The air classifier separates the husk in three grades: powder, broken husk and whole husk. The de-husker units separate husk from seed and separate seed from husk in single operation. The complete processing plant was tested and demonstrated at



Ispaghul processing machinery developed by AEI, NARC, Islamabad

Hasilpur. For commercialisation of this technology among stakeholders, a small unit was gotten fabricated from the private industry comprising, four de-husking units, a cleaner and a classifier. The unit was installed at NARC for product development, demonstration and commercialisation purpose. The complete processing plant consists of 16 de-husking units and conveyors for continuous processing of ispaghul. The complete ispaghul processing plant can process about 1.0 tonne of seed in 10 h shift.

Impact: The processing cost and income of complete ispaghol plant 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.

Productivity Enhancement of Wheat – Pak Seeder

The rice-wheat growing districts in the Punjab are Gujranwala, Sheikhupura, Hafizabad, Narowal, Kasur, Lahore and Sialkot. Total rice-wheat area in the Punjab is 1.25 million hectares, which is 57% of the total rice-wheat area in the country. For enhancing wheat productivity, timely sowing of crop is very important factor. In the rice-wheat area of the Punjab, rice crop is mainly harvested using a combine harvester leaving very heavy residue and stubbles in the field. Handling of combine harvested paddy residue has been becoming a great concern to the farmers in rice-wheat cropping system and sowing of wheat crop is vulnerable to delay. Generally, the rice residue is burnt in the fields, which is an easy and cost-effective method of straw disposal. However, burning of residue not only results in loss of precious crop nutrients, but also poses a great threat to the environment, human health and economy. The smog restricts road and air traffic and causes respiratory problems in humans and animals.

Objective: The objective of this project was to refine rice residue management machinery and promote these technologies in rice growing areas of the country.



Field trials of Pak Seeder and other rice residue management machinery

Achievements: Agricultural Engineering Institute (AEI) of Pakistan Agricultural Research Council (PARC) has developed a rice residue management technology called as Pak Seeder, which can directly sow wheat crop in the combine-harvested paddy fields with minimal disturbing of soil. Pak Seeder is a resource conservation technology and rice-wheat growers can conserve soil, residue and water their resources, time and money by adopting this technology. This technology not only improves soil biological and physical health, but also increases wheat and rice yield. Demonstration plots were established at ten sites in rice-wheat growing areas, such as Gujranwala, Gujrat, Hafizabad, Sheikhupura and NARC using Pak Seeder, zero-tillage drill, rice straw mulcher, bed planter and fertilizer band placement drill. Pak Seeder and rice straw mulcher was very much appreciated in the farming community that is the solution of straw burning.

Impact: These resource conservation technologies can enhance crop yield up to 10%, reduce nutrients loss of the soil and save environment from smoke pollution. These technologies will help reduce the smog problem in the country.

Onion Seed Planter

Onion is sown in two cropping seasons, autumn and spring. For spring crop, nursery of onion is sown, which is then transplanted in the field manually. For autumn crop, nursery raising is also difficult due to hot month of June. Mostly farmers in the Punjab province, bring onion seedlings from Sindh province. Due to hot summer, 30-40% seedlings die before their transplanting. To overcome this menace, onion production in autumn is now being done by set sowing. Sets are small onion of about 17-21 mm diameter, directly sown in soil. In Baluchistan, onion cultivation is done by direct seeding of onion seed by broadcasting. All these methods of nursery sowing, set sowing and broadcasting methods are manual. These methods require a lot of manpower and it is a continuous fatigue on farmers from nursery raising to bed shaping, transplanting and harvesting.

Objective: The objective of this project was to develop a tractor-mounted machine for sowing of onion seeds for set production purpose. The onion seed is very tiny, which requires specially seed metering mechanism that could handle this small seed.



Testing and demonstration of onion seed planter

Achievements: The machine was developed at AEI, which consists of furrow openers, a metering mechanism and a bed shaper. The machine can sow seed simultaneously in 7 rows with row spacing of 3 inches for onion set production while it could also be used for direct sowing in 3 rows with spacing of 6 inches on raised bed of same specification (21 inch). The metering mechanism is consisted of rollers with chain sprocket mechanism. There are 7 rollers on both side of the shaft having diameter of 2.5 inches each. The cavity on each of the roller is according to the seed dimensions. The machine was tested at farmers' fields and successfully demonstrated to farmers and local agricultural manufacturers in Multan.

Impact: The machine can save onion planting labour and give better yield to farmers by set production method. Sets of uniform size can be produced by using this machine.

Postharvest Processing of Peach

Postharvest processing is an integrated function of harvesting, cleaning, grading, cooling, storing, packaging, transporting and marketing. The rapid cooling of peach after harvest is very important to remove field heat of the produce. Currently in Pakistan, peach is marketed without any washing. The quality losses of peach can be reduced by putting it in cold water or in refrigerated storage for some time. After washing air-dryers are used to remove moisture from the fruit surface. Another critical factor for reducing postharvest losses in fruit is the introduction of a proper sorting and grading system. In Pakistan, most of the peach is transported in local market without initial sorting and grading, which is causing great losses to farming community. Sorting and grading is mainly done manually or by automatic grading lines. Size grading can be done subjectively (visually) with the use of standard size gauges. Round produce units can be easily graded by using sizing rings. Similarly,

packaging provides the cushioning effect to the produce and saves it from external injury. In Pakistan, like other fruits peach is also transported either in bulk loaded on truck or by packing in paper/wooden boxes without performing any initial postharvest processing operations. By applying postharvest processing interventions, we can reduce postharvest losses, present similar quality fruit in a carton box and increase the shelf-life of the produce.

Objectives: The objective of this project was to introduce postharvest processing methods initially for peach fruit to reduce postharvest losses and increase the income of fruit growers. The processing methods will be extended to other fruits and vegetables so that the postharvest losses in fruits and vegetables can be reduced.

Achievements: Required peach post-harvest machinery was identified from china and local market with complete specifications of machinery. The procurement of peach postharvest machinery is under process. The machines will be tested and demonstrated in the fruit growing clusters in the Khyber Pakhtunkhwa.

Impact: About 10-15 % losses of the peach fruit would be reduced. The shelf-life of peach will be increased and its export will also be increased.



Testing and evaluation of peach processing machinery

Productivity Enhancement of Rice -Rice Mechanization

Rice is a relatively less mechanised crop as compared with wheat in Pakistan. Currently, three rice sowing methods are being adopted in the country, such as manual transplanting, use of transplanting machines and Direct Seeded Rice (DSR). The manual transplanting is laborious and time consuming process and it provide less output as compared with mechanised transplanting. The plant population achieved by manual transplanting is 50% less as compared to mechanised transplanting, which makes mechanised transplanting more economical solution. The harvesting of rice is carried out manually, by using reapers and wheat combine harvesters. The use of wheat combine harvesters for rice harvesting results in reduced grain output and increased breakage of rice grain during milling operation. The grain damage can be reduced if properly designed rice kits are installed on them. The current project was initiated under Prime Minister's National Agriculture Emergency Programme to enhance productivity of rice. The mechanization of rice crop sowing and harvesting is focused for crop production enhancement.

Objectives: The objective of this project was to refine seed drill of direct sowing of rice. The other objective was to encourage progressive farmers/entrepreneurs for starting rice nursery raising and mechanized transplanting business and to launch awareness campaign regarding adoption of head-feeding combine harvesters for harvesting of rice crop.

Achievements: The direct seeded rice (DSR) drill was field tested and evaluated 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. The modified drill was tested during rice season and its performance data was recorded. Meetings were held with progressive farmers/entrepreneurs already involved in nursery raising and mechanized transplanting process. The service providers for rice machinery were encouraged to use head-feeding combine harvesters for rice harvesting. The benefits of using head-feeding type combine harvesters were briefed to the service providers. Some farmers and entrepreneurs were identified and encouraged to start nursery raising and mechanical rice transplanting business.



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

Impact: The improved DSR drill will help to maintain the proper seed placement and better yield of the crop. The mechanized rice nursery raising, rice transplanting and harvesting will help to enhance the productivity of rice up to 10-20%. 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.

PLANNING AND DEVELOPMENT DIVISION

Planning and Development Division (P&DD) with its three directorates is supporting agricultural research by designing, processing, monitoring and evaluation of development projects funded under (a) Public Sector Development Program (PSDP); (b) Agricultural Linkages Program (ALP), based upon competitive research grant system and (c) Memorandum of Understanding funded projects (MoU). PARC since its establishment has been instrumental in providing the much-needed research funding to all components of the National Agricultural Research System (NARS) for the improvement of research and development efforts. PARC through diverse efforts is also contributing in bringing significant improvement in the agriculture productivity improvement and poverty alleviation. It has been playing significant role in NARS infrastructure improvement and human resource development by availing funding from multilateral donors. In the following paragraphs the performance of P&DD in term of projects appraisal, implementation & desk monitoring and review & evaluation has been summarized.

APPRAISAL, PROCESSING AND APPROVAL OF PROJECTS

Agricultural Linkages Program

- i. Under ALP 9th Batch 1579 concept papers have been received and are under review/ appraisal after short-listing of projects.
- ii. During the year 2020-21, one meeting of Board of Directors was convened in which 22 projects were approved for funding.

Public Sector Development Program

- i. Two Projects were completed titled, “AZRI DI. Khan” and “National Pesticides Residues Monitoring System in Pakistan” during FY 2020-21.
- ii. 15 New project proposals were submitted to M/o NFS&R for approval of competent forum. (CDWP, DDWP, ECNEC). However, One project titled, “Strengthening, up-gradation and accreditation of National Labs in compliance with national and international standards on food quality, safety and SPS requirements” principally approved by DDWP and an allocation of Rs. 324.118 million has been made during CFY 2021-22.
- iii. Seven project proposals were submitted under Accelerated Agricultural Development of Balochistan.
- iv. Prepared/approved online Cash Plans & Work Plans of 10 On-going PSDP funded projects.
- v. Conducted five Steering Committee and Four Technical Committee Meetings during FY 2020-21.

Research Agreement (MoU type) Projects

- i. Overall 15 research agreement projects (MoU type) were ongoing during the 2020-21. The MoU section of PM&E has processed and revised administrative approval of 14 projects for revision/re-appropriation of budget breakup and extended the project duration of different MoU projects as desired by the NARC/PARC scientists 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

Plant Sciences	Animal Sciences	Natural Resources	Social Sciences	Agricultural Engineering	Total
06	01	03	05	0	15

(ICARDA), Royal Botanical Garden (RBG), Kew UK, CABI-Pakistan, International Atomic Energy Agency (IAEA), Punjab Agricultural Research Board (PARB), NSLP (PSF) etc.

ii. MoU type Projects implemented in 2020-21.

- iii. The MoU section has also processed 20 project proposals and concept papers to the different local and international donors like FAO-Turkey, JICA, NSLP (PSF), German Academic Exchange Service (DAAD) 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 of the world. Some of the research agreements with international organization are underway for implementation in the future.

Projects Implementation

Regular monitoring is an essential management practice which play an imperative role in the successful implementation of projects and programs. To have an oversight on the implementation of the on-going projects P&DD is regularly reviewing the financial & technical progress of projects through involving Finance & Technical Divisions and solving day to day issues regarding the revision of projects, change of PIs, revision of budget, releases of funds, inspection and handing over /taking over of capital assets on completion of projects, preparation of annual cash plan of PSDP projects etc. The detail of completed and on-going projects under Agricultural Linkages Program (ALP) is presented in table 1. Forty-five projects had been completed with total cost of Rs.244.585 million during the year 2020-21 under various disciplines. There are 98 on-going projects with total cost of Rs.601.655 million. Among the on-going projects, the maximum 38 number of projects are under Plant Sciences and three under Social Sciences discipline.

Table-1: Discipline wise completed and of on-going projects under ALP during 2020-21

(Rs. in million)					
S#	Discipline	No. of Projects Completed	Total Cost	No. of Projects On-Going	Total cost
1.	Plant Sciences	27	154.054	38	240.557
2.	Animal Sciences	11	49.900	33	189.721
3.	Natural Resources	04	24.705	16	89.064
4.	Social Sciences	0	0	03	12.63
5.	Agricultural Engineering	03	15.926		69.683
TOTAL		45	244.585	98	601.655

Table-2: Region wise implemented and monitored on-going projects during 2020-21

S#	Discipline/ Region	Plant Sciences	Animal Sciences	Natural Resources	Social Sciences	Agricultural Engineering	Total
Agricultural Linkages Program (ALP)							
1.	NARC	15	12	06	02	05	40
2.	PARC Outstation	10	0	0	01	01	12
3.	Other Federal	04	02	02	0	0	08
4.	Punjab	04	13	07	0	0	24
5.	Sindh	0	0	0	0	0	0
6.	Khyber	04	02	0	0	02	08
Pakhtunkhwa							
7.	Balochistan	0	02	0	0	0	02
8.	Gilgit Baltistan	0	0	0	0	0	0
9.	AJ&K	01	02	01	0	0	04
SUB -TOTAL		38	33	16	3	8	98

COORDINATION AND MONITORING DIVISION

Coordination and Monitoring Division is established in pursuance of Independent Third Party Evaluation Report and post devolution scenario. The C&M Division consists of two Directorates; Coordination and Human Resource Development. The functions of this Division include; i) coordination between PARC and national agricultural research systems of various countries; and UN/CGIAR/US based agricultural research agencies (International Development Partners), ii) coordination and facilitation of research at national level, and iii) identification of training needs (local/foreign) for NARS and arrangement of pre-service and in service training along with budget & placement proposals.

The Coordination and Monitoring Division (C&MD) has 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 smallholder 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. During 2020-2021, this Division also facilitated in signing 02 MOUs/ Agreements with international and 06 with national organizations.

The CMD also deals in capacity building in terms of Post Doc., Ph.D. and M.Sc. levels besides other long/ short term trainings, visits for meetings/ symposia etc. During 2020-2021, 02 scientist obtained PhD and 02 MSc degrees from foreign countries. Similarly, 06 scientists obtained PhD, 02 M. Phil, and 02 scientists obtained Master degrees from Pakistani Universities. During the same period, due to COVID pandemic, most of the (foreign and local) short-term trainings in virtual format, in the areas of Poultry Production & Health, Plant Genetic Resources, Sustainable Mechanization for Smallholder Farmers, Vegetable Breeding for the Tropics, R&D Postharvest & Processing, were imparted on 109 scientists.

FINANCE DIVISION

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 the other organizations.
- iii. Foreign aid and loans obtained or raised with the approval of the Federal Government.
- iv. Receipts from other sources.

An Overview of PARC's Budget

Budget Head/Funding Source	2019-20 Actual	2020-21		(Rs. in million)
		Budget	R.B	
Current Expenditure (GOP Grant)	3001.540	3159.215	3965.800	
Own Resources (PARC)	67.950	80.000	69.542	
Total :	3069.490	3239.215	4035.342*	
Development Expenditure (PSDP)	1483.453	2191.601	1940.975	
Agricultural Linkage Program (ALP)	189.854	310.606	310.606	
Memorandum of Understanding (MOU's)	17.215	44.181	24.517	

*Supplementary Grant of Rs. 806.585 million has been included in Revised Budget of Non- Development 2020-21 which has been received on account of Payment of Pension arrears and commutation to pensioners of PARC.

Current Expenditure

Objects	2019-20 Actual Exp	Budget	2020-21		(Rs. in million)
				Revised Budget	
Establishment Expenses	2132.600	2328.000		2328.007	
Employee Related Benefits	602.207	600.263		1406.848	
Operational Expenses	334.683	310.952		300.487	
Total :	3069.490	3239.215		4035.342	

Development Expenditure Budget

Development Expenditure budget of Rs. 2,191.601 million was allocated for the following on-going PSDP Projects for the Financial year 2020-21 which was subsequently revised to Rs. 1,940.975 million. An expenditure of Rs. 1,926.807 was incurred. The detail of projects is as under:-

On-Going Projects

Sl. No.	Title of the Projects	Approval Date/Forum	Total Budget	Revised Budget 2020-21	Actual Expenditure 2020-21	(Rs. in million)
1.	National Pesticides Residues Monitoring System in Pakistan (PARC)	DDWP 06-08-2013	325.000	262.871	256.149	
2.	Up-gradation of AZRI D I KHAN	CDWP 30-04-2018	95.000	47.037	44.652	
3.	Strengthening/Up-Gradation of Agriculture and Livestock Research System of (AZRI) Umerkot, Sindh	DDWP 03-05-2017	116.601	106.601	106.454	
4.	Productivity Enhancement of Pulses	ECNEC 29-08-2019	300.000	199.412	198.852	
5.	Productivity Enhancement of Rice	ECNEC 29-08-2019	350.000	314.750	313.946	

6.	Productivity Enhancement of Sugarcane	ECNEC 29-08-2019	150.000	141.900	141.239
7.	Productivity Enhancement of Wheat	ECNEC 29-08-2019	625.000	547.600	547.592
8.	Commercialization of Potato Tissue Culture Technology in Pakistan	DDWP/17-08-2020	50.000	44.900	43.782
9.	Sino-Pak Agricultural Breeding Innovation Project for Rapid Yield Enhancement	DDWP/15-05-2020	150.000	254.240	253.220
10.	Upgradation of Agro-Ecological Zones for Pakistan through Satellite and insitu Data Mapping	DDWP/05-08-2020	30.000	21.664	20.921
TOTAL			2191.601	1940.975	1926.807

Agricultural Linkage Program (ALP) Budget 2020-21

Keeping the principal amount Rs.1300.000 million of the Agricultural Research Endowment Fund (AREF) ALP intact, the funds generated through income from such investments are used to finance the research activities/ program under ALP. The position of utilization of ALP funds has been tabulated hereunder:

Province-wise Budget allocation of projects is given as under

(Rs. in million)

Sr. No.	Location	Budget 2020-21		Revised Budget 2020-21*	
		Total Number of Project Executed	Total Amount	Total Amount	Total Amount
1	Federal	55	83.057	114.809	
2	Punjab	53	52.362	62.794	
3	KPK	24	22.894	30.111	
4	Sindh	07	8.169	8.588	
5	Balochistan	04	3.988	5.643	
6	AJK.	04	5.249	6.494	
7	PARC, H.Qtr	01	42.233	42.233	
8	Block Allocation	Block Allocation	86.000	33.280	
9	Sponsoring of Short Term Exchange of Agri. and Scientist and Experts		0.000	0.000	
10	Scientist Award		1.500	1.500	
11	Membership Fee to Foreign Agencies		5.154	5.154	
TOTAL		148	310.606	310.606	

*As on 22-02-2022

MoUs

A total of 10 projects at a total budget of Rs.44.181 million were approved under MoU's with different National and International organizations for the Financial year 2020-21. An overview of expenditure for F.Y 2019-20 and Budget and Revised Budget of F.Y 2020-21 is as follows:

MoU's 2020-21

(Rs. in million)

Objects	2019-20 Actual Exp	2020-21 Budget	Revised Budget 2020-21
Budget	17.215	44.181	24.517
No. of Projects	09	10	10

An Overview of PARC's Budget

(Rs. in million)

Budget Head/Funding Source	Revised Budget 2020-21
Current Expenditure (GoP Grant)	3965.800
Own Sources (PARC)	69.542
Total (A)	4035.342
Development Expenditure (PSDP)	1940.975
Agricultural Linkage Program (ALP)	310.606
Memorandum of Understanding (MoU's)	24.517
Total (B)	2276.098
GRAND TOTAL (A+B)	6311.440



Syed Fakhar Imam, Federal Minister for NFS&R is addressing to the participants of World Food Day-2020 at NARC on Oct 16. Mr. Omar Hamid Khan, Federal Secretary for NFS&R, Ms. Mina Dowlatshahi, FAO Rep. Dr. Muhammad Azeem Khan, Chairman PARC, Mr. Shahnawaz, Country Rep. OXFAM and Mr. Chris Kaye, Country Director / Rep. WFP Pakistan are also sitting on the stage on the occasion.



Rao Muhammad Ajmal Khan, Chairman NA Standing Committee on NFSR is presiding over a meeting of the Committee in the presence of Syed Fakhar Imam, Federal Minister for NFS&R, Mr. Ghufran Memon, Federal Secretary for NFS&R, Dr. Muhammad Azeem Khan, Chairman PARC held at NARC on Jan 11.



**Pakistan Agricultural Research Council
Plot No. 20, Sector G-5/1, Islamabad**