



# ANNUAL REPORT 2022-2023



Pakistan Agricultural Research Council



*Tariq Bashir Cheema, Federal Minister for National Food Security and Research, Zafar Hassan, Federal Secretary, NFS&R, Dr. Ghulam Muhammad Ali, Chairman PARC, Dr. Kauser Abdulla Malik, Former Chairman PARC/ Director ORIC, FCCO Lahore and Dr. Iqrar Hussain Khan, VC, University of Agriculture Faisalabad sitting on a stage during the Inaugural Session of National Dialogue on Agricultural Research held at NARC on May 02.*



*A group photo of Rana Tanvir Hussain, Minister for Education and Professional Training, Dr. Ghulam Muhammad Ali, Chairman PARC along with senior scientists and participants of National Dialogue on Agricultural Research at NARC on May 04.*

# PARC

## Annual Report

### 2022-23



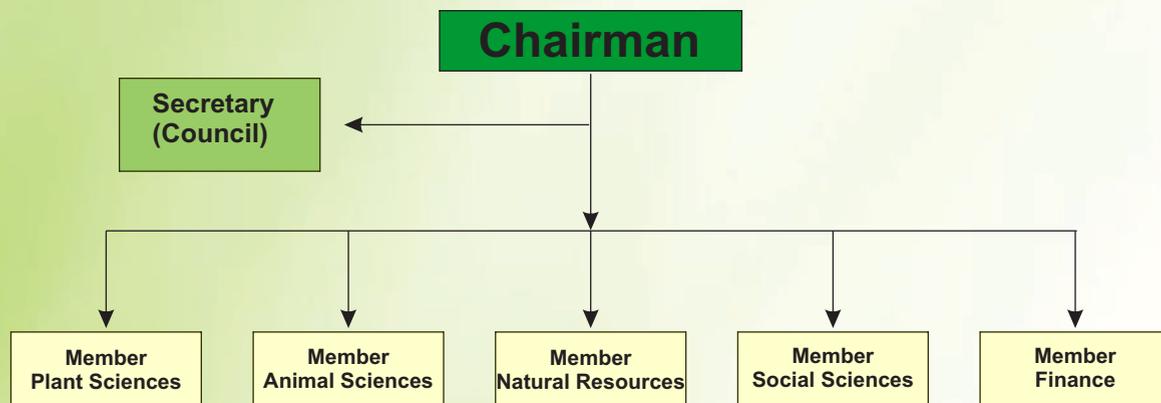
**PARC**

<http://www.parc.gov.pk>

## CONTENTS

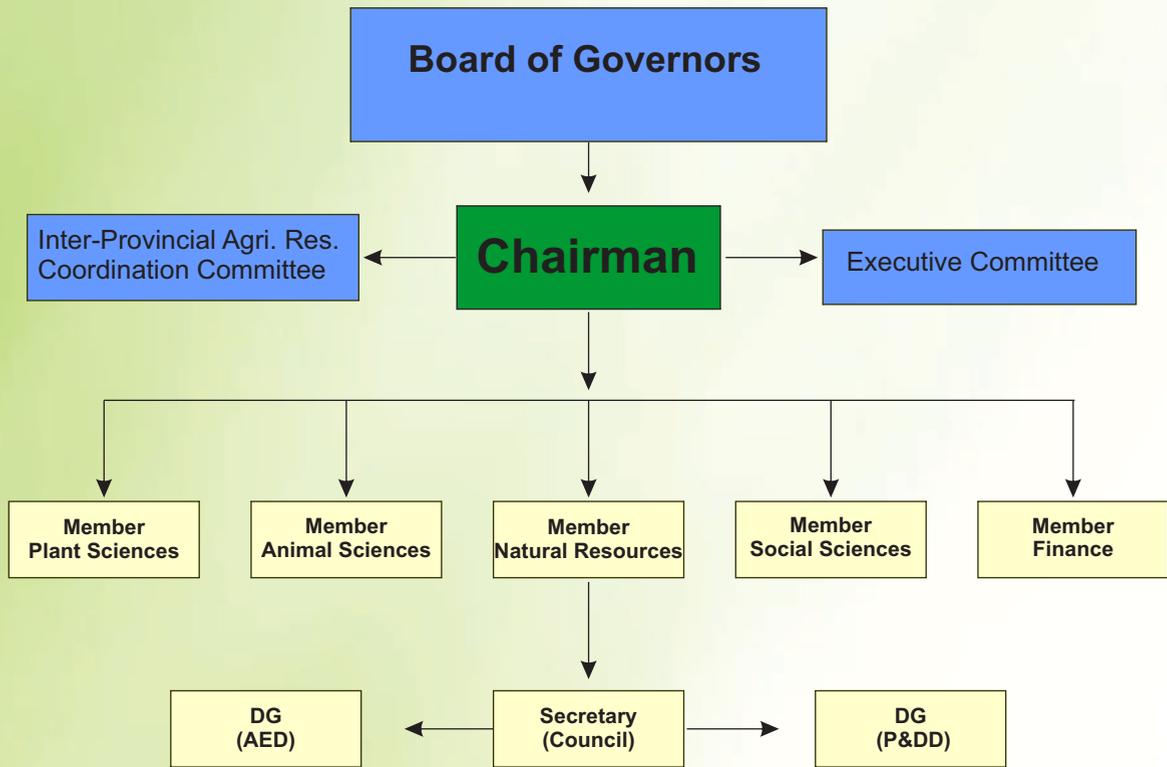
01	Plant Sciences Division	01
02	Natural Resources Division	30
03	Animal Sciences Division	45
04	Social Sciences Division	54
05	Agricultural Engineering Division	67
06	Planning and Development Division	72
07	Coordination and Monitoring Division	83
08	Finance Division	89

# Executive Committee Structure



President (BoG) Minister Incharge (MNFS&R)	
Ex-Official Member	Non-Official Member
Secretary MNFS&R	Member from Punjab
Chairman, PARC	Member from Sindh
Member (FC&CC) Planning Commission	Member from KP
Secretary Finance or Rep	Member from Balochistan
Whole Time Members 1. Plant Sciences Division 2. Natural Resources Division 3. Social Sciences Division 4. Animal Sciences Division 5. Finance Division	Member from GB/AJK
	Total BoG Member = 15

# Governance Structure



## Research & Development Initiatives

- **Establishment of New Research Programs**
  - Smart Farm Agriculture and Certification
  - Organic Agriculture and Certification
  - Bio-Safety Level-III Laboratory & Animal Vaccine Development
  - Agricultural machinery design through 3D CAD & CAM (CNC)
- Genomics based crop varietal development-Rice, Wheat, Sugarcane, Oilseeds, Pulses etc.
- Indigenous Potato variety Development and Nucleolus Potato Seed
- Development through Aeroponics
- Banana Tissue Culture
- Intelligent greenhouse and speed breeding
- Genetic Improvement of Livestock Breeds
- Controlled breeding through Laparoscopic AI
- Vaccine Development Against Lumpy Skin Disease
- Hybridization of vegetable seeds
- Small scale Agricultural Machinery with Korean collaboration
- Up-dation of agro-ecological zone

- **Ecology based high value crops**
  - GB-pine nut, walnut, cherry, kiwi fruit etc.
  - Sindh, Thatta - Banana, sugarcane
  - Balochistan - Pine nut, pistachio, olive, saffron
- Climate Smart agriculture - RDI for water scarce areas & diverse crop
- Establishment of State of art lab for the mitigation of aflatoxin
- Piloting regenerative agriculture
- Established mother block orchards of fruit plants
- In-vitro embryo production and transfer in Nili Ravi buffalo

### **International Collaboration**

- Aeroponic Greenhouses Established at NARC in Collaboration with RDA, Korea - 10 million USD
- **Partnership with KOPIA for a TCP collaborative project**
  - Aeroponic Greenhouse Technology
  - Post - harvest machinery/technology for chili crop
  - Ryegrass cultivars as winter fodder
- Pakistan-Korea Joint program on certified Seed Potato Production System (Rs. 950 million - 625 Korean and 325 million GoP)
- **New Programs with KOPIA**
  - Breed Improvement through Efficient Artificial Insemination in Cattle (0.15 M USD)
  - Seed Production of oat and rye grass as fodder (0.15 M USD)

## Picture's Gallery



A group photo of Dr. Ghulam Muhammad Ali, Chairman, PARC with Mr. Wu ZhongHua, General Manager, Hubei Allwin high tech seed company Ltd. China and the participants at NIGAB, NARC



Dr. Ghulam Muhammad Ali, Chairman, PARC, is inaugurating wheat sowing throw regenerative Agricultural Planter at NARC developed by Agricultural Engineering Institute, NARC,



A group photo of Dr. Ghulam Muhammad Ali, Chairman PARC with a delegation from Islamic Organization for Food Security during their visit at NARC



Rao Muhammad Ajmal, Chairman NA Standing Committee on NFS&R is chairing the meeting of the committee held at PARC Islamabad.



Dr. Ghulam Muhammad Ali, Chairman, PARC, are sitting on the stage during plant wise Plus Programme launch and Stakeholder meeting at NARC



Dr. Ghulam Muhammad Ali, Chairman, PARC is presiding 52nd meeting of Technical Advisory Committee of Board of Directors of ALP held at PARC



Dr. Ghulam Muhammad Ali, Chairman, PARC is chairing Variety Evaluation Committee meeting on wheat and pulses crops at PARC. Dr. Imtiaz Hussain, Member (PSD) PARC/Chairman VEC and other committee members are also present.



A group photo of Federal Minister for National Food Security & Research, Chaudhry Tariq Bashir Cheema, along with other participants during inauguration ceremony of Aeroponic Greenhouse virus free potato seed production complex at NARC



Dr. Ghulam Muhammad Ali, Chairman, PARC is being briefed by Dr. Malik Muhammad Yousaf, Director AZRI Bahawalpur about R&D activities at PARC, AZRI, Bahawalpur



Dr. Ghulam Muhammad Ali, Chairman, PARC is briefing to Dr. Habib Bukhari, vice Chancellor Kohsar University Murree about potato nucleus seed production tunnels during his visit at NIGAB, NARC



Dr. Ghulam Muhammad Ali, Chairman, PARC is presenting PARC shield to Mr. Mao, Chief Representative of Beijing Genomics Institute, South Asia, during his visit to NARC



Dr. Ghulam Muhammad Ali, Chairman, PARC is presenting PARC shield to Dr. Muhammad Galal Mohamed Ahmed, President of National Academy of Sciences, Sudan during his visit to NARC



Dr. Ghulam Muhammad Ali, Chairman, PARC are sitting on the stage on the occasion of two days National Conference on Efficient use of Fertilizers at NARC auditorium



Dr. Ghulam Muhammad Ali, Chairman, PARC is meeting with Mr. Asad Ullah Habib President/CEO ZTBL at NIGAB, NARC





Dr. Ghulam Muhammad Ali, Chairman, PARC in a meeting with Lt. Gen @ Amir Riaz, during his visit at NARC



Dr. Ghulam Muhammad Ali, Chairman, PARC and Mr. Asad Ullah Habib, President/CEO, ZTBL are exchanging files after signing memorandum of understanding between PARC and ZTBL at NARC



Dr. Falak Naz, Member Coordination, PARC and Mr. Meesaq Arif, Executive Director Intellectual Property Organization of Pakistan are signing Memorandum of Understanding



Dr. Ghulam Muhammad Ali, Chairman, PARC along with Member PSD, Member, NRD and other senior scientists of PARC and SARD are being briefed about wheat experimental blocks at SARC Karachi



Dr. Ghulam Muhammad Ali, Chairman, PARC addressing during a two days training workshop jointly organized by PARC and CIMMYT at NARC



Dr. Ghulam Muhammad Ali, Chairman, PARC sitting on stage during a stakeholders engagement workshop at NARC



Dr. Ghulam Muhammad Ali, Chairman, PARC meeting with Mr. Shaukat Ali Chadhar, Chairman Kisan Board and senior member of Kisan Board at PARC



Dr. Ghulam Muhammad Ali, Chairman, PARC is presenting PARC shield to professor Amir Mahmood, Dean, School of Business, Western Sydney University during his visit at PARC



Dr. Ghulam Muhammad Ali, Chairman, PARC in a meeting with professor Amir Mahmood, Dean, School of Business, Western Sydney University



Mr. Muhammad Ishaq, Secretary, PARC and Dr. Kaiser Shehzad, Project Manager Royal Cell Biotechnology Pakistan signing a letter of intent at PARC



Dr. Ghulam Muhammad Ali, Chairman, PARC in a meeting with ECO-Science Foundation Delegation during their visit at NARC



Dr. Ghulam Muhammad Ali, Chairman, PARC and Maj Gen. (Retd) Saleem Ahmed Khan, A/Vice Chancellor, NUNS signing a document of understanding at PARC



A group photo of members during 3rd joint coordination committee meeting of project "Capacity Development of Agriculture Extension services in Balochistan Province



Dr. Ghulam Muhammad Ali, Chairman, PARC in a meeting with FAO Country Rep. Pakistan



Dr. Ghulam Muhammad Ali, Chairman, PARC in a meeting with Owner/CEO, Drip Irrigation (USA/UAE)



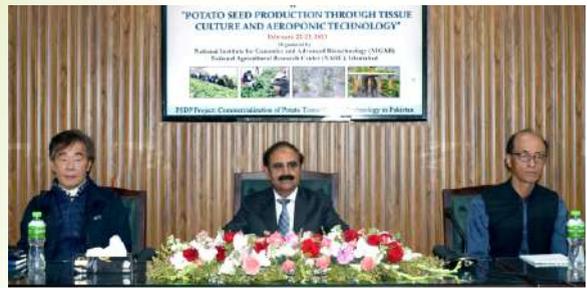
Dr. Ghulam Muhammad Ali, Chairman, PARC is a meeting with Mr. Sarkhan Sarkhanov, Chairman, State Foundation Seed, Ministry of Agriculture, Republic of Azerbaijan during their visit to PARC



Dr. Ghulam Muhammad Ali, Chairman, PARC is holding a meeting with Mr. Sami Muhammad, Mr. Erwin Bernhard and Mr. Salah Balla from Al-Shifa honey, Kingdom of Saudi Arabia



Dr. Ghulam Muhammad Ali, Chairman, PARC is chairing a meeting with Ms Seo Jung Oak, Chairman, OAKS CAF and high officials of OAKS at PARC



Dr. Ghulam Muhammad Ali, Chairman, PARC sitting on stage with Director KOPIA Pakistan Center during a stakeholder meeting at NARC



H.E. Donald Blome, U.S. Ambassador to Pakistan addressing the launching ceremony of "Fertilizer Right" project at NARC, Dr. Ghulam Muhammad Ali, Chairman, PARC and Dr. Shehzad Asad, DG, NARC are also attend the event



Dr. Ghulam Muhammad Ali, Chairman, PARC is presenting PARC shield to Dr. Shaista Sohail, Vice Chancellor Quaid-i-Azam University during her visit at NARC. Senior Scientists of PARC & QAU also witnessing the occasion

# Plant Sciences



## PLANT SCIENCES DIVISION

The Plant Sciences Division (PSD) is dedicated to undertaking, supporting, promoting, and coordinating agricultural research. It is responsible for executing activities in coordination, research, and development pertaining to crop improvement, crop management, plant protection, plant genetic resources, food quality, and value addition.

### National Coordinated Research

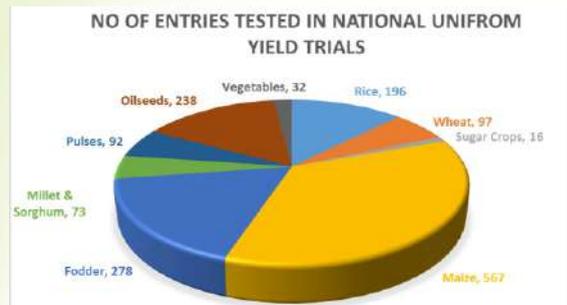
The Plant Sciences Division (PSD) oversees seven national coordinated research programs focusing on Wheat, Rice, Maize Sorghum Millet and Fodders, Pulses, Oilseeds, Sugar, and Horticultural crops. These programs are tasked with acquiring and distributing germplasm, conducting national testing, as well as planning and monitoring research activities in a coordinated manner. In accordance with the Seed (Amendment) Act, 2015, and Seed (Business Regulation) Rules, 2016, the Pakistan Agricultural Research Council (PARC) is responsible for the impartial evaluation of varieties/hybrids developed by the National Agricultural Research System (NARS) in the country.

#### Germplasm Sharing

In 2022-23, the Plant Sciences Division (PSD) disseminated over 6,329 local and exotic germplasms of Wheat, Rice, Maize, Sorghum, Millet, Potato, Sugarcane, Soybean, and Pulses to relevant partners within the National Agricultural Research System (NARS). This initiative aimed at facilitating the development of improved and climate-resilient varieties/hybrids.

#### National Testing

The PSD conducted more than 40 National Uniform Yield Trials (NUYTs) of 35 crops across 135 locations nationwide, evaluating a total of 1,589 candidate varieties/hybrids spanning field and horticultural crops. The number of trial locations for specific crops varied, ranging from 4 to 50 locations across the country.



#### Variety Evaluation Committee (VEC)

Eight Variety Evaluation Committee (VEC) meetings were conducted, during which a comprehensive review of 382 proposals for candidate varieties/hybrids took place. Following a thorough discussion, a total of 143 high-yielding and disease-resistant hybrids/varieties, spanning crops such as wheat (02), rice (30), pulses (04), oilseeds (29), potato (14), maize, sorghum, millet, and fodder crops (64), were recommended. These recommendations were based on the two years' performance data gathered from National Uniform Yield Trials (NUYT), and the endorsed varieties/hybrids were subsequently proposed for enlistment by FSC&RD or registration by Provincial Seed Councils

#### Traveling Seminars

National Coordinated Programs organized Traveling Seminars on wheat, rice, pulses, and sugarcane, with the participation of 83 individuals from various institutions within the National Agricultural Research System (NARS).

I. A 12-day Traveling Wheat Seminar was conducted from February 28 to March 11, 2023. Around 25 wheat stakeholders from Research and Development (R&D) institutes participated. The seminar aimed to evaluate the crop growth and performance of advance wheat lines in NUYT across various ecologies. It was noted that the wheat crop exhibited better growth due to favorable climatic conditions, increased use of certified seeds, and

**Table 1. Details regarding varieties / hybrids recommended from VEC**

Name of Crop	No. of Proposals Presented	No. of Varieties/ Hybrids Recommended
Rice	113	23 Hybrid & 07 OPV Fine
Wheat	07	02
Maize, Sorghum, Millet & Fodder	108	47 Maize, 01 Sorghum, 16 Fodder crops
Pulses (Chickpea)	04	04
Oilseeds	34	04 Rapeseed, 17 Mustard & 08 Sunflower
Potato	28	14
Total	294	143

timely planting.

ii. A 15-day traveling seminar focusing on rice took place from October 10 to October 24, 2022. The event brought together 20 rice scientists from National Agricultural Research System (NARS) across the country. During the seminar, participants assessed Rice NUYT as well as observed rice fields in diverse ecologies.



iii. A Sugarcane Traveling Seminar spanning 11 days (November 20-30, 2022) was conducted, bringing together 15 sugarcane scientists from various Research and

Development (R&D) institutes and private sugar mills across the country. The seminar involved the assessment of Sugarcane NUYT and the observation of sugarcane fields in diverse ecological settings.

iv. Travelling seminars for Rabi season pulses (chickpea and lentil) was conducted involving 23 scientist from NARS system partners in 2022 and participants recommended ridge sowing of chickpea in Thal area of the Punjab and promotion of organic pulses in Balochistan.

**Annual Planning Meetings**

National Coordinated Programs arranged Annual Planning Meetings for wheat, pulses, and sugarcane, drawing the participation of over 50 individuals from diverse institutions within the National Agricultural Research System (NARS).

i. The Annual Planning session for Wheat, held on September 27-28, 2022, at NARC Islamabad, brought together over 50 stakeholders. The meeting focused on addressing wheat-related concerns and concluded with a recommendation that wheat breeders should actively engage in developing varieties through local hybridization programs. This approach was seen as crucial for enhancing wheat productivity in Pakistan.

ii. On January 29, 2023, the Annual Sugarcane Planning Meeting took place at PARC-NSTHRI Thatta. The meeting served as a platform to review the previous year's sugarcane

crop and strategize for the effective management of the newly planted crop.

iii. Annual Review Meeting was held in 2022, wherein progress and targets of AED, KP regarding pulses seed (25000 acres) and machinery (119 units) on 50% subsidy were discussed in detail.



## Field Crops Research

### Crop Improvement:

PARC released 03 varieties i.e., Wafaq-2023, NARC-SOY-2021 and sunflower hybrid, NARC-SUN-2020 during 2022-23.

I. A high-yielding wheat variety “**Wafaq-2023**” resistant to rust (leaf, yellow, and stem) and drought-tolerant, has been approved by the KP Seed Council for cultivation in rain-fed areas of Khyber Pakhtunkhwa and Punjab provinces. It boasts a yield potential of 8.0 tons/ha and a protein content of 14%.

ii. A high yielding, disease resistant and climate adapted soybean variety “**NARC-SOY-2021**” has been approved by KP seed council for general cultivation with yield



potential of 3000 kg ha<sup>-1</sup>.

iii. A high yielding sunflower hybrid “NARC-SUN-2020” recommended from VEC for general cultivation with yield potential 4000 kg ha<sup>-1</sup>.



**Wheat**

I. In NUWYT 2022-23, Wheat Program contributed eight promising lines (6 bread wheat and 2 durum wheat). Advance lines NR-583 and NR 559 ranked first and third in all over Pakistan and produced 3696 kg ha<sup>-1</sup> and 3596 kg ha<sup>-1</sup> grain yield respectively. Other advanced lines NR-582 ranked 8th (3501 kg ha<sup>-1</sup>), NR-566 ranked 11th (3456 kg ha<sup>-1</sup>) on the Pakistan.

ii. The Wheat Speed Breeding facility at NARC is the only one in Pakistan, and it was utilized for generation advancement to expedite the varietal development process. The facility played a crucial role in accelerating wheat generations, with the ability to complete a cycle in just 8 weeks. Sixty cross combinations were made, leading to the advancement of 210 different wheat filial generations (from F2 to F6). Additionally, 80 populations were advanced for various national and provincial institutes. As a result, 3000 head rows of 17



*Hybridization of wheat in Speed Breeding*



*Wheat Hybridization*

*Evaluation of elite wheat lines*

populations (F6 generation) were grown in the field.

iii. About 755 crosses were attempted to develop diverse recombinants involving appropriate wheat parental material. Maintained 1440 populations at different filial generations (F1-F6) and selected about 802 desirable populations for advancement and yield testing. About 2026 F7 head rows were planted at NARC and 163 genetically stable lines were selected on the basis of performance. Evaluated 765 elite bread/durum wheat lines for yield, adaptability and other traits of economic importance in station yield trials and regional yield trials (RYT). Based on the performance at various stages of testing, 24 advance bread

wheat and 02 durum wheat lines were provided to CDRI, NARC for testing against different diseases in National Wheat Diseases Screening Nursery (NWDSN). Four (04) bread-wheat lines sent to FSC&RD for DUS study and 18 advance lines contributed to Provincial Uniform Yield Trials (PUYTs).

**Rice**

I. Five advance lines (RC22151, RC22158, RC22164, RC22168 and RC22169) were contributed to NUYT 2022-23 out of which 3 lines surpassed the checks (KSK 133 and IR6). Three lines have been added to 2<sup>nd</sup> year of NUYT and DUS.



*Field evaluation of NUYT candidate rice lines*

ii. 380 crosses combinations were attempted, 105 successful cross combinations were harvested. A set of 5 GSR lines and 4 coarse rice varieties have been crossed in line x tester mating design for hybrid vigor estimation and best combiner lines. 02 sets of 25 F<sub>2</sub> progeny and 51 F<sub>3</sub> progeny raised from seeds of succeeding generation. Generation advancement of F<sub>3</sub> progeny done and 37 F<sub>4</sub> progeny seeds harvested after selection for next season plantation. F<sub>4</sub> progeny of 04 commercial hybrids (Pride-1, WDR, LP-2 and LP-18) raised as reverse breeding and 10 panicles separately harvested from 10 selected plants as F<sub>5</sub> progeny for next cycle of selection. 160 F<sub>8</sub> progenies of fine basmati rice raised and 20 single rows were selected for next season trial plantation. Basmati cultivars were used in mutation breeding (four levels of gamma radiation (350Gy, 300Gy, 250Gy, 200Gy). Advanced Yield Trial (AYT) of 135 rice lines (70 fine 45 GSR & 20 course) 31 fine & 10 GSR line have been selected on the basis of higher yield (>8 tons/ha).



*Salinity screening for Rice*



*Physiological assessment*

**Sugarcane**

I. The promising sugarcane line Thatta-1909 selected for NUYT on account of better performance in terms of cane yield, sugar recovery and other characters of commercial worth.

ii. 3356 gram true fuzz was produced from 262 varieties/ lines (National and International) and 13000 gram fuzz was collected from different areas of extreme coastal

climate in Thatta, Badin and Sujawal districts. The fuzz was dried, packed and stored in deep freezer (-20 °C). 10500 seedlings were developed from locally collected Polly-Fuzz and bi-parent crosses. 366, 185, 187, 14, 12, 6 and 3 sugarcane clones/genotypes were maintained in single plant trial, 1<sup>st</sup> cycle, 2<sup>nd</sup> cycle, 3<sup>rd</sup> cycle, 4<sup>th</sup> cycle, preliminary yield trial, advanced varietal trial, NUYT first and second plant crop, respectively.

**Oilseeds**

I. Spot examination of 02 groundnut lines i.e. PG-1221, PG-1267 and 02 sesame lines i.e. SG-132, SG-133 conducted by Punjab Seed Council and KP Seed Council respectively.

ii. Contributed 22 advance lines/hybrids (06 Sunflower hybrids, 09 rapeseed-mustard lines, 03 Soybean lines, 01 Sesame lines and 03 Groundnut lines) to NUYT for national testing.

iii. Distinctness, Uniformity and Stability (DUS) data of mustard advance line (MS-57) and soybean advance line SA-7260 were recorded by FSC&RD. 20 new hybrid combinations each in sunflower and rapeseed were made.



SG-133

**Pulses**

I. The Pulses program contributed three advanced genotypes of Lentil (LS-18-01, LS-21-01, LS-21-02) to NUYT, and these lines were ranked 1st, 2nd, and 3rd out of 15 genotypes at 14 locations across the country. DUS studies spanning two years for the high-yielding Lentil advance line LS-18-01, which exhibits disease and shattering resistance, have been completed.

ii. A high-yielding advanced line of Mung bean, known for its tolerance to MYMV and CLS, was provided to NUYT under the name MSPS-119. This line achieved the 2nd rank among 18 lines across 15 locations throughout the country

iii. Advance lines of chickpea, lentil, mung and mash bean have been evaluated for selection of elite plant material for breeding program. 05 National Uniform Yield Trials (NUYT); 3 in Rabi (lentil, Chickpea Desi and Chickpea Kabuli) and 2 in Kharif season (Mung and Mash bean) conducted at 25 locations.



Field view of Mung bean: MSPS119

**Fodders**

i. 06 Oat and 04 Vetch advance lines were contributed in NUYT.

ii. 60 lines of oat germplasm selected on the basis of green fodder yield, lodging resistance, late maturing and dual purpose characteristics. 264 lines (Sorghum, 100 lines, Millet 110 lines, Sudan grass 21 lines, barley 30 lines and vetch 13 lines) evaluated to meet the fodder requirement of the country. Adaptability trials of 05 Korean rye grass lines GF, GF2, GC, GC2 and IR604 with one local check conducted. DUS of PARC-oat completed successfully.



Oat Germplasm



*Mott Grass Production*



*Vetch Production*

### Maize sorghum & millet

- i. One maize OPV (NARC Pops) was recommended in the 12th VEC meeting of 2022 matures in 105-115 days having yield potential of 5.5 ton/ha. Developed maize Doubled Haploid Lab for rapid inbred lines development.
- ii. Developed two maize isolation facilities.
- iii. Germplasm acquisition, crosses and filial generations in maize and millet.
- iv. 300 maize inbred lines were maintained, 96 crosses were attempted of synchronized lines and 26 inbred lines were selected on the basis of vigour and other desirable traits.
- v. 95 millet lines were maintained.
- vi. 70 maize OPVs of different categories (Yellow, White, Sweet & POP corn) were evaluated during spring 2023 and 02 OPVs namely OPV-7 (5.6 ton/ha) and OPV-8 (5.9 ton/ha) gave higher yield compared to check (5.1 ton/ha) were selected for PYT.



*Spot Examination of NARC Pops (Maize)*

### Plant physiology

- i. 240 lines of wheat, rice, maize, and mungbean germplasm were screened at germination, seedlings and reproductive growth stages in laboratory, greenhouse/glasshouse and field conditions with objective to identify genotypes tolerant to drought, heat and soil salinity.
- ii. 04 NUYT wheat lines and 03 advance wheat lines identified as heat tolerant (35-40 °C) at reproductive stage. 10 NUYT and 02 advance wheat lines were observed drought tolerant at (35% FC). 04 NUYT and 02 advance wheat varieties exhibited salt tolerant. 03 maize lines i.e. ILC-88, C2P-132001 and ILC-314 identified as drought tolerant at germination and seedling stage under PEG (20%) induced drought stress. 04 Mungbean lines identified as heat at flowering stage. 02 rice lines i.e. Chenab basmati and KSK-434 identified as tolerant to saline alkali soil.

### Crop Management

- i. Trials conducted at NARC for planting date experiments indicated that the highest wheat grain yield for wheat was attained when planted during the last week of October under rain-fed conditions.
- ii. 180 wheat demonstration plots were planted in the rain-fed areas of Potohar, Punjab, Khyber Pakhtunkhwa, Baluchistan, Sindh, Gilgit Baltistan, and AJK on farmer fields and research centers. Wheat demonstrations included zero tillage planting, planting of wheat on beds and ridges, showcasing improved wheat varieties, and wheat planting in cropping systems such as Sesbania-Wheat, Fallow-Wheat, and Mung bean-Wheat. The wheat grain yields were higher in demonstrations as compared to farmer practice.
- iii. Management of macro-nutrients (NPK) through foliar and basal doses enhanced the productivity of mung beans and mash beans under rainfed conditions.

- iii. The combination of chemical desiccants (Paraquat and Glyphosate at 1500 ml/acre) demonstrated better and earlier foliage drying (within 6-9 days) in mash beans before mechanical harvesting.
- iv. The planting geometry of advanced lines of Lentil (LS-18-02, LS-21-01, and LS-21-02) has been validated. The results indicate that a seed rate of 40 kg/ha, coupled with a row spacing of 30 cm, may be recommended for achieving higher productivity.
- v. 158 seminars/workshops had have been conducted on chickpea, lentil, mung and mash crops.
- vi. In the rice planting technique trial, mechanical transplanting resulted in a paddy yield of 4192 kg/ha, followed by DSR (3922 kg/ha) and CTR (3654 kg/ha). The maximum net income and benefit-cost ratio (Rs. 109050; 2.27) were obtained from DSR, followed by mechanical transplanting (Rs. 106100; 2.02), and conventional transplanting (Rs. 85400; 1.90).
- vii. Production technology of six major fodder crops i.e. Oat, Vetch, Mottgrass, Maize, Sorghum and Millet established.

### Seed Production

- i. The Wheat program successfully produced 455 tons wheat seed of various categories, including Pre-basic, Basic, Certified, and approved, encompassing wheat varieties such as Pakistan-2013, Borlaug-2016, Zincol-2016, Markaz-2019, NARC Super, Wafaq 2023, and AZRC-Dera. These seeds were distributed to 30 public and private seed companies, as well as 1000 farmers.
- ii. The Pulses program produced 13 tons of quality seed for chickpea, lentil, mung bean, and mash bean, which was distributed to farmers. Additionally, 110 on-farm demonstrations showcasing the production technology for chickpea, lentil, mung bean, and mash bean were conducted.
- iii. The Oilseeds program successfully generated 202 tons of high-quality seed, comprising 175 tons of Soybean, 25 tons of NARC Sarson, 0.5 ton of Groundnut, 0.5 ton of Sesame, and 1 ton of Sunflower, which were distributed to farmers.
- iv. The Fodder program produced 80 tons of high-quality Oats seed, 0.5 tons of Millet seed, and provided 0.24 tons of Mottgrass cuttings, along with 0.2 tons of Maize seed, for the farming community across the country.
- v. NTHRI Thatta transplanted 81360 seedlings of five sugarcane varieties namely YT-55-Thatta (44500 seedlings), Th-2109 (24500 seedlings), Thatta-326 (1450 seedlings), HoTh-300 (9560 seedlings) and YtTh-1707 (1350 seedlings) for the purposes of seed multiplication on 15.5 acres of different grower fields in Sindh.
- vi. Sugarcane seed of Thatta-326, Thatta-2109, YT-55-Thatta and HoTh-300 was increased on 43 acres through conventional method in different location of Sindh.
- vii. Trained field staff of different growers and sugar mills of lower Sindh area for sugarcane nursery development through bud chip method



# Horticultural

## Horticultural Crops

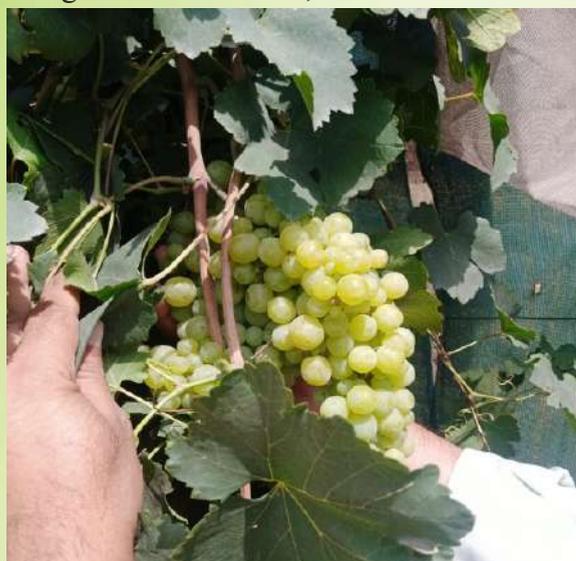
### Fruit

#### Crop Improvement

**Razaki** seedless variety of Grapes was approved from KP seed council. '**Razaki**' is very early maturing variety in comparison with the check variety '**Superior Seedless approved as Shogra-1**' and have the potential to be cultivated on commercial scale in sub-tropical areas of the country including Khyber Pakhtunkhwa and Pothowar region of Punjab

#### Evaluation of Citrus varieties and rootstocks under Pothowar Region

Evaluation of exotic citrus varieties viz., Arnold Blood, Cara Cara, Harvard blood, Rayan Navel, McMohan Valencia, Hockney, Tangor, Fremont, Beyenda Valencia, Kenan V, Caffin, Nules, Berri Valencia, Hamlin, Lane late, Atwood, Clementard, Handerson and Fisher and seven exotic rootstocks i.e. *Poncirus trifoliata*, Cleoptera mandarin, Troyer citrange, Carrizo citrange, Cox mandarin, C-35 citrange, Benton citrange including control (Rough lemon) are being carried out at HRI, NARC.



#### Evaluation of Kiwi varieties under Pothowar Region

Eight varieties of Kiwi (*Actinidia spp.*) viz., Hayward, Hongyang, Hor 16A, Jinyan, *Actinidia argute*, *Actinidia farinose*, Allison and Bruno with their respective male varieties are being evaluated at HRINARC)

#### Establishment of Germplasm Unit (GPU) of fruit plants at NARC

Selected site and prepared plots for establishment of GPU of different fruit plants (Fig, Peaches, Grapes, Plum, Apricot, Pear, Litchi, Citrus, Pecan nut, almond and Kiwi). Most of the available fruit varieties were planted in the foundation/evaluation block. The whole activities of the GPU were carried out under the supervision of FSC&RD.



## Crop Management

### Impact of hand thinning on the qualitative and quantitative attributes of peach

Manual fruit thinning was practiced in early maturing peach cultivars (Early Grand, Florida King, Spring Crest and Flam Crest), small sized fruits (93.80 cm<sup>3</sup>) were produced by the un-thinned plants leading to heavy fruit load (51.25 kg) and limb breakages that caused 20% fruit losses in the un-thinned plants. An equilibrium in terms of fruit volume (168.69 cm<sup>3</sup>), weight (132.75 g), yield (42.00 kg) and TSS (13.03 °Brix) was established when fruit thinning was practiced at 10 cm spacing, 5 days after petal fall. Quantity of marketable size fruits was increased in the thinned plants.

### Nursery Plants Production

Total 23400 fruit plants produced (9600 through sexual means, 6700 through cutting and 7100 through grafting/budding). Established green-house for Handling of Germplasm and Mass-Scale Production of True to Type Fruit Plants” from Turkish corporation & Coordination Agency (TIKA) Program Office Islamabad

## Vegetable

### Crop Improvement:

#### Indeterminate Tomato

On the basis of the Preliminary Evaluation I & II (2020-2022); 05 round fruit shape advance lines viz; 04-08 27-2/2(8)(1)G-R\*, 04-08 27-2/2(8)(4)G-R\*, 07-08 9-7/8(8)(2) Ex. R\*, 07-08 32-8/2(5)(2) V.G-R\* & 07-08 32-8/2(5)(6) G-R\* performed significantly high fruit yield as compared to the check hybrids and OPVs. However, 01 oblong fruit shape advance lines viz; Sahil 15-13/6-4 BFS; G-OB\* performed significantly high fruit yield as compared to the check hybrids and OPVs.

#### Development of source population and pure lines in indeterminate tomatoes using double hybrids.”

Selections from source population were made and 21 single plant selections and 18 bulk population selections were done. Selections were done on the basis of fruit shape, plant stature, leaf shape and yield per plant.



Pictorial views of fruits of advance lines of indeterminate tomato in F8

**Evaluation and selection of indeterminate cherry & beef tomato genotypes.**

Out of thirteen cherry & eight beef indeterminate tomato genotypes which were maintained last year, 6 promising cherry tomato & 05 beef genotypes were sent for first year NUYT through FSC&RD.

**Introduction of new vegetables**

Basella genotypes were introduced in VCRP program and observations were made regarding flowering time, number of leaves and leaf color. Later on, selections were made and coding was done for NUYT and material was sent to 05 locations.

**Breeding for hybrid and inbred line development in cucumber.**

In the past different genotypes were crossed to develop F1 hybrids with the purpose to develop F2 (source populations). Currently we have five F2 populations from which selection will be made in the years to come and 2 S0 are available, which were selected on the basis of plant vigor and more number of female flowers. To develop more source population in 2023 different genotypes were allowed to openly pollinate seeds from these genotypes have been harvested and stored.

**Breeding in Okra.**

Crossing for the development of experimental hybrids and subsequently the development of source population has been started. A total of 72 hybrid crosses have been made and about 12 have been harvested.



**Breeding in Potato:**

Disease resistant exotic clones of CIP, Peru evaluated. 12 clones were selected and basic seed (700 kg) were produced. 1300 kg mini tubers of 39 local crosses were produced for further multiplication. 1400 kg seed of NARC Potato-I, NARC Potato-II and NARC Potato-III produced. Also 27 clones were evaluated for dry matter among them 09 clone having high dry matter traits and 6 clone having dry matter from 18.2 – 20.2



**Crop management:**

**Standardization of Production Technology of two new Onion lines (NARC Onion -05 & NARC Onion-06).**

Highest yield (19.4 t/ha for NARC Onion-05 and 21.0 t/ha for NARC Onion-06) was depicted by the transplantation done on January 1<sup>st</sup> with the above mentioned plantation geometry (10 x 25 cm).

**Impact of different irrigation and mulching types on growth and yield of garlic NARC-HG1**

Yield per plot of 90 ft<sup>2</sup> was obtained 67 kg under drip irrigation with combination of black plastic mulch, whereas control treatment had 47 kg yield per plot.

**Seed Production**

- i. Produced 0.2 tons BNS seed of garlic variety “NARC Humayoun Garlic I”
- ii. Provided 0.5 million seedlings and 3000 seed kits to kitchen gardeners

**Coordinated Research:**

Performed NUYT on 08 different vegetable Crops (Tomato; [Det. Ind. & Hyb], Spinach, Basela, chillies, Peas, Onion).

		
NARC-2008 H**	NARC 17-19 X Axona(10)	MF-1 X TPS-13
		
Murato X Axona(17)	Folva X Axona (1)	NARC 17-19 X Axona(19)
		
Blue Denubi X Axona(11)	Blue Denubi X Sarpomira (4)	Blue Denubi X Axona (10)
		
Murato X Axona (1)	SH-5 X Axona (7)	



# Floriculture

## Floriculture

### Crop Improvement:

- I. 06 flower varieties (03 Cut iris , 02 Narcessus and 01 Chrysenthemum) are in registration process with FSC&RD.
- ii. Germplasm of 20 native flowering plants collected and screened.
- iii. Twelve annual flowers were tested and screened for seed production and multiplication. 200 to 400 grams seed with excellent germination of each entry was harvested.
- iv. More than 2000 cuttings/bulbs of 98 lines of flowering plants have been harvested



*NARC Iris Yellow, NARC Iris Purple and NARC Iris White*



**Tea and High Value Crops:**

- NTHRI focused on the optimization of production technology of quality tea and tea progeny garden consist of 14 unique tea varieties / lines. The data of four candidate tea lines for variety registration was completed that will be submitted to FSC&RD for registration. During 2022-23, 35 acres of tea garden was managed for tea production which produced 5,487 kg of made green tea. The International Tea Day festival was celebrated on June 01, 2023 aiming at the promotion of tea at national level by bringing all the stakeholders (tea growers, researchers and tea companies) together.



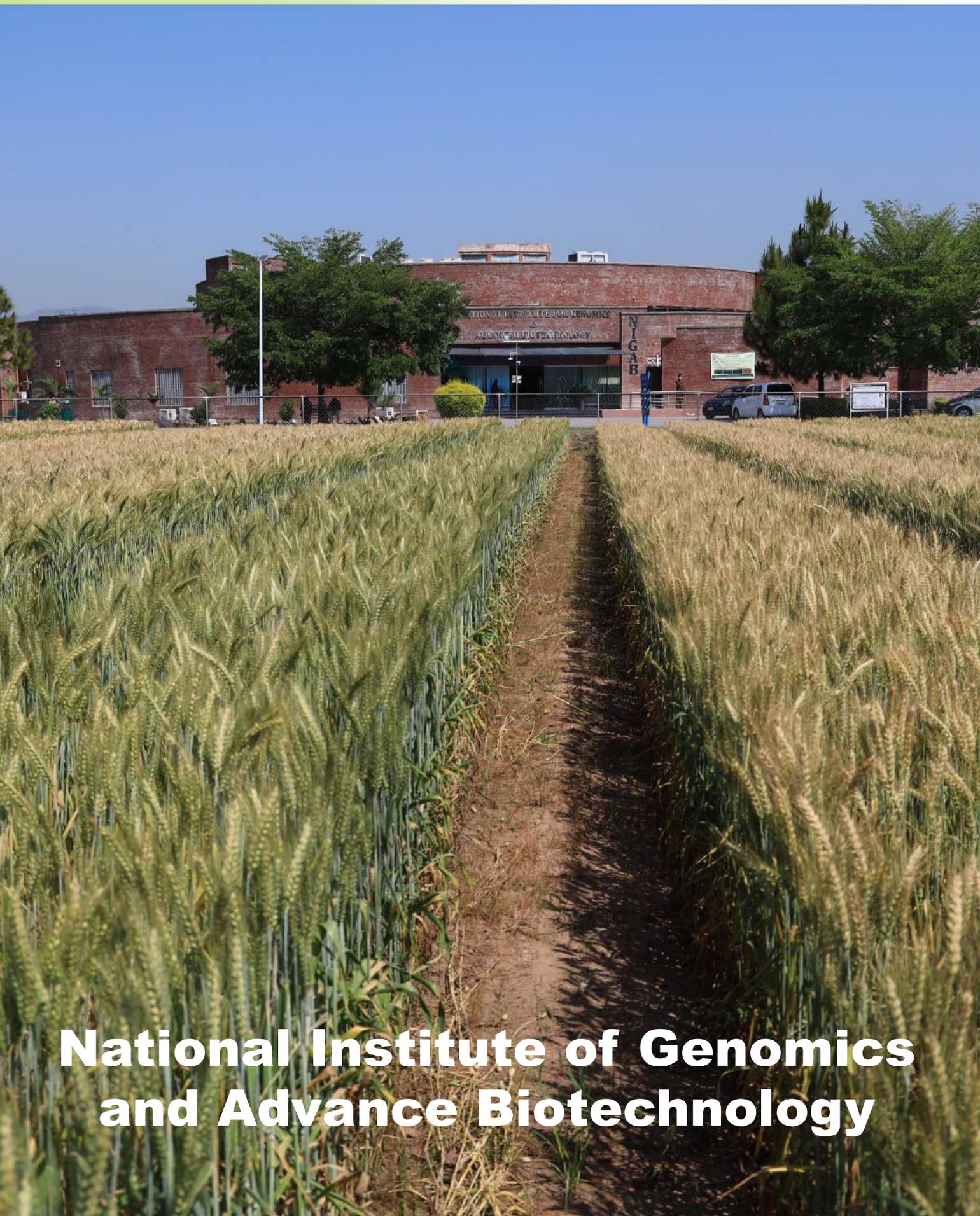
- Mother block of 08 Kiwifruit varieties was established at Shinkiari and adoptability trials of kiwifruit cultivars were conducted at Swat, Shangla, North and South Waziristan. Produced 2,000 Kiwifruit plants of different varieties through grafting and cutting and provided to farmers. NTHRI Obtained 50,000 graft wood from Fruit Germplasm Unit (GPU) for further propagation.



- In PSDP funded olive project (Promotion of Olive Cultivation on Commercial Scale in Pakistan, Phase-II) established 02 olive orchards for adoptability trials in Balakot & Battagram. The institute distributed 10,142 indigenous olive nursery plants grafted 10,100 wild olive plants in various ecologies of Hazara Division.

**Dragon Fruit Adaptability in sindh:** PARC-SARC through its Institute of Plant Introduction (IPI) introduced Dragon fruit (*Selenicereus undatus*), Cv. Red H-undatus of South American origin during 2021-22 and 2022-23 using marginal quality groundwater (EC=3.2 dS/m). After almost one year the plants matured and started flowering, however, flower shedding was noticed at higher temperature. The fruit harvested weigh an average of 370 grams. Efforts are being underway to multiply and introduce this important fruit crop on larger scale in the coastal zone ecology of Sindh province.





# National Institute of Genomics and Advance Biotechnology

## Genomics and Biotechnology

**Transgenic Research:** Biosafety testing trials of transgenic cold tolerant tomato on environmental and health related aspects were completed for 1st year prior to commercialization. GM tomato was found to safe as it had been observed for non GM tomato.

### TOXICITY OF TRANSGENIC TOMATO IN MICE

S. No.	Toxicity study	Animal used	Description
1	Acute oral toxicity (14 days)	Mice	*Group: NT, NT, C) Dose: 5000 mg/kg n= 15 /dose /group
2	Sub-chronic (70 days)	Mice	*Group: NT, NT, C) Dose: 5000 mg/kg n= 15 /dose /group

1. Transgenic (GMO) Tomato Fruit (with DREB2A Protein)  
2. Non transgenic (PLACEBO) Tomato Fruit (without DREB2A Protein)  
3. Control (Without any fruit intake only)

**Allergenicity Analysis**

### ACUTE ORAL TOXICITY OF TRANSGENIC TOMATO IN MICE

- Test Sample: Tomato Fruit (transgenic / non transgenic)
- Vehicle nature: Feed
- Experiment Duration: 14 days
- Dose: 5000mg/kg

Group	Sex	*Clinical Observations	*Behavioral Observations	*Mortality
1. Transgenic (GMO) (Dated Tomato Fruit with DREB2A Protein)	Male	No toxic signs or symptoms	No notable findings	No notable findings
2. Non transgenic (PLACEBO) (Dated Tomato Fruit without DREB2A Protein)	Male	No toxic signs or symptoms	No notable findings	No notable findings
3. Control (Without any fruit intake only)	Male	No toxic signs or symptoms	No notable findings	No notable findings

**Histopathology Study**

	CONTROL	PLACEBO (5g)	GMO TOMATO (5g)
GIT			
LIVER			
BRAIN			
KIDNEY			

### Genetically modified organism testing for health risk assessment

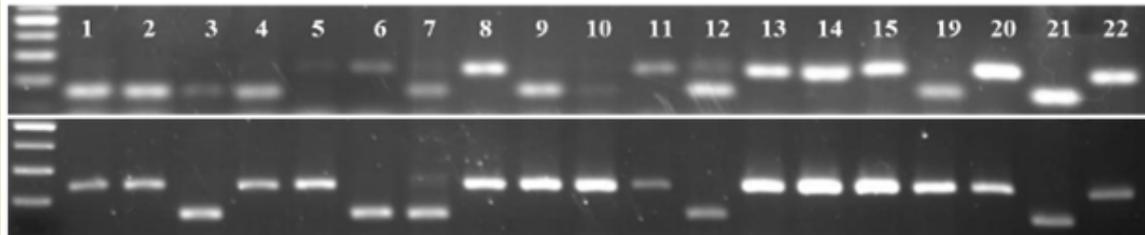
- i. Gene editing in potato for late blight resistance and reduced enzymatic browning started. Vector constructs completed.
- ii. Four advanced rice lines developed through genomic approach have been recommended by Variety Evaluation Committee in 2023. Moreover, 05rice lines are in second year of NUYT while 2 rice lines are in first year of evaluation in NUYT.
- iii. Developed 16 and 83 sugarcane lines by using exotic fuzz, are in nursery 2 and 1 respectively.
- iv. Developed 16 KASP markers to identify local sugarcane cultivars, DNA barcodes were developed for these local sugarcane varieties. Patent filed for 16 KASP markers.



DNA extraction of 552 lines and SNP genotyping using NGS for genome-based breeding by design strategy (GBBD)



### Resistance to smut and Red Rot



*DNA based evaluation of sugarcane samples on gel electrophoresis*

### Marker Assisted Breeding

Screened population for Stripe, Leaf and Stem rust resistance genes by using 73 Egyptian wheat genotypes against 31 SSR markers linked with wheat rust resistance genes.

- I. Developed sex determination method in date palm. PATENT filed.
- ii. Preliminary Yield Trials of 600 wheat (Chinese x Local) F6 lines previously screened for rust resistance genes using DNA markers were conducted. About 94 lines which gave higher yields are in second year yield trials. Eleven best lines are in advanced yield trials.

### Tissue culture

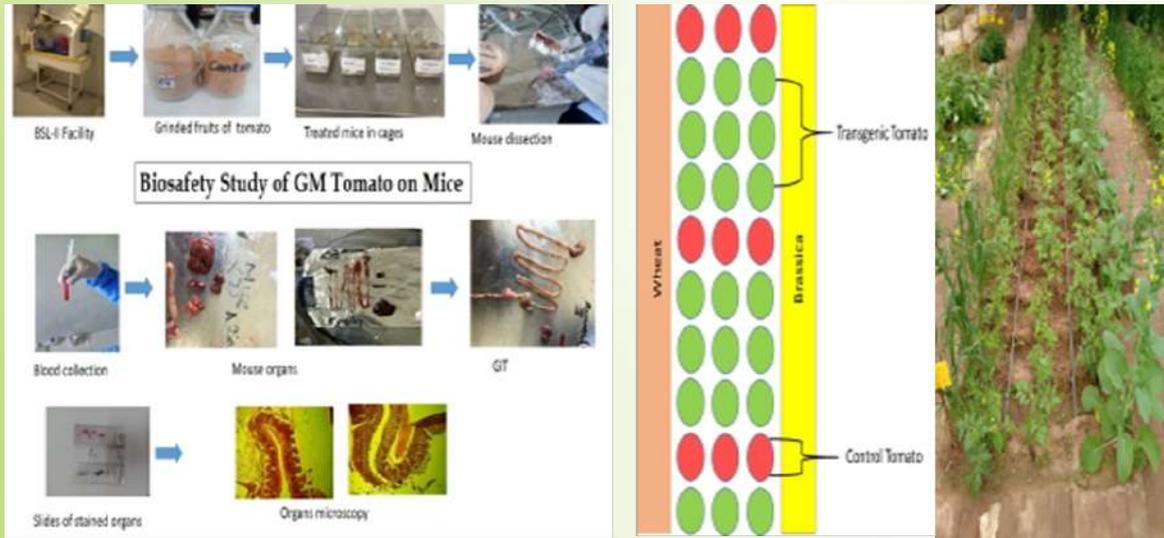
Harvested 167,638 (G1) virus free potato nucleus seed from Aeroponic and field and planted 70,000 (G1) material in screen houses at NARC and field in Astore.

- i. Produced 20,000 in vitro ginger plants and shifted for hardening. 4500 plants survived.
- ii. Multiplied 06 banana varieties i.e. NIGAB-1, NIGAB-2, NIGAB-3, NIGAB-4. 65967 plants produced.

### Animal Biotechnology

The Illumina Bead-chip 100K Bovine SNP Array of selected samples from Sahiwal & Tharparker cattle was performed for true to type breed identification and potential marker screening. A total of 168 SNPs were identified. GWAS analysis was performed and identified potential SNPs on different chromosome for marker development.

- i. Developed mono clonal antibodies against PPR virus in Sheep and Goat.
- ii. Developed local indigenous probiotics for milk productivity enhancement in buffalo.
- iii. Production of yeast extract from locally isolated yeast strain to be used in beverages food product as taste enhancer and lab purpose.
- iv. Lumpy skin Disease (LSD) virus was isolated as a first step towards vaccine production.



*Biosafety testing of GM tomato (Health and environmental safety)*



*DNBSEQ7-RS Next Generation Sequencing platform at NIGAB, NARC*



*Olive oil extraction mill at PARC-BARDC*

*Pictorial representation of commercialization of potato tissue culture Technology in Pakistan*





PRESTATION  
LABORATORY  
ICES INSTITUTE

# Plant Genetic Research Institute

## Genetic Resources

**The National Genebank of Pakistan:** is the only national facility for germplasm conservation. There are 43000 germplasm accessions conserved in the Genebank for sharing and utilizing by the researchers working under NARS.

**Germplasm Distribution:** This year the National Genebank of Pakistan provided a total of 6217 accession's samples of cereals, legumes, oilseeds, vegetables, fodder crops, medicinal plants and crop wild relatives to breeders and researchers across the country.

**Acquisition/Donation and Collection:** A total of 1040 samples of various crops including wheat, barley, maize, rice and medicinal plants were added to Genebank collection through acquisition/ collection and donation.

**Seed Germination and Viability Testing:** This year 4135 accessions were tested for seed viability including samples from PATCO.

**Evaluation and Characterization of Germplasm:** The germplasm accessions of various crops preserved in the National Genebank of Pakistan including brassica, rice, wheat, maize, Soybean, lentils, Quinoa, mungbean, cowpea, mashbean, brinjal, chilli, garlic, onion and tomato were regenerated and characterized for traits of interest. Biochemical evaluation using SDS-PAGE of total seed storage proteins was carried out for genetic diversity assessment and discrimination of rice, wheat, maize, lentils, and cowpea germplasm.

**In-vitro propagation of Germplasm:** *In vitro* conservation of sugarcane, potato, sweet potato and orchid was carried out during reporting period by using different concentrations of growth hormones in MS culture media.

**Management and adaptability of herbs:** Local and exotic plants that are being maintained in the clonal repository such as *Thymus vulgaris*, *Apium graveolus*, *Plectranthus* sp., *Aloe vera*, Stevia, *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.

**National herbarium** maintains over 100000 herbarium specimens and more than 500 native and exotic plants in the Botanical Conservatory. National Herbarium accessioned 582 herbarium specimens of native flora from different areas of Pakistan. A collection of 250 native and exotic plants is being maintained in the Botanical Conservatory. National Herbarium has also described four new species of plants, including *Astragalus* from Qamardin Karez, *Allium sulaimanicum* from Takht-e-Sulaiman, *Chesneya balitistanica* from Skardu, and *Oxytropis mandokhailii* from Zhob district. In addition, the program has recorded six new species of plants from Pakistan: *Astragalus hololeios*, *Cicer chorassanicum*, *Amaranthus polygonoides*, *Lythrum hyssopifolium*, *Lepidium bonariense*, and *Lepidium campestre*.

**Awareness and Information Dissemination:** A total of 1265 visitors including high-level national and international delegates/dignitaries, researchers and university students paid visit to National Genebank and allied facilities.

## Plant Protection

### Insect Pest Management

- I. Evaluated wheat (80) and rice (82) NUYT entries under induced pest infestation

and by employing electrical penetration graph (EPG) system.

- ii. Two bacterial strains ([Bacillus amyloliquefaciens](#) and [Serratia nematodiphila](#)) isolated indigenously showed promising mortality in the rice leaf folder.
- iii. Molecular biopesticide involving the dsRNA targeting the Fer1, Fer2 genes, and their combination (Fer1 + Fer2) treatments exhibited high mortality (98%) in brown plant hopper (BPH).
- iv. In wheat crop the population of aphids has significantly been decreased and the yield increased by 11% through intercropping with brassica for the conservation of biological control agents. (Fig. 1, 2).
- v. *Trichogramma chilonis* released in sugarcane along with granule application reduced the infestation of borers by 9%.
- vi. The molecular approach RNAi was adopted to suppress the *B. dorsalis* male attraction to Methyl Eugenol (ME).
- vii. Application of Neem oil at 1% concentration reduced jassid population in okra crop at par of Imidacloprid (64%).
- viii. Three different species of fruit flies were monitored by using methyl eugenol traps. The *B. zonata* with a population of about 90% was the dominant species.
- ix. Fumigation inspection services were provided to Food Department, Government of Sindh in all wheat storage facilities of Sindh i.e., Karachi, Hyderabad, Mirpur khas, Mithi, Shaheed Benazir Abad, Sukkur and Larkana at various locations as per schedule given by the food department.

### Vertebrate Pest Management

- i. Novel approaches has been evaluated and adopted for monitoring and mitigation wild boar (*Sus scrofa*) in standing crops. Used lubricants attracted 19 times more wild boar to bait stations than the control.
- ii. To mask the pungent taste of sodium nitrite (NaNO<sub>2</sub>), that is highly toxic to wild boar, maize based formulation in pellets form was effectively used (Fig. 3).
- iii. Five indigenous plants (*Euphorbia millii*, *Cinnamomum zeylahicum*, *Jatropha integerrima*, *Lilium* and *Lantana camara*) as repellent/attractant were evaluated against rodents.

### Pesticide Residue Analysis

- i. Ecotoxicology Labs maintained ISO17025:2017 accreditation from PNAC.
- ii. Field trials on the dissipation of profenofos on chili were conducted at Umerkot, Kunri and Mirpurkhas in collaboration with CABI. The concentration of profenofos was below its CODEX MRL and minimal human health risk was associated with consumption of chili.
- iii. Tomato samples (59%) were found contaminated with fourteen different pesticides and 7.8% samples were non-compliant with the EU-MRLs. The most frequently detected pesticides were imidacloprid (12 samples) and tebuconazole (10 samples). Chlorpyrifos, metalaxyl, pyraclostrobin, tebuconazole and thiamethoxam were exceeding the EU-MRLs (Fig. 4)

### National Insect Museum (NIM)

- I. National Insect Museum houses and curates about hundred thousand insect specimens. During current year, 40 insects specimens were added to this repository and 17 species were molecularly characterized.
- ii. Identification services provided to academia and research organizations and more than 500 visitors were briefed on the importance of insect curation and identification.

### Crop Diseases Research Management

The institute has three coordinated labs in Pakistan, which includes CDRI, NARC

Islamabad, CDRI Murree and CDRI Karachi. The CDRI Islamabad have state of art laboratories on virology, mycology, phytobacteriology, plant nematology and aflatoxin research at the NARC. However, CDRI Murree has engaged on wheat rusts gene postulations and rust race analysis as well as CDRI Karachi has been working on stem rust and leaf rust at SARC, PARC.

**Rice:** Fifty-six OP rice varieties (36 fine and 20 course) and 140 rice hybrids were screened against bacterial blight (*Xanthomonas oryzae*) of rice (Fig. 1). The disease response was evaluated according to the standard evaluation system for rice. Out of 36 fine rice lines, 02 lines showed resistant/moderately resistant response. Out of 20 course lines 07 were resistant/moderately resistant. Out of 140 hybrids, 30 were resistant/moderately resistant. The rest of accessions were found susceptible. We contributed in recording disease data of 14 released rice hybrids and 06 OP varieties.

**Wheat:** None of the wheat line in NUYT 2022-23 was found resistant to all three rusts. Among 80 only three lines were found effective and showed Relative resistant Index 6 and above. Only 06 candidate lines were found resistant to yellow rusts (*Puccinia striiformis f. sp. tritici*) and 12 to leaf rust (*Puccinia triticina*) only. We contributed in recording disease data of 12 varieties being released in 2023 viz Mansehra -1, Ratta Kulachi-23, AZRC Daman, Naurang 2023, Tanda 2023, Tarnab Gandum-1, Tarnab Rehbar, NIFA Nijat, Fakhre NIFA 2023, Pirsabak-2023, Khyber-2023 and Wafaq-2023.

**Race analysis of wheat rusts (*Puccinia spp*):** Only 15 yellow rust (*Puccinia striiformis f. sp. tritici*) races were identified from 2022-23 disease samples. Among them, the races were 574210, 574202, 574232, 454212, 474230, 470212, 130200, 544200, 550210, 570200, 574212, 414220, 474200, 454232 and 451230. The leaf rust (*Puccinia triticina*) races had 09 in number as viz MKTTS, MHTFS, MDTCD, LCTTG, MJSTF, MJTTS, MCDNS, MHTTS, CBTSL and one race of stem rust (RRTTF) were identified respectively.

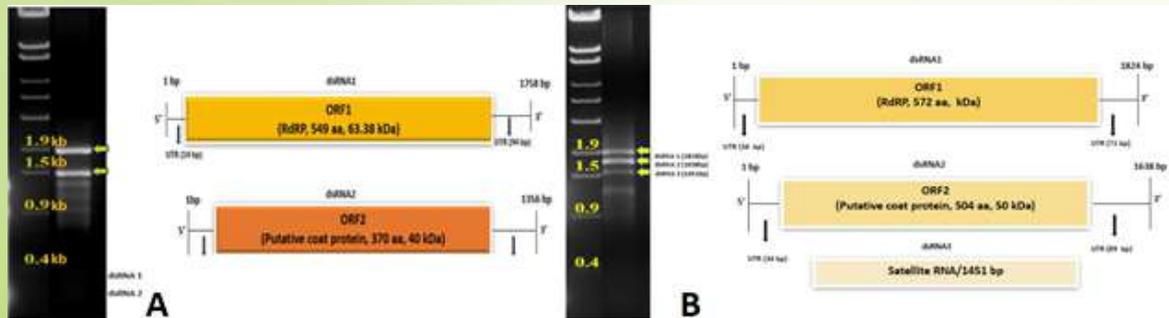
**Leaf Rust (*Puccinia triticina*):** Under National Wheat Diseases Screening Nursery (NWDSN) comprising 835 lines/ Entries of advance wheat breeders material. The data revealed that 209 lines (25.2%) showed Resistance (R), 532 lines (63.71%) were Moderately Susceptible to Susceptible (MSS) and 94 lines (11.25%) were Susceptible (S).

**Stem Rust (*Puccinia graminis*):** Under NWDSN the data revealed that out of 835 lines/entries 3 lines (0.35%) were showed Resistant (R), 2 lines (0.23%) were Resistant to Moderately Resistant (RMR), 34 lines (4.07%) Moderately Resistant (MR), 275 lines (32.93%) were Moderately Resistant to Moderately Susceptible (M), 43 lines (5.14%) were Moderately Susceptible (MS), 388 lines (46.46%) were Moderately Susceptible to Susceptible (MSS), 88 lines (10.53%) were Susceptible (S) and 2 lines (0.23%) were variable in reaction (V).

**MITIGATION OF AFLATOXIN (*Aspergillus flavus*) IN CHILIES (USDA/ USAID & CABI):** The atoxigenic strains were identified in the lab and also trials are underway to check the efficacy of the first-ever Bio-pesticide; AflaPak for mitigating aflatoxin in chilies. The atoxigenic strains doesn't have ability to produce aflatoxin owing to defect / deletion in aflatoxin biosynthesis cluster. For the determination of deletions in *A. flavus* isolates Cluster Amplification Pattern (CAP) analysis was carried out. Eighteen markers comprising aflatoxin (AC01-AC13) and cyclopiazonic acid (CC01-CC04) clusters were aggregated into three groups. Out of 192 isolates analyzed for a aflatoxins cluster deletion, 24 isolates showed deletions having similar patterns.

Six training's conducted for the purpose of dissemination of aflatoxin technology under the

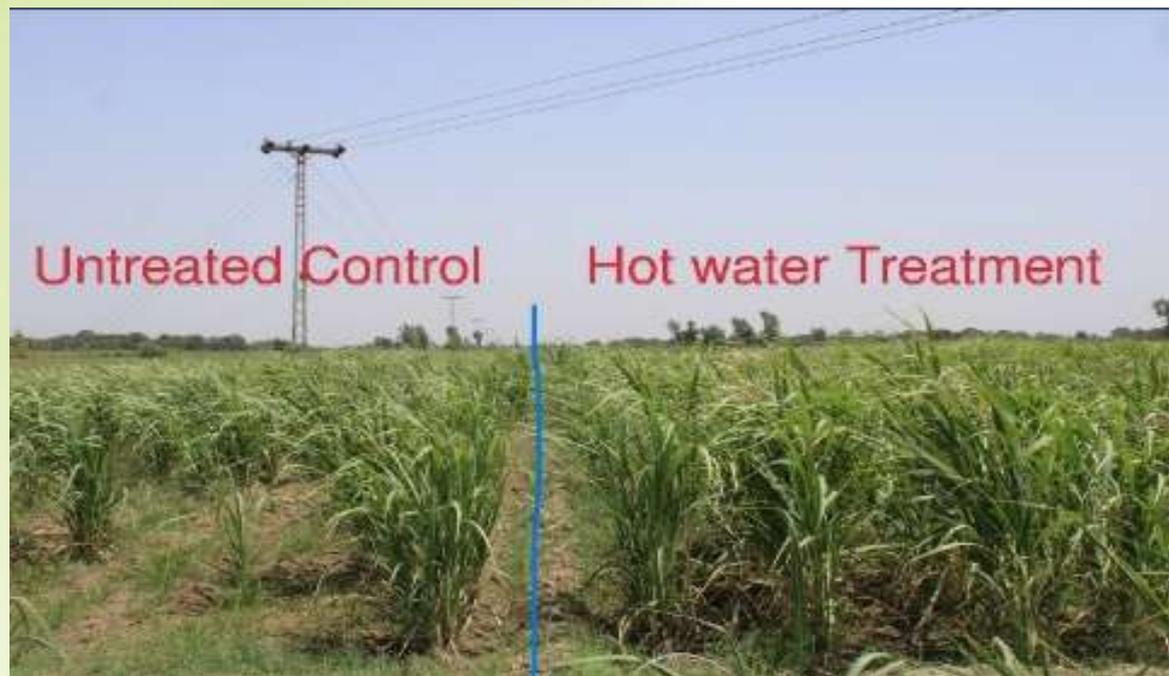
project “Regulatory Harmonization in Pakistan for MRLs and Biopesticides” in Karachi, Tandojam, NARC Islamabad.



Genome organisation of *P. variotii partitivirus-1* (PvPV-1) and *T. pinophilus partitivirus-1* (TpPV-1) along with dsRNA's profile on the gel showing the size of all segments.

**Sugarcane Diseases Management (PSDP-PESC-III-CDRI Project)**

Three bacteria viz., *Xanthomonas albilineans* (Xa) yielding pale yellowish small circular colonies whereas, *Pantoea stewartii* subsp. *stewartii* (Pss) showed dark yellow convex and a bigger colony were isolated, purified and subject to molecular identification through. *X. albilineans* was confirmed by specific primers XaF/XaR on which it showed band at 600 bp while *P. stewartii* subsp. *stewartii* and *Acidovorax avenae* subsp. *avenae* gave clear bands at 1500bp with universal primers B16SF/B16SR and P0f/P6r respectively. Both Pss and Aaa were sequenced through Sanger sequencing method by Macrogen company Korea. After blasting, our sequenced result of *P. stewartii* subsp. *stewartii* and *A. avenae* subsp. *avenae* showed similarity with Chinese, Malaysian and USA isolates (MW015765, MF351732 for Pss and KU948662, CP028300 for Aaa respectively). Furthermore, these sequences were submitted to GenBank (NCBI) with the accession number SUB11720155 (ON965180, ON965181) for Pss and SUB11952181 (OP267574, OP267575) for Aaa.



## Food Quality and Value Addition

Food Science Research is an integral part of plant sector of PARC. Pakistan Agricultural Research Council for this purpose have well equipped labs at Food Science Research Institute, NARC Islamabad and Food Safety and Quality Research Institute (FSQRI), SARC Karachi. The major activities being performed are research and development related to food science, nutrition and safety, development of value-added products and recipes, food testing services to private/public sector and human resource management.

Wheat/rice varieties and advanced lines were analyzed for various physio-chemical and rheological parameters, end use product quality and potential of dephytinized wheat flour. Studies were initiated on probiotic strains to prepare a healthy and nutritious product using selected probiotics. Isolation and Employment of Biochemical Components for Development of Specialized Functionality & Intelligently Oriented Product were developed such fruit bars, syrups and powders of date palm, jujube fruit, strawberries, *Prunus domestica* and citrus peel were developed. Similarly value-added products of Oyster Mushroom was also developed. 1344 different food samples including honey were tested for adulteration. More than 1000 students/internees/farmers were trained in areas of food testing and value addition.

**Quality Evaluation of Wheat: wheat samples (341)** including varieties/line/flour from different research institutes/centers were evaluated for folic acid, gluten, protein, Ash, moisture, falling number, farinographic properties and mineral analysis etc. More than 20 types of quality tests (Physical, milling, nutritional/proximate, safety, rheological, cooking quality, Baking quality etc.) were also performed, data is gathered and analyzed to report the results to different stakeholders of public and private sector.

**Quality Characterization of dephytinized wheat:** Pakistani wheat varieties around 60 were analyzed for essential minerals (iron, zinc, copper, manganese) and anti-nutrient phytic acid content, Additionally, Enzymatic Dephytinization were done to remove phytic acid and then bioavailability of iron, zinc, and copper were carried out. The dephytinized flour was found to have increased minerals bioavailability as a result of reduction in phytic acid content.



**Quality Evaluation of Rice:** 360 samples from National Coordinator (Rice), Rice Research Program, NIGAB, NARC, Rice Research Institutes of Sindh, Syngenta, etc. were evaluated against 19 different milling, physical, nutritional (Fe & Zn) cooking and chemical (amylose, gel consistency and alkali spreading value) quality parameters. All the data obtained being analyzed statistically.

**Microscopic study of Pollen Spectrum to Develop Lab Database:** For adulteration source identification, direct adulteration of different honey samples was done in order to identify the particles of certain products, which are suspected as most common adulterants in honey.

Microscopic particles of common adulterants i.e Sucrose and Starch were identified and their reference images were added to lab database.

Intelligent packaging enhances food products quality and meets consumer satisfactions. Films were formulated and tested for raw fruits and vegetable and sea food item.



**Use of Improvers To Enhance the Quality of Baking Product Bread:** Study evaluated the individual and combined effects of bacterial xylanase (BX), vital gluten (VG) and ascorbic acid (AA) to improve weak flour properties for bread making. BX, VG and AA improved gluten strength (GI), VG increased the water absorption capacity of flour (WA) and prolonged dough development time (DDT). All improvers increased loaf volume (LV) and retained or improved sensory attributes of bread.

**Isolation, identification, and characterization of Probiotic bacterial strains for Pickle Production:** Probiotic bacterial strains have been isolated from different food sources and then characterized comprehensively for health, nutritional benefits and product development. Based on biosafety assessment (hemolytic activity and antimicrobial susceptibility test) 29 promising probiotic potential bacterial strains were selected for further analysis. Among the characterized strains, whole genome of 6 candidate probiotic novel bacteria were sequenced. Based on invitro and in silico characterization, strain NCCP-2648 was used in production of functional pickle.



**Functional fruit bars having extracted polyphenols from agriculture wastes:** Extraction of polyphenols from different fruit wastes (05 types) and herbs/medicinal plants (10) were carried out. Total polyphenols, flavonoids and antioxidant activity of extracts were determined. Functional fruit bars/date bars containing extracted polyphenols were developed and evaluated for quality parameters.

**Gluten Free Product Development:** Formulations of gluten-free cupcakes based on buckwheat and rice flour in three different ratios 10/90, 20/80, and 30/70 were developed.

Physicochemical, rheological and sensory analysis indicated that gluten-free buckwheat and rice-based composite flours exhibited acceptable quality characteristics.



*Polyphenolic Extracts Fortified Fruit Bars*

**Fruit and Vegetables Products:** Syrups and powders of date palm, jujube fruit, strawberries, *Prunus domestica* and citrus peel were developed.



# Natural Resources

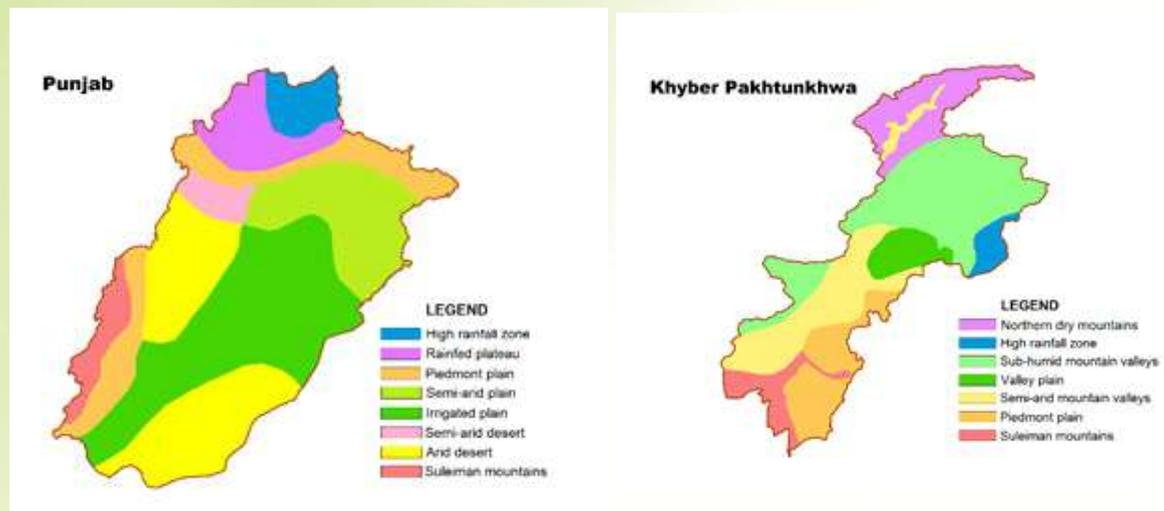
## Natural Resources Division

Effective management of natural resources in Pakistan is crucial to mitigate the adverse effects of climate change and ensure sustainable development, as the country is vulnerable to increasing environmental challenges such as water scarcity, extreme weather events, and ecosystem disruptions. Natural Resources Division focused on carrying comprehensive research to understand the state of natural resources, their vulnerabilities to climate change, and the impact of human activities. During 2022-23 major emphasis was given for developing and implementing monitoring and evaluation systems for enhancing resilience in vulnerable farming communities. The main focus of Natural Resources Division was to introduce and make adaptability of climate smart natural resources management practices, land and water resources management, arid horticulture, range management and mountainous agriculture.

### Climate, Energy and Water Research Institute

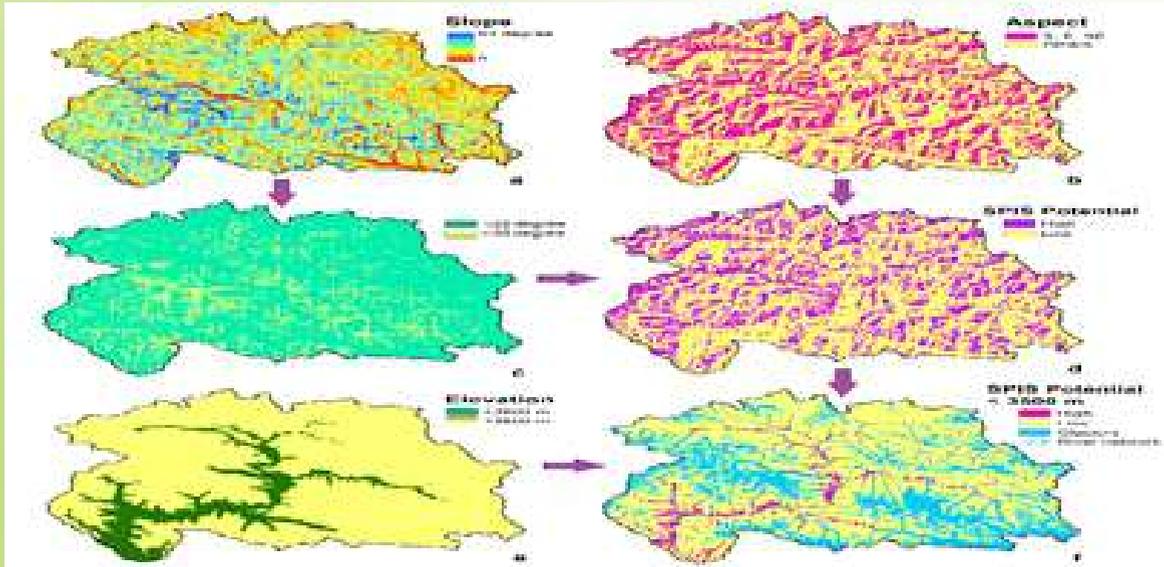
#### Sub-ecological zonation of KPK and Punjab

PARC identified sub-ecological zones in Khyber Pakhtunkhwa and Punjab provinces based on recent agro-climatic, landform, and land use data. In KPK, seven zones were delineated, with dominant sub-humid mountain valleys in the north and semi-arid mountain valleys in the south, where agriculture is limited and grazing is prevalent. Punjab province comprises eight zones, including irrigated plains in the central part, semi-arid plains in the north-east, and rainfed plateaus in the north-west.



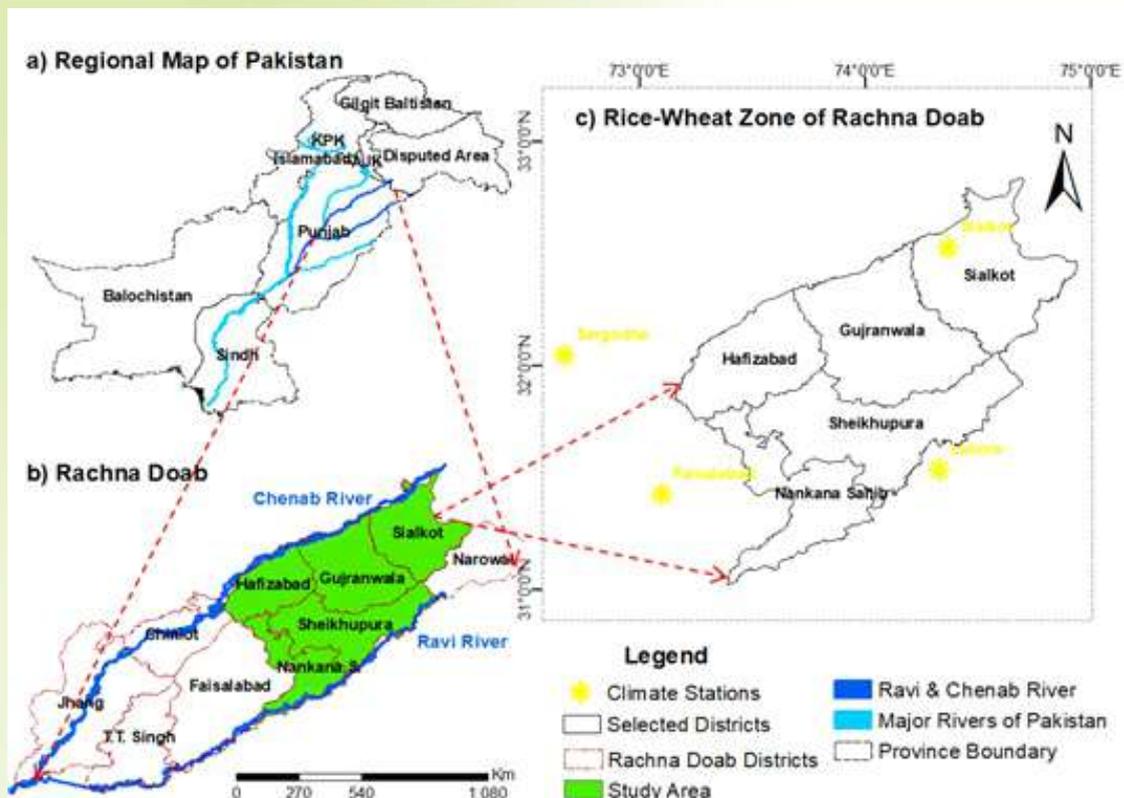
#### Evaluating Irrigation Adaptation Options for Hunza

Sustainable agriculture in Pakistan's Hunza basin was explored by assessing water-yield and groundwater potential with a focus on solar-powered irrigation systems (SPIS). The study in Hindu Kush-Karakoram-Himalaya (HKH) region revealed 73% water-yield from the basin, with limited prospects for groundwater due to geological factors. SPIS showed promise over a 680 km<sup>2</sup> area along the Hunza River network, complementing the traditional kuhl system.



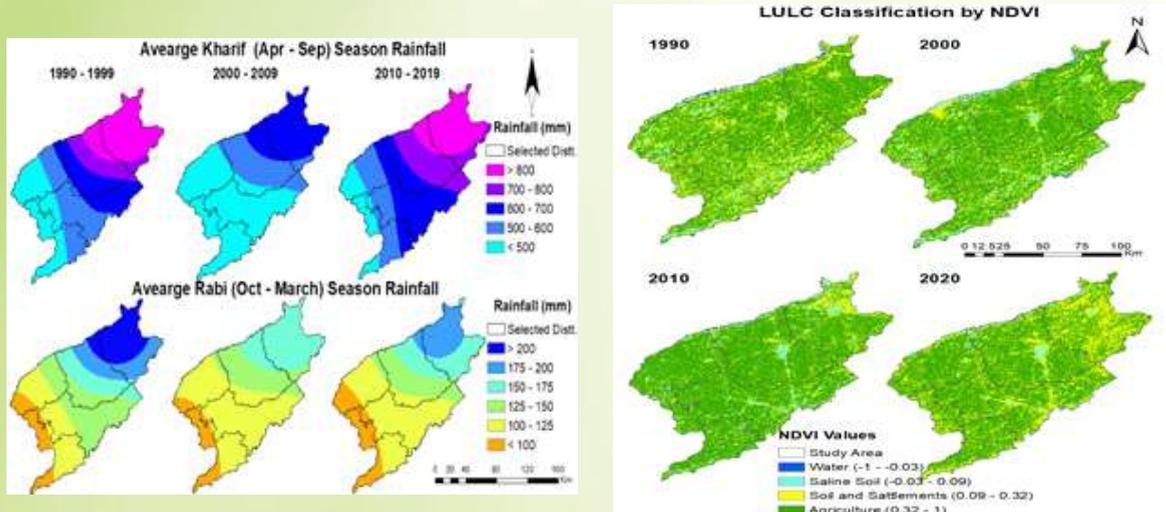
**Assessment of agricultural area degradation using remote sensing and spectral indices techniques: A case study of the rice-wheat zone of Rachna Doab, Punjab.**

A comprehensive risk assessment, using state-of-the-art data and techniques in the rice-wheat zone of Rachna Doab, Punjab province, was carried out to address food security threats and draw the attention of authorities to the severity of the situation. The study showed that the agriculture land is reducing as the farmers are abandoning thousands of cultivable hectares as fallow lands which exacerbates vulnerability to salinity resulting in using for other purposes than agriculture or categorizing it as wasteland.



### Spatiotemporal rainfall variability and agricultural area loss assessment

The study revealed significant changes in Kharif and Rabi rainfall patterns over a decade, with Kharif experiencing increased rainfall while Rabi faced below-average precipitation, impacting wheat sowing and exacerbating salinity issues. The NDVI vegetation index indicated substantial agricultural area loss in 10 years, with salinity showing fluctuations due to wheat growth. Waterlogged expansion was observed on 7883 ha using MNDWI water index, and urbanization increased by 46554 ha, posing a serious threat to food security in productive agricultural areas.



### Evaluation of Responsive Drip Irrigation (RDI) in comparison with conventional drip and furrow irrigation for seasonal vegetables

PARC garlic was evaluated for three irrigation methods: Responsive Drip Irrigation (RDI), conventional drip irrigation, and furrow irrigation. The results highlighted that RDI and conventional drip irrigation demonstrated superior water usage efficiency, achieving remarkable water savings of 85% and 70%, respectively, compared to furrow irrigation. Additionally, the drip irrigation methods positively impacted yield, with a 10% increase observed for conventional drip irrigation and a 5% increase for RDI, showcasing their effectiveness in conserving water and improving crop yield.



Garlic on furrow irrigation



Garlic on drip irrigation



Garlic on RDI

Table 1: Water usage and impacts of different irrigation methods

on Method	Water Usage (litres)	Yield Increase (%)	Water Saving (%)
Responsive Drip Irrigation	3500	5	85
Conventional Drip Irrigation	12000	10	70
Flood Irrigation	24000	0	0

**Establishment of Demonstration plots of RDI/HEIS Technology**

Our main work encompassed implementing various advanced irrigation systems for wheat cultivation, including subsurface Responsive Drip Irrigation, Integrated drip lines, Impact sprinklers, and Improved surface irrigation methods on a 0.1-acre plot at CEWRI field station NARC, contributing to enhanced crop productivity and water efficiency. While also introducing innovative interventions like Responsive Drip, Flooding, and Drip irrigation for vegetable crops, alongside setting up Portable Rooftop walk-in tunnels for efficient kitchen gardening of tomatoes and cucumbers, all contributing to sustainable agricultural practices and increased yields.



**Dissemination of technologies to farmers/professionals and agricultural service providers**

The institute developed a brochure on Nano Porous pipe and a soft copy is available for distribution and printing. Capacity of 88 farmers, 1035 professionals and students were improved on water management technologies through trainings, workshops, field days and field visits to demonstration sites.



Handing over certificates of distinction on the successful completion of two days (Dec 6 to 7, 2023) professional training workshop



Exposure visit of professionals from AARDO countries to Satrameel field station

## LAND RESOURCES RESEARCH INSTITUTE

### Integrated Nutrient Management (INM) based demonstrations

Integrated Nutrient Management (INM) based demonstrations were conducted on farmers' fields across the country. It was observed that nutrients (N:P:K:Zn:B=120:90:60:5:1 kg/ha) and biozote/humic acid at fifteen sites resulted in a decrease in soil pH and a significant 15-30% increase in crop yield compared to Farmers' Practice (FP).

### Role of microbial decomposers on composting of some invasive weeds

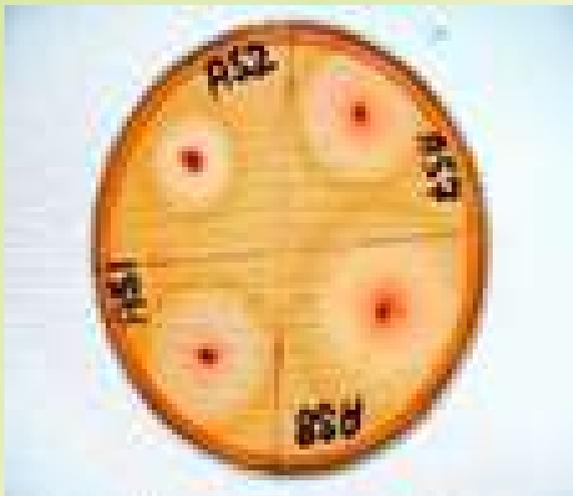
A study was conducted with objective to find the best decomposer bacterial strain for efficient compost production from green wastes. Bacterial isolate RGD 6(4) and consortia RGD 6(4), RND 6(1), RGD 6 outperformed the control in terms of pH, EC, temperature, moisture content, and total organic carbon, indicating their effectiveness for rapid decomposition and superior compost quality.

### Farm waste management through biogas production

NARC-inocula (*B. diminuta*, *P. bauzanesis* and *B. paramycoids*) were prepared and tested for biogas production along with un-inoculated control in static batch reactor (1-2 L) under laboratory conditions for 40 days and compared with other inocula.

The trend of various inocula efficiency for biogas production was NARC-inoculum > Ch-inoculum > D-inoculum showing 12 folds, 11 folds and 8 folds increase in biogas production over control.

The quality of biogas in terms of methane contents was also improved by bacterial inoculum as compared to control.



### Health Risks Assessment of Food Chain Derived Heavy Metals

Using untreated effluents for irrigation leads to adverse health effects. Interventions included sampling irrigation water, soil, vegetables, cereal crops, and fodder for heavy metal analysis. The outcomes revealed toxic levels of heavy metals in untreated effluents, translocation in crops, and detectable levels in shallow drinking water and human/animal blood, posing health risks. Some of the HMs were detected in shallow drinking water above the permissible limit where untreated industrial effluent is continuously used for irrigation. Heavy metals translocation into the animal and human blood was detected above the permissible limit in some areas, showing carcinogenic and non-carcinogenic risk.

### Rice Residue Management for Sustainable Wheat Productivity

The challenge of abundant crop residues left after combine harvesting, was addressed through interventions with Pak-Seeder and Super-Seeder. These innovative tools successfully enabled for timely wheat sowing in standing residues. Field trials demonstrated remarkable outcomes, including an 8-12% increase in wheat yield, reduced bulk density by 5%, and a 16% increase in soil aggregate stability after three years. Moreover, effective porosity increased by 4%, refilling porosity by 8%. Water conservation of 21% with Pak-Seeder and 12% with Super-Seeder was recorded as compared to conventional methods used by farmers.



Super-Seeder



Pak-Seeder



Crop Residue Removal

### Driving Agricultural Innovation from Laboratory to Field for Sustainable Crops with Bio-Zarkhaiz: A 3rd Generation Biofertilizer

Land Resource Research Institute has introduced Bio-Zarkhaiz. This product has unparalleled ability to enrich soil health. It is packed with diverse beneficial microorganisms. Various trials have reflected its ability to thrive soil microbiome thus enhancing nutrient uptake for plants. Experiments have revealed that Bio-Zarkhaiz can increase crop productivity up to 30-35%. It has also reduced the reliance of crops to chemical fertilizers up to 30-35%.

### HONEYBEE RESEARCH INSTITUTE

Technology Validation of Apitoxin Collection from Honeybees Apis mellifera L. as high value product in apiculture.

Bee venom production for therapeutic purpose in Pakistan is quite underexplored. A study was carried out to gather bee venom from Apis mellifera L. colonies using

different collectors. It was assessed that how it affected bee colony behavior. HRI compared a local bee venom collector with an imported one from Korea. The results revealed peak production at 0.45mg/colony achieving considerable results. Study identified that though locally designed venom collectors displayed high bee mortality but is considerably easy to use and hence is quite promising for future use.

### **Impact of honeybee pollination on seed increase of sesame (*Sesamum indicum* L.) crop**

In 2022, at NARC's oilseed program field, a trial had three setups: free honeybee and pollinator visits, caged plants with bees, and caged plants without pollinators, each with three repetitions. Sesame seed yield data indicated significant differences in pods, seed weight, and yield. Most pods, seed weight, and highest yield were in open-pollinated (41.53 pods, 3.44 gm/1000 seeds, 91.97 gm/m<sup>2</sup> respectively), followed by *A. mellifera* and caged pollination (35.80 pods, 3.14 gm of 1000 seeds, and 77.33 gm/m<sup>2</sup> respectively). It was concluded that pollinators significantly enhance sesame yield. Shifting honeybee colonies during sesame flowering is recommended for improved yield.



*Bee Venom Collection*



### **Evaluation of some essential oils and plant materials locally available for controlling *Varroa* destructor and their effects on brood rearing and honey production in field conditions**

A study was carried out to control *Varroa* destructor using essential oils for better production of honey. The results showed essential oils and formic acid to be excellent in controlling *Varroa* mites. Thyme oil was most effective in controlling mites, followed by formic acid. Higher Multiflora honey (4.5 kg per colony) was extracted in colonies treated with Thyme oil as compared to other essential oils, plant material and untreated control colonies.

## **RANGE RESEARCH INSTITUTE**

### **Adaptability Trials of Seeds of summer and winter grasses**

In order to improve degraded lands adaptability of imported seeds of various grasses and forages were tested. Rhodes grass produced up to 19 t/ha, Rye grass reached 33 t/ha, alfalfa hit 23 t/ha. These trials lead to *Chloris gayana*'s expansion over 35,000 acres and *Lolium multiflorum* over 6,000 acres nationwide. Outcomes include 14 adaptable forage varieties evaluated, guiding federal seed certification and supporting farmers.

**Adaptability Trials of Italian Rye Grass in Mountain Grazing lands of AJ&K**

Among the sixty Italian ryegrass lines tested in Azad Kashmir, Line No. 05 emerged victorious, showcasing the highest fresh biomass production of 35.42 t/ha, followed by Line No. 06 with 30.83 t/ha. Awareness programs, forest officials, farmers, and local stakeholders meetings were also arranged at the experimental site.



**Introduction and propagation of fast-growing hybrids MPTS in agro-forestry nursery in RRI, NARC.**

Raising of nurseries provide quality planting stock and self-employment opportunities to the farmers where they can use their free time for nursery operations. Nursery in RRI produced five hundred Turbo hybrid Robinia plants, a thousand willow cultivars, two hundred Hybrid Paulownia elongata 9501, fifty hybrid Tecoma grandis, and five hundred Hybrid Populus deltoides were successfully propagated using advanced techniques in our agro-forestry nursery.

**Assessment of Potential Fast Growing Hybrid Tree Species in Silvo-agricultural System.**

The project successfully introduced and evaluated the yield and carbon stocks of five fast-growing agro-forest tree species, with hybrid Populus deltoides standing out for its impressive 5.28 t/ha biomass productivity and 2.64 t/ha carbon stock. The initiative also assessed the influence of trees and intercropping on soil health and carbon stocks, while promoting awareness among local farmers and timber industries.



## Balochistan Agricultural Research & Development Center (BARDC Quetta)

### Release of Varieties

BARDC achieves significant progress in crop breeding. As 3 new wheat, 2 barley, and 1 lentil varieties were released. Notably, last year marked the release of 03 more varieties including Ejaz-21, JE-21, and Dasht-21, while high-yield disease-resistant durum wheat and 02 barley lines are set for release.



### Promoting Research for Productivity Enhancement in Pulses (PSDP funded project)

Through PSDP pulses project entitled “Promoting Research for Productivity Enhancement in pulses” lentil plantation on 400 acres and chickpea plantation on 10 acres has been carried out in the province at farmer's fields successfully. The total lentil seed of 120 tons were produced by farmers and will be further disseminated on farmer to farmer basis in Balochistan.

### Establishment of Olive Orchards at BARDC and on farmer fields in Balochistan.

BARDC is working on olive since 2013 and till 2022-23 about 9300 acres were brought under olive cultivation. During the year 2022-23 about 180,000 (on 1300 acres) olive plants were distributed (33% farmer's share) in 18 districts. In total pkr 16.704 million were collected as farmer's share through BARDC component, which is the 35 % of total collection by Olive PSDP project.

### Installation of Olive Double Shaded Nursery Tunnel under PSDP Olive Project at PARC-BARDC Quetta.

Olive double shaded nursery tunnel is operational at PARC-BARDC Quetta, a standout achievement under the Olive PSDP project. With 80000 cuttings set to thrive, this facility leads PARC-BARDC as Balochistan's premier nursery producer, fortified by its exclusive mother orchard. In coming years by using double shaded tunnel, PARC-BARDC will be able to fulfill Balochistan requirements of olive plants.



Seed distribution event at BARDC



Lentil farmer field at Mastung



Olive plantation on farmers field in Kila Saifullah

**Installation of Solar Tube Well at PARC-BARDC under PARC Research Fund.**

Installation of Solar Tube Well completed at BARDC farm Quetta amounting PKR 9.6 million from PARC Research Fund 2023. This solarization will irrigate 45 acres of farm, orchards, nurseries, office buildings and BARDC colony and will save huge expenditure on utility bills and will payback in 3-4 year time.

**Introduction and installation of High Efficiency Irrigation System in Balochistan**

Despite being the largest province, low yield is prevalent mostly due to water scarcity. BARDC aims to address this issue by introducing High Efficiency Irrigation Systems (HEIS) to conserve water for generations. The impact is quite huge as 900 acres of Drip Irrigation have been installed since 2014-15 and 555 acres have come under HEIS during this year alone, aided by farmer contributions.

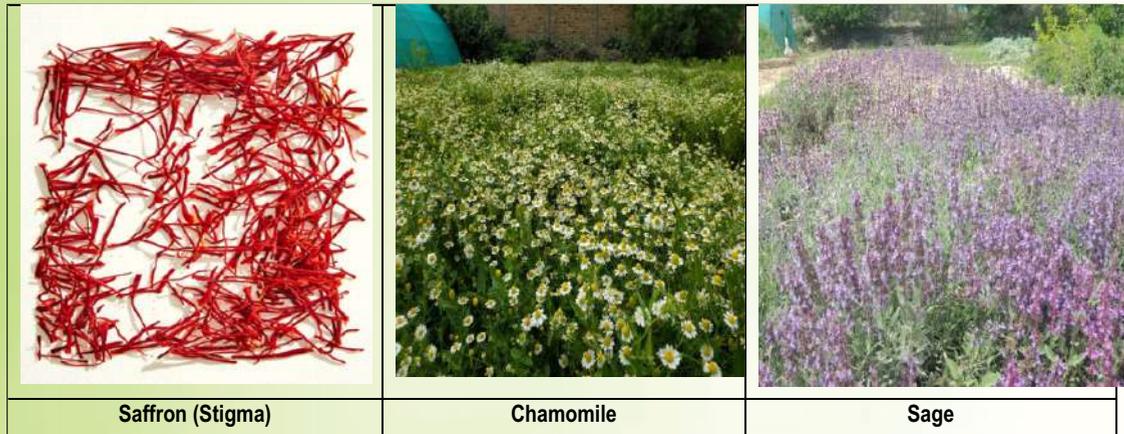
**Products Developed by BARDC**

BARDC is working on medicinal herbs since 2004. BARDC have about 52 different medicinal herbs in its medicinal herbs garden. During the year 2022-2023 BARDC



Olive Double Shaded Nursery Tunnel at PARC-BARDC Quetta

produced different herbs like Rosemary (37.0 kg), Chamomile (33.0 kg), Oregano (7.5 kg), Lemon grass (7.0 kg), Thyme (6.0 kg), Tarragon (6.0 kg), Mint (7.0 kg) and Saffron Stigma (200 grams). The herbs were either sold by PATCO, Islamabad or sold by BARDC to generate income. Likewise, 6000 saffron bulbs were provided to PATCO for sale during 2022-23.



**Mountain Agriculture Research Centre (MARC, PARC)**

**Wheat Yield Trials at MARC and Substations**

In a series of experiments, wheat yield trials depicted remarkable achievements. From the GB PUWYT at multiple sites, Entry-2 displayed 3150 kg/hac yield at MARC, Juglote, followed by Entry-3 at FCRS, Basin Gilgit (1161 kg/hac) and FCRS, Goner Farm, Chilas (2030 kg/hac). Notably, the NESWYT-B and NESWYT-A trials highlighted Entry-12's high production, delivering 2970 kg/hac at MARC, Juglote. Even higher production was revealed in National Uniform Wheat Yield Trials, as Entry-54 displayed an impressive 3740 kg/hac yield at MARC, Juglote.

**Establishment of MPTs Nursery**

BARDC established nursery of 1000 cuttings of three different varieties of Poplar in order to know the comparative analysis of growth and selection of diseases resistant variety, survival rate and growth performance of Chilgoza pine nursery was also assessed.



**Nursery of Multipurpose trees Testing of Vegetables Variety**

At MARC Juglote, we evaluated 8 Tomato, 4 Brinjal, 4 Hot Chili, and 3 Radish varieties. It was observed that Roma Tomatoes (47.2 t/ha), Padagoda Brinjals (29.3 t/ha), China Red Chilies (7.63 t/ha) and China Red Radishes (36 t/ha), displayed impressive yields. The experiments will be continued next year for final selection. 83 kg seed of China Cabbge and China Red Radish produced and distributed to progressive farmers on subsidize rate promising a flourishing harvest ahead. The centre produced 70 thousand seedlings of sweet pepper, hot chili, tomato, brinjal and onion; and provided to farmers / agriculture Extension department GB.



### Enhancing production of fruits in Gilgit-Baltistan

Significant achievements and results emerged from the provision of 5000 deciduous fruit plants including apricot, apple, cherry, pear, plum, fig, walnut, and almond, benefiting farmers, NGOs, and government organizations. Additionally, 6000 deciduous fruit plant root stocks were grafted for apricot, apple, pear, peach, and cherry. Notably, 30,000 local olive plants were distributed to farmers, NGOs, and the Pak Army, alongside the collection of GPS data for 240 olive orchard fields.

### Effective Botanical Pellets Combat Onion Maggot Infestation

The potent insecticidal activity of botanical pellets derived from four native herbs against onion maggot was explored. Through field trials, these botanical pellets were pitted against four synthetic insecticides in combating *Delia antiqua*, particularly executed at Thorgu Bala village. The results displayed potential of *A. sieversiana* pellets, which proved equally effective as chemical insecticides in curbing onion maggot infestation.

### Maintenance of Demonstration plots/Potato Crop

Maintenance of Medicinal Plant demonstration plots are thriving through extreme care, where new plants are consistently replaced by withered ones. The process consists of essential tasks like weeding, irrigation, and diligent hoeing. Furthermore, for attaining self-sufficiency, the planting and nurturing of Seed Potato Crops is being carried out since 2022-2023 cropping season, in PARC-MARC Astore's Screen houses and leased fields under the "Self Sufficiency of Virus free Potato Seed Multiplication" project.

## Arid Zone Research Institute, Bahawalpur AZRI PARC

### Response of different weed control methods (Chemical & Cultural) on Mungbean cultivars

A Kharif 2022 field experiment at Arid Zone Research Institute, Bahawalpur, focused on cost-effective weed control methods. Among the treatments, Treatment 4, featuring Stomp 330 EC (Pendimethlin) pre-emergence weedicide and two hoeing, yielded the highest seed yield of 1734.6 kg/ha.



### **Testing of Wheat Advance/ Candidate Lines of PARC AZRI, Bahawalpur in National Uniform Yield Trial 2022-23 & Wheat Disease Screening Nursery-2022-23.**

PARC-AZRI Bahawalpur, under the genetic improvement theme, carefully screened wheat genotypes resilient to biotic and abiotic stresses in Bahawalpur's arid climate. From these efforts, advance line AZRI-08, yielded 5675 kg/ha in the Punjab National Uniform Yield Trial 2020-21. Following this the high-yield AZRI-08 was forwarded for evaluation in the Wheat NUYT and National Wheat Disease Screening Nursery-2022-23, assessing its potential for further impact under challenging conditions.

### **Comparison of various techniques for cotton productivity in Saline Soil of Cholistan under ACIARASSIB Project of PARC, AZRI, Bahawalpur**

This project aimed to reclaim salt-affected soil and saline water for agricultural purposes, specifically cotton cultivation, employing diverse techniques. Flat Bed Ridges delivered the highest cotton yield of 1802.7 kg/ha, showcasing a breakthrough for cotton productivity in Cholistan's saline soil conditions.

### **Testing Evaluation and Yield Comparison of various advance lines of Ispaghool for their growth & yield performance (screened out of Ispaghool under ALP Project for varietal development under agro-climatic conditions of Bahawalpur.**

The experiments yielded 17 high-yield genotypes, excelling in traits like drought resistance, heat tolerance, and productivity, have been selected for further varietal development, depicting a significant achievement in arid Cholistan desert conditions.

### **Adaptability Trials of Olive for Growth and Yield Performance under Saline and Drought Conditions of Cholistan desert of Bahawalpur**

Sixteen olive varieties were evaluated, with Arbequina, Gemlik, and Arbosana standing out for their impressive performance in Cholistan's drought-stressed environment. These varieties demonstrated robust growth rates and successful fruiting, marking a significant advancement for olive cultivation in the region.

## **ARID ZONE RESEARCH CENTRE D.I.KHAN (AZRC D.I Khan)**

### **Varieties Developed at AZRC**

Wheat variety "AZRC DAMAN" released from Provincial Seed Council, KP during 2023.

### **Major Technical Achievements**

Substantial quantities of basic and pre-basic seed of Wheat (22 ton), Chickpea (10 ton), Lentil (3.5 ton), and Guar (62 kg) varieties were produced. Pulses varieties were distributed to end-users in D.I.Khan, Tank, and Lakki Marwat. Advisory services were extended to the farming community, offering guidance on livestock and agricultural practices.

### **Arid zone Research Centre Umerkot (AZRC Umerkot)**

### **Strengthening/Up-gradation of Agriculture and Livestock Research System of Arid Zone Research Institute, Umerkot-Sindh**

The Arid Zone Research Institute (AZRI) in Umerkot, Sindh, has undergone "Strengthening/Up-gradation of Agriculture and Livestock Research System,"

PARC has extended the project by one year to finalize pivotal elements, including the construction of a modern guest residence, RO plants, a 15 KW solar system, camel shed, and a rainwater harvesting pond. The initiative also included the establishment of state of art laboratory, furnished with lab glassware, chemicals, and machinery, further emphasizing the institute's commitment to advancing agriculture in this promising but less developed area.



**Establishment of good chili production and development of postharvest management technologies**

Project under KOPIA-Pakistan project carried out Chilli cultivation, including setting up effective nursery sheds to combat pests like white flies. By monitoring and aligning pre and post-harvest processes, the project ensured high-quality chillies with minimal losses. The installation of two advanced Solar Energy Dehydration Plants, powered by 25KV solar energy, led to the successful drying of 16,000 kg of fresh chillies, yielding 4,480 kg of top-grade dried chillies with a 28% recovery rate.

**Introduction & maintenance of high efficiency irrigation system in arid areas**

A significant achievement has been made through the maintenance of 14 high-efficiency solar-powered submersible water pumps at the center. These pumps have proficiently irrigated orchards spanning 62 acres, including Ber, Chiku, Date palm, Guava, and Lemon. The adoption of these advanced irrigation systems resulted in impressive water savings of 75-80%.

**Selection and development of potential crop varieties/Lines**

The project is developing crop varieties such as Mustard, Chillies, Cluster Bean, Mung Bean, Kidney Bean, Chickpea, Cotton, and Groundnut for adaptability and yield performance. Notably, 52 cluster bean, 50 mung bean, 30 chillies, 20 Mustard, 12 Chickpea, 12 groundnut, 15 Mung bean, 7 kidney bean, and 5 cotton lines were evaluated, leading to the selection of promising lines for further breeding. Additionally, Cotton's successful introduction in the Thar area was highlighted by an average yield of 26 munds acre-1 across three locations.



## Capacity building of different farming communities & members of different organizations

AZRC conducted various capacity building activities involving diverse farming communities and organizational members through comprehensive training, including Training of trainers, farmers, extension workers, and NGOs. Over 100 Local Government and Agriculture Extension Department members, 50 NGO representatives, and 500 community farmers were equipped with enhanced knowledge on climate change, CSA, and various agricultural practices.

## Water and Agricultural Waste Management Institute, Tando Jam (WAWMI, Tando Jam)

### Expansion of Tissue Culture Banana Cultivation in Sindh

In 2021-2022, the approval and recommendation of NIGAB-1 and NIGAB-2 Tissue Culture Banana varieties for commercial cultivation in Sindh Province marked a significant milestone. Additionally, the ongoing approval process for NIGAB-3 and NIGAB-4 varieties further establish the advancement of banana cultivation in the region.

### Management of Nursery and provision of Tissue Culture Plants to Growers

Banana Tissue Culture Plants (in rooting jars) provided by Bio-Technology Research Laboratory, NARC, Islamabad were kept for shifted to nursery bags for primary and secondary hardening and provided to different progressive growers of Sindh for field plantation at their farms.





# ANIMAL SCIENCES

## ANIMAL SCIENCES DIVISION

The objective of this division is to set priorities of research according to the needs of the Provinces and monitor research activities being conducted at the Federal and Provincial level and eventually finding solutions of the burning issues confronting livestock sector. The researchable areas under ASD are animal health, animal feeds and nutrition, animal reproduction and genetics, dairy technology and inland aquaculture and fisheries.

### AIM:

To improve production potential of food animals.

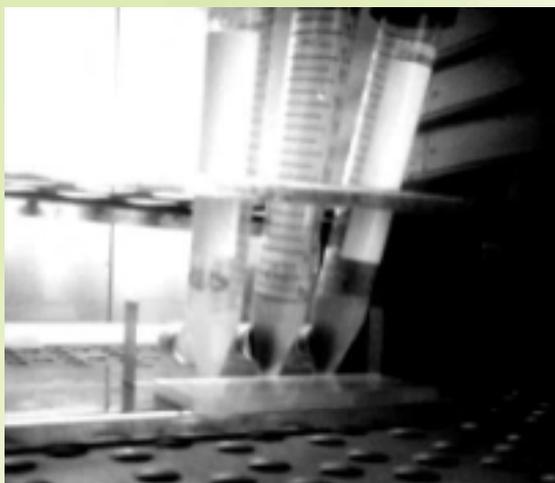
### OBJECTIVES:

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

### 1. Animal Reproduction and Genetics Program (ARGP)

#### Project 1: Investigations and Optimization of Sperm Sexing and Cryopreservation Techniques in Water Buffalo (ALP-337)

**Salient achievement:** The Magnetic Nanoparticle based sperm sexing technique was optimized for buffalo spermatozoa. Mean fold expression of female specific gene (X-linked proteolipid protein) was 15.34-fold higher in sex sorted spermatozoa as compared to unsexed spermatozoa (1.60).



*Sperm Sexing in Water Buffalo through MNPs*



*Validation of sperm sexing technique by real-time PCR*

#### Project 2: Nanotechnology-Enabled Improvement of Spermatozoa Cryopreservation Technique for Water Buffalos (ALP-341)

**Salient achievement:** Doses of Zinc Oxide (12.29 mmol/l), Cerium Oxide (0.29, 0.58 and 1.16 mmol/l) and Manganese Oxide (0.2, 0.4 and 0.6 mmol/l) nanoparticles (nano-antioxidants) were optimized for buffalo spermatozoa. It is expected that use of these nano-antioxidants in cryodiluent will improve the cryopreserved quality and fertility of buffalo spermatozoa.

**Project 3: Improvement in the livelihood of Rural Farmers through Improving Livestock Reproduction Services at Union Council Rang Shah, Arif Wala, Pakpattan (FAO-ASI Project TFD-21/Pak/001)**

**Salient achievement:** The marginal livestock farmers (n=955) from 27 villages of District Pakpattan got facilities of AI services and pregnancy diagnosis. An overall conception rate of 70% was achieved with AI of Nili Ravi buffalo, Sahiwal and Holstein Friesian bulls frozen thawed spermatozoa.



*AI with high genetic semen of exotic Holstein Friesian*



*Crossbred calf born through AI with exotic Holstein Friesian semen*

**Project 4: Breed Improvement of non-descript Goat through Assisted Reproductive Techniques**

**Salient achievement:** The high genetic progeny of Beetal (n=20) and Saanen (n=11) bucks were produced through Laparoscopic Artificial Insemination by using frozen thawed spermatozoa.



*Laparoscopic AI in goats*



*Saanen crossbred kid*

**Project 5: Standardizing the Outcome of In Vitro Fertilization and Embryo Transfer Technologies in Water Buffalo**

**Salient Achievement:** In Pilot experiment, one buffalo was detected pregnant through embryo transfer (vitrified embryo) at ASI.



*Embryo Transfer in buffalo*



*Ultrasonogram of buffalo fetus at day 40 of gestation*

**National and international linkages:** National Linkage has been developed with Indus hospital & Health Network, Karachi and FAO to uplift the livelihood of livestock farmers through modern reproductive techniques.

Annual planning meetings: Total 14 meetings were conducted/attended.

Public Private Partnership:

**MoU signed:** LOI was signed between PARC and Royal Cell Biotechnology, Pakistan to “Optimize and Standardize the In-Vitro Fertilization and Embryo Transfer Technologies in Water buffalo”.

**Technology transfer:** One day National Training Workshop was conducted for academicians, researchers and field veterinarians on Laparoscopic AI in Goats under ALP project.



Mr. Muhammad Nihal, Secretary PARC and Dr. Qaiser Shaukat, Project Manager Royal Cell Biotechnology Pakistan signing a Letter of Intent at PARC Hqs Islamabad. Chairman PARC, Dr. Ghulam Muhammad Ali, alongwith senior scientists and members of PARC and Royal Cell Biotechnology Pakistan, also witnessing the occasion on 03-02-2023 [D/o of PARC, PARC]



Glimpses of one day National Training Workshop on Laparoscopic Artificial insemination in goats

**Knowledge generation and management:** Five research Articles Published in Peer-Reviewed International Journals.

**Financial resources and budget:** ALP Projects = Rs. 4.1 million

**Visit of diplomats/dignitaries to research facility:**



Visit of Indus Hospital & Health Network Team at Small Ruminant Farm, ARGP, ASI, NARC



Demonstrating the Modern Reproductive Facilities to Livestock Officials from all over the country at ARGP, ASI

## 2. Animal Product Improvement Program (APIP)

**Project 1: Isolation, Characterization and Utilization of Riboflavin (Vitamin B2) Producing Lactic Acid Bacteria for Preparation of Nutraceutical Yogurt.**

**Salient achievement:**

- i. The mean riboflavin level in the currently available market milk and yogurt was found to be  $2.55 \pm 0.57$  mg/L and  $2.52 \pm 0.66$  mg/L.
- ii. Four strains of Lactic Acid Bacteria were identified as riboflavin over producers. The riboflavin concentration produced by these strains in the yogurt ranged between 4.71 mg/L to 6.38 mg/L (significantly higher than that of market yogurt samples), and thus were considered suitable for preparation of riboflavin enriched nutraceutical yogurt.

**National and international linkages:** National Linkage has been developed with National Probiotics Lab, NIBGE, Faisalabad.

**Knowledge generation and management:** One Research Article Published in Peer-Reviewed International Journal.

**Financial resources and budget:** ALP Project =Rs. 4.943 million

### 3. Aquaculture and Fisheries Program (ARGP)

#### Project1: Validation and Establishment of Intensive Production Packages for High Value Fisheries

##### Salient achievement:

- i. Developed protocol for different stocking densities and culture systems of carps and catfish under poly culture system (monoculture, bi-culture and polyculture).
- ii. Developed different feeding regimes for optimum growth (15%, 20%, 25% and 30% Crude protein).
- iii. Appropriate stocking densities and species combination with various management inputs are successfully made. American channel catfish showed highest total weight gain i.e.0.81 kg followed by silver carp i.e.0.76 kg.

#### Project 2: Introduction of a High Value Fish Channa striatus (Saul) in Aquaculture system of Pakistan

##### Salient achievement:

- i. Successfully acclimatized Channa striatus (Saul) germplasm in semi-intensive culture system installed at experimental site.
- ii. Protocols for Saul growth performance using different stocking densities in semi-intensive culture systems have been developed. Up to 0.30 kg total weight gain has been achieved in Saul fish.



*Different fish species in intensive farming system at NARC*



*Channa striatus acclimatization and measurement of growth performance*

**National and international linkages:** National Linkage has been developed with Punjab Fisheries Department and Fisheries Development Board.

**Technology transfer:** Mono sex all male tilapia seed transferred to farmers.

**Knowledge generation and management:** Four Research Articles Published in Peer-Reviewed International Journals.

**Financial resources and budget:** Two ALP Projects = Rs. 24.152 million.



*Visit of Gilgit Baltistan Administration officials to AFP, ASI, NARC*



*Visit of Punjab Livestock Department to AFP, ASI, NARC*

#### 4. National Reference Laboratory for Poultry Diseases (NRLPD)

##### **Project1: Monitoring of Avian Influenza and Newcastle Disease in Backyard Poultry in Pakistan (PM Initiative of Backyard Poultry under L&DDB, MOU project, ASI, NARC Component).**

**Salient achievement:** Under the L&DD project “PM initiative for Backyard poultry” 560 backyard poultry serum samples were received at NRLPD. The samples were analyzed for Avian Influenza and Newcastle Disease through serology. The HI titer for AIV subtypes ranged between 0.0-9.0 for H5, 0.0 for H7, and 0.0-11.0 for H9. The titer ranged between 0.0-11.0 for NDV.

##### **Project 2: Surveillance of Anti-Microbial Resistance (AMR) in Poultry (Fleming fund UK)**

###### **Salient achievement:**

- i. Commercial broiler birds (n=628) sampled from Live Bird Markets (LBM) were analyzed for *E. coli*, *Salmonella* and *Enterococcus* and for antimicrobial susceptibility.
- ii. The most commonly resistant antibiotics were Tetracyclines, Nalidixic Acid, Quinolones, Penicillin, Streptomycin, Quinopristin/Dalforistin, Erythromycin, Trimethoprim and Sulfonamides.
- iii. Participated in 2nd EQAsia Matrix and round 5 EQAsia PT schemes for evaluation of laboratory capacity with quality management to correctly analyze AMR in bacterial pathogens.

###### **Annual planning meetings:**

Consultative meeting of the national laboratory networking group of animal health (NLNG-AH) held on 27th September, 2022 in Islamabad.

Consultative meeting of the national laboratory networking group of animal health (NLNG-AH) held in May, 2023 in Islamabad.

**Technology Transfer:** Capacity building/training of provincial veterinarians for isolation, identification and antimicrobial susceptibility testing for *E. coli*, *Salmonella* and *Campylobacter* under Fleming Fund.

**Financial resources and budget: Two projects= Rs. 0.777 million**

#### 5. Animal Health Program (AHP)

##### **Project1: Epidemiology and Control of Brucellosis in Pakistan (AS-074)**

###### **Salient achievement:**

- i. The prevalence of brucellosis in peri-urban herds of two regions i.e., Islamabad Capital Territory (ICT) and Azad Jammu and Kashmir (Muzaffarabad, Mirpur and Bhimber) was 33.75% and 31.1%, respectively.
- ii. In total 19 *Brucella abortus* isolates were recovered from milk samples and confirmed by using real time PCR.



Milk samples collected from dairy herds of ICT and AJK were analyzed using Milk Ring Test



Collection of blood samples from a goat herd

iii. This study determined that the prevalence of brucellosis (32.24%) is high in dairy herds of ICT and Azad Jammu and Kashmir and this disease could be an occupational hazard for livestock workers, veterinarians, butchers, and households.

**Project 2: One World-One Health: Holistic and Cost-effective approach to counter Brucellosis in sheep/goats in Pakistan (As156)**

**Salient achievement:** The overall prevalence of brucellosis in small ruminants of Azad Jammu and Kashmir and Khyber Pakhtunkhwa was 1.32% (n=376). The prevalence of brucellosis was higher in sheep (10.3%) compared to goats (0.57%).

**Project 3: Preparation and evaluation of bovine serum and chicken egg derived immunoglobulins for the treatment of *Staphylococcus aureus* mastitis in cattle and buffaloes (PSF)**

**Salient achievement:** *Staphylococcus aureus* bacterin was prepared using Montanide. The safety of the bacterin was assessed in rabbits (n=5). The bacterin was found safe in rabbits.

**Project 4: Field validation of a newly developed homologous Lineage thermotolerant Peste des Petits Ruminants (PPR) vaccine for control of PPR (As385)**

**Salient Achievement:** Quality control procedures for PPR vaccine development were standardized. For this purpose, a sterility test was undertaken. The vaccine strain was found to be free of any bacterial and fungal contaminants.



Homogenization of antigen toxoid with Montanoid Adjuvant



Chinese delegate visited AHP, ASI NARC

**Project 5: Development of models for control of Warble fly in Pakistan (AS340)**

**Salient Achievement:** A questionnaire was designed to collect epidemiological data to assess warble fly prevalence in Pakistan.

ii. A survey was conducted in Dera Ismail Khan and Quetta to assess the current situation of warble fly infestation (WFI). Only four cases of WFI were observed in these areas.

**Project 6: Genetic and Antigenic characterization of foot and mouth disease (FMD) viruses for development of improved and potent vaccines**

**Salient Achievements:**

Sixteen FMD viruses were recovered from 51 epithelial cells/ samples collected from cattle and buffaloes in Quetta, Balochistan and characterized as “serotype O”.

**National and international linkages:** Developed linkages with PMAS Arid Agriculture University Rawalpindi and Provincial Livestock and Dairy Development Departments regarding ALP and PSF funded projects.

**Annual planning meetings:**

- i. Consultative meeting of the national laboratory networking group of animal health (NLNG-AH) held on 27th September, 2022 in Islamabad.
- ii. Consultative meeting of the national laboratory networking group of animal health (NLNG-AH) held in May, 2023 in Islamabad.

**Knowledge generation and management:** Four Research Articles Published in Peer-Reviewed Journals.

**Financial resources and budget:** ALP Projects = Rs. 28.896 million

**6. Livestock Research Station (LRS)****Project 1: Evaluation of crop residue based total mixed fermented ration for ruminants (ALP)****Salient achievement:**

- i. An experimental trial on feed intake and weight gain has been conducted in cattle calves (n=10) at Rawat area.
- ii. The results revealed that average total weight gain was higher in the calves fed on TMR-Beet pulp silage than those fed TMR-Wheat straw-based diet (52.5 vs 47.6 kg).
- iii. The feed cost per unit of weight gain of calves fed TMR with beet pulp silage was lowest (Rs 192.98 vs 214.99) compared to TMR with wheat straw.

**Project 2: Refinement of Feedlot Fattening Rations for Cattle and Buffalo Calves under Different Feeding Systems (PSDP sub project)****Salient achievement:**

- i. The data on feed intake and weight gain has been recorded on 15 post-weaned calves with 3 treatments.
- ii. The average total body weight gain (BWG) and dry matter intake (DMI) were improved with the TMRs containing Beet pulp silage (BWG: 71.40 kg, DMI: 5.62 kg) followed by citrus pulp silage (BWG: 69.20 kg, DMI: 5.54 kg) and oat fodder based TMRs (BWG: 59.60 kg, DMI: 5.45 kg).
- iii. The feed cost per kg gain in calves fed TMR with Beet pulp silage was lowest (Rs. 183.87) followed by those fed TMR with Citrus pulp silage (Rs. 192.65) and Oat fodder (Rs. 204.92), respectively.
- iv. In conclusion, Beet pulp silage was better in terms of weight gain and economical benefit in buffalo calves compared to others.



*Field trial at Rawat area*



*Fattening trial at NARC*

**Project 3: Effects of Supplement substituting maize grain with dried sugar beet pulp in a high forage diet on milk yield, milk composition and economics in lactating buffaloes**

**Salient achievement:**

i. The feeding trial on buffaloes (n=15) has been completed with 03 treatments i.e., 0, 10 and 15% levels of supplements substitution with dried sugar beet pulp (DSP). Average milk production was highest in the treatment group with 10% level of supplement substitution with DSP.

ii. A Seminar/Workshop was arranged on 30th December, 2022 to disseminate the salient findings.



**National and international linkages:**

National Linkage has been developed with FAO and Livestock and provincial Dairy Development Departments.

**Annual planning meetings:** Total 14 meetings were conducted/attended.

**Technology transfer:** A seminar was organized at Livestock Research Station, ASI, NARC, Islamabad on 30th, December 2022 to disseminate information to farmers regarding use of crop residue based total mixed fermented ration for ruminants.

**Knowledge generation and management:** Two research articles published in peer-reviewed journals

**Financial resources and budget:** ALP project = Rs. 1.085 million

**7. Animal Nutrition Program (ANP)**

**Project 1: Improving productive performance of backyard poultry through propagation of superior hybrid poultry birds (PSDP sub-project)**

**Salient achievement:**

i. The parent flock around 200 birds of different breeds (Black Australorp, Rhode Island Red, Hybrid Naked Neck) was maintained at poultry farm.

ii. Around 120 sets (5 hens + 1 cockerel per set) i.e., 720 birds were distributed among farmers at a subsidized rate through LDDB.

iii. One trial on parent flock to evaluate egg production performance of different breeds with commercial vs home-mix feed was completed.

iv. Results revealed that egg production of birds in all breeds was higher on commercial feed (58.3%) compared to home mix (54.6%). There was non-significant difference in egg mass per bird (4.54kg) and cost per kg (Rs.267) egg mass production between commercial and home-mix feed groups. Although egg production was higher on commercial feed however, egg mass production per bird and feed cost per kg suggest that backyard poultry can be reared economically on simple home mix feed consisting of grains and meals.



*Rearing of parent stock*

**Project 2: Characterizing *Aspergillus flavus* from cotton fields to improve environmental, feed and food safety (NAS-USA)****Salient achievement:**

- i. In total 60 samples of soil, cottonseeds and cake were collected from different cotton growing regions of Punjab and Sindh.
- ii. Over 20 isolates of *Aspergillus flavus* were obtained from these samples and examined morphologically and subjected to aspergillic acid and aflatoxin production tests.
- iii. Four toxigenic isolates have been identified. These isolates are being characterized using PCR.

**National and international linkages:** Established linkages with National Academy of Science, USA and Livestock Dairy Development Board, Islamabad.

**Annual planning meetings:** Two planning meetings were conducted/attended.

**Technology transfer:** Distributed 120 sets (720 birds) of improved hybrid Naked-Neck breed among farmers.

**Knowledge generation and management:**

Published 5 research papers in national and international peer reviewed journals.

Interns (n=24) from different universities were provided hands on trainings and livestock visitors/farmers/students (n=250) were advised regarding feed formulation and feeding of dairy and fattening animals and poultry.

**Financial resources and budget: PSDP = Rs. 4.85 million**



# Social Science

## Social Science Division

Social Science Division (SSD) has its research institute in all provinces including AJK. The core objective of these institutes is to carry out the research on socio-economic issues and also facilitate and support interdisciplinary applied research that addresses critical social and economic problems primarily in Pakistan. The SSD works with other Divisions at PARC and provincial and federal researchers in crop, livestock, and natural resources. Currently, SSD is working under different thematic research areas. SSD is the pivot research institute that gives direction to its research networks. During 2022-23 different research studies have been carry out at SSRIs under the supervision of SSD.

### Virtual Water Trade in Pakistan

Virtual water trade is the hidden flow of water in food or other commodities that are traded from one place to another. In Pakistan, unsustainable consumption, over-extraction, and climate change have put additional pressure on water sustainability. Water crisis is putting the largest sector of the country's economy at risk. The major crops of Pakistan (Rice, Wheat, Cotton, Sugarcane, and Maize), fruits, and vegetables are the main consumers of agricultural water and contribute the most to the domestic virtual water trade among provinces. In the recent past, virtual water trade has received much attention and has become an important tool for balancing water budget at regional as well as international levels. On the other hand, virtual water trade may also adversely affect the exporting region/country's water balance and the economy. In this study, virtual water trade was analyzed based on data from secondary sources for major crops.

The research results provided the magnitude and direction of the virtual water trade in Pakistan. The Khyber Pakhtunkhwa province was found to be a net importer of 9168 million cubic meters (Mm<sup>3</sup>) of virtual water (rice 600, wheat 3652, sugar 413, fruits 354 and vegetables 733 Mm<sup>3</sup>) from other provinces. Similarly, Sindh province was a net importer of 2616 Mm<sup>3</sup> of virtual water (maize 1807, fruits 37 and vegetables 775 Mm<sup>3</sup>) from other provinces. Balochistan province was a net importer of 1090 Mm<sup>3</sup> of virtual water (wheat 27, sugar 640, and maize 423 Mm<sup>3</sup>) from other provinces. It is suggested that clustering of agricultural commodities may be encouraged based on the comparative advantage, each province has, to make best use of water available to each province. Low water availability regions need to specialize in high value crops that could be exported to other provinces.

### Recommended Technologies and Farm Practices of Major Crops in Context of Decreasing Profitability in Punjab Province of Pakistan

Pakistan has been experiencing stagnating yields for quite some time. There has been a belief that one of the reasons for low yield is lack of knowledge of modern production practices available to a majority of the farmers. To measure this factor of knowledge gap and the difference in profitability of farmers adopting recommended modern production packages and those not following these, this study was designed. In the year 2022-23 there was a difference of about thirteen percent in the cost of existing and recommended production packages of sugarcane crop. Furthermore, investment gaps were found to be inversely related with farm size. Mean knowledge gap of the growers was 59 percent. Sugarcane growers have low to medium knowledge gaps about recommended production package of the crop. As for as adoption of the production practices is concerned, land preparation practices for crop sowing, seed rate and fertilizer application were moderately adopted vis-à-vis recommended levels. While, seed treatment, irrigation application and disease control are poorly adopted by the growers. However, chemical weed and insect-pest

control practices were comparatively better adopted.

In case of Cotton, there was a difference of about thirteen percent in the cost of existing and recommended production packages of the crop. Investment gaps between recommended and existing production packages were 7.6, 21.1 and 5.21 percent at, small, medium and large farms, respectively. Mean knowledge gap of the cotton grower was 46 percent. Most of the farmers had medium level of knowledge about recommended production practices. Adoption of recommended chemical weed control practice was comparatively better adopted than other practices. Land preparation and fertilizer application practices were partially adopted by the farmers, while, adoption of recommended seed rate, its treatment before sowing and irrigation practices was poor. Thus, concerted efforts through extension and financial services are required to enable farmers to improve adoption of recommended practices.

For rice crop, the survey covered the Kharif season of the year 2021. The cost difference between existing and recommended production packages was about 13 and 12.5 percent for fine and coarse varieties, respectively. The investment gaps varied based on farm size. The average knowledge gap among rice farmers was 45.4 percent, increasing with farm size. Regarding spring maize crop, field surveys in Okara, Sahiwal, and Chiniot districts in 2022 showed that the gross cost of cultivation at sample farms was about 11 percent less than the recommended production package. Maize growers had a mean knowledge gap of 25.8 percent regarding the recommended production package, with small farms showing higher knowledge gaps. For wheat crop in the Rabi season of 2020-21, the study focused on rice-wheat and mixed cropping zones. The cost difference between existing and recommended production packages was around nineteen percent. Investment gaps were observed to be higher at medium farms and lower at large farms. The average knowledge gap among wheat farmers was 53 percent. This research highlights the need to bridge the information gap and provide assistance to enhance investment for farmers to enable them to adopt recommended production packages of major crops. By addressing these gaps, farmers can possibly achieve potential yields of major crops in the province.

### **Crop Diversification in Pakistan**

Agricultural diversification is considered vital mechanism for risk aversion, both at foreign and national levels. This study aimed to determine the crop diversification in Pakistan. To capture the variations in provinces, crop diversification indices were computed for four provinces of the country. Temporal changes in diversification over four decadal intervals, 1990-91, 2000-01, 2010-11 and 2020-21 were analyzed based on secondary data. The study revealed that Pakistan's agricultural sector is still concentrating in favor of cereals crops. Cereals crops exhibited positive growth rate in area which validated decreasing trends in crop diversification. Crop diversity was at low level in 2020-21 as compared to 1990-91s in Pakistan. There is variations among provinces in the extent of crop diversification. Punjab has comparatively more diversified than other provinces. However, temporal comparison between, 1990-91 to 2020-21 demonstrates that the extent of crop diversification has decreased in all provinces except in Balochistan.

There was an increase in crop diversity in Balochistan province over the whole period under analysis. Sindh also registered increase in crop diversity during 1990-91 to 2010-11 followed by a slight decrease after that. Temporal decrease was noted in Khyber Pakhtunkhwa (KP) and Punjab provinces with slight improvement in Punjab after 2010-11. There is a little diversification in Sindh and Khyber Pakhtunkhwa towards horticultural commodities. These results show that there was ample room to increase crop diversity in country. From policy perspective, there is a

need to identify evidence-based understanding of factors that facilitate the process of crop diversification. A comprehensive study is needed to examine the determinants of cropping pattern diversification, and evaluate the role of crop diversification in increasing farm income and overall growth of the country.

### **Impact Assessment of Project Interventions under the Project “Increasing Productivity and Profitability of Pulses Production in Cereal-based Cropping Systems in Pakistan**

In the agricultural sector, innovations and their adoption have a significant impact on profitability and productivity. The impacts of innovations with or without their adoption, provide valuable information for decision makers. This study was designed to explore the impact of various interventions introduced under the Pak-Australia collaborative pulses project. The project introduced the different intervention to address the pulses production constraints in six sites at farmer's fields in Pakistan. The farmer-led research approach has adopted to enhance the pulses' productivity and profitability. The project interventions focused on providing certified seeds, improved pulses production technologies and better crop management practices was carried out to assess the impact of these interventions on both beneficiary and non-beneficiary farmers across Pakistan. Primary data was collected from 219 pulses farmers, including 1st stage beneficiaries, 2nd stage beneficiaries, and non-beneficiaries at six project sites.

Currently, at all the six project sites beneficiary farmers had certified seed that was treated with rhizobium Inoculum and fungicides. The certified seed was provided by the project staff, fellow farmers and village-based seed banks. Chickpea fields were found to be weed-free and farmers had the knowledge about pre-emergence weedicides and applied these to control the weeds which reduced labor cost and increased farm profitability. However, attack of pod borer was found even after use of insecticides and root rot the disease, was also observed. The farmers reported issues like availability and accessibility of inputs including seed fungicides, and insecticides. Private sector players including input suppliers and potential service providers can play an active role in increasing productivity by timely provision of inputs and entering into the value addition part of the value chains.

### **Impact of Area Expansion under Oilseed Crops: Possible Repercussions**

Pakistan is the third largest edible oil importing country, after India and China. This study was conducted to provide evidence on different aspects of area expansion under oilseed crops specifically the net gains from area expansion in relation to trade-off with other competing crops in Pakistan. Domestic oilseed production contributes only 13-15 percent of the total consumption, and the rest is met through imports. Major share of oil imports goes to Palm oil. Over time, per capita consumption of vegetable oil has increased from 5-6 liters per capita per annum in 1970s to 22 liters in 2020-21. The major oilseed crops in Pakistan are Cottonseed (67% contribution in local oil production), and Rapeseed-Mustard (19.6%). Other minor oilseed crops are sunflower, sesame, and linseed, while groundnut is mainly used for table consumption. Major competing crops of oilseeds are Wheat, Maize, Sugarcane, and Rice. Different scenarios were selected for trade-off analysis using 1 %, 3%, 5% decrease in area of competing crops to calculate net gains from oilseed area expansion. Analysis revealed that if area under oilseeds is increased by replacing the competing crops, net gains are negative for all the targeted oilseed crops (traditional and non-traditional both). Low productivity of oilseed crops was found to be one of the main reasons for low returns from these crops. This was also supported by existing literature. Due to the negative net returns when trading off with other competing crops, farmers were reluctant to grow oilseed crops. Moreover,

existing literature established that absence of a consistent oilseeds policy, lack of procurement system and excessive import of cheaper palm oil, further deteriorated oilseeds situation with the passage of time. Furthermore, literature also revealed that the production of oilseeds was more common on the farms having fallow lands due to late harvesting of previous crop etc.

To achieve import substitution to a considerable level, productivity is the key. Increase in productivity will help increase profit margins, but supporting through competing crop ever increasing subsidies prove counterproductive for oilseeds. In the presence of palm oil imports, local oilseed prices are expected to stay depressed. COVID-19 pandemic period saw reduced palm oil imports by Pakistan due to increase in palm oil prices in the international markets, which caused local oilseed prices to rise and hence increase in area under oilseeds in the next season.

### **Understanding, Integrating and Mainstreaming Gender into Vegetable Value Chains in Pakistan: An Ex- Post Analysis of SVVCP**

The research draws on the experience and outcomes of “Strengthening Vegetable Value Chains for greater Livelihood benefits” (SVVCP) project conducted in Punjab and Sindh Provinces of Pakistan. The project aimed at integrating gender research and development into tomato, potato, and onion value chains to reduce the gender participation gap and enhance agricultural development outcomes. This study provides quantitative and qualitative evidence in which the agricultural advisory service providers were able to understand, integrate and mainstream gender research, develop selected vegetable value chains, and categorised in terms of best-fit practices. Furthermore, this research looks at success in terms of reducing the gender participation gap by building methodologies and capacities within the project team. Moreover it aims to identify and document strategies for increasing women's access to information, skills, and assets, leading to changed behaviour among farming communities and improved development outcomes. The research utilized mixed methods, including 148 survey-based interviews with male and female farmers and nine Focused Group Discussions (FGDs) with men, women, and women labourers at each site.

The SVVCP project encountered challenges of low community engagement and lack of farmers' interest. To address this, a Whole Family Approach (WFA) was adopted to improve gender and community participation. This approach facilitated the involvement of smallholder farming households, including women. This resulted in indirect benefits such as increased education opportunities for young girls. Through continuous learning and skill development, farmers, especially women, gained expertise in improved production, harvest, and post-harvest techniques. Valuable skills acquired by farmers included nursery production, transplanting, sorting, grading, picking, post-harvest management, and marketing practices, leading to positive changes in tomato, potato, and onion value chains. Key changes across the three value chains after SVVCP interventions included the adoption of new production practices, such as improved nursery production under tunnels, transplantation methods, plant-to-plant distance, potato seed grading and treatment, irrigation management in onions, and sorting and grading.

The study emphasized the emergence of women's groups, leadership roles, and collaborations within smallholder villages and with other villages and enhancing their social networks. The Whole Family Approach facilitated women's participation and improved the recognition of their role by male family members. Therefore, to promote gender inclusive agricultural and rural development, gender mainstreaming, training and capacity building are crucial to enhance the skills and knowledge of smallholder farmers, particularly women, and promote equal participation and decision-making. The continuous monitoring and evaluation of

gender mainstreaming efforts are carried out to ensure sustained progress over time. Furthermore, the government should invest in education to encourage youth participation in agriculture and provide incentives to smallholder farmers, especially women, to improve their livelihoods and promote sustainable agriculture practices.

### **Potential Repercussions of Increasing Area under Export Crops in Pakistan**

This study was conducted to produce evidence on different aspects of area expansion under export crops of Pakistan, specifically the net gains from area expansion in relation to trade-off with other competing crops in Pakistan. The analysis revealed that rice is not competitive to maize and sugarcane crops as the net gains are negative. Moreover, reducing maize area can convert it from an export crop to the status of import crop and the country would have to import maize for domestic needs, which will cost higher. Rice is competitive to the cotton crop with positive net gains. However, keeping in view the importance of cotton-based textile industry in earning country's foreign exchange reserves, it may not be feasible to further reduce cotton area which is already declining due to many factors. Moreover, if cotton area declines, country may have to import more cotton for its textile industry and it would cost higher due to higher global prices and additional transportation costs. Beside the economic aspects, there are other elements that are also needed to be considered regarding rice export enhancement including low productivity, losing competitiveness especially in case of basmati, and contamination issues. It concludes that increasing rice area is not viable option rather productivity enhancement and export market diversification should be focused to increase rice production and exports instead of area expansion.

Economics of citrus was found promising as compared to rice, cotton, and maize crops but not so good in case of sugarcane. However, citrus supply chain across Pakistan has faced diminishing returns over the time. Multiple factors are considered responsible for this. Inadequate technical support, non-availability of improved varieties, infestation of diseases and abrupt climatic changes are stressors for the supply chain. Other hindering factors include low density and low productive citrus orchards, primitive management practices, inadequate storage facility, limited processing, lack of certification and branding, non-compliance of SPS protocols and lack of certifications. Poor quality followed by adoption of traditional packaging practices appear to be detrimental for higher returns in international market. Citrus area expansion is viable in economic terms but it is suggested that the hindering factors especially post-harvest losses (up to 40%) in the citrus value chain should be dealt first before thinking to expand the area.

Mango area expansion is profitable in Punjab where yields are higher as compared to Sindh areas. However, the country has been facing a declining export-production ratio due to quality issues and gradual decline in country's competitive position in the world market. Therefore, despite positive net gains of mango area expansion, it cannot ensure the export. It is suggested that hindering factors should be considered before planning for mango area expansion. Moreover, Pakistan's mango exports is concentrated in a few countries with low-end markets, due to which Pakistan receives the lowest export price despite some recent improvement in mango value chain. It is proposed that market diversification should also be focused by entering the high-end markets.

### **Rural Development in Pakistan: A Review**

Pakistan is predominantly a rural country. General prosperity of the country is principally linked with rural development and rural development is critically linked with agricultural development. Analysis of rural development, agricultural development, and rural poverty nexus indicated that agriculture is crucial for rural

development and reducing rural poverty and it requires more attention. Though, agricultural development is pre-requisite for rural development but this is not a sufficient condition, as non-farm sector is equally important to fully achieve the objective of rural development.

Because of development plans executed over the time, some improvements have taken place in terms of access to/availability of social amenities like health, education, water & sanitation, and other indicators of living standard in rural Pakistan but still these are not up-to-the mark. Overall performance of state-led rural development programs has been quite disappointing in terms of their ability to reach the poor and to produce a significant impact on the living standard of the rural population. The weaknesses of these programs include lack of participation of local leadership, lack of trained technical staff, top down development approaches, inconsistency, political interests, delay in release and mis-use of funds, institutional conflicts/lack of coordination between line departments, no monitoring and evaluation mechanism, skewed distribution of benefits, and negligence toward agriculture sector.

NRSP schemes had a relatively higher success rate in sustainable service delivery and cost effectiveness than schemes undertaken directly by Government due to participatory and bottom approach. However, aspects like sustainability of RSPs, proper monitoring and evaluation, and impact assessment remain a challenge. For sustainable rural development, the country needs to devise and implement policies that ensure the adequate provision of inputs to the rural communities. Successful rural community development calls for an integrated and comprehensive approach.

### **Exploring Linkages between Agricultural Work Performance of Cotton Pickers and Nutritional Status in the Southern Punjab**

Cotton being important source of raw material for textile industry, foreign exchange earnings and important source of livelihood for rural families has a significant role in Pakistans economy. In Pakistan, women play a significant role in cotton picking because this is exclusively female activity and provide supplementary income to both rural farm and non-farm households (especially poorest population). Under nutrition and obesity has become a public health concern worldwide and even in the developing countries like Pakistan that can result in serious diseases thus negatively affecting labor productivities. Pakistan has a high prevalence of malnutrition among rural women involved in agriculture that may affect their daily work performance. In this background, present study was conducted in four major cotton growing districts (Multan, Khanewal, Vehari and Lodhran) of the cotton-wheat cropping system of Punjab. Overall 120 female cotton pickers were interviewed to explore the relationship between agricultural work performance and nutritional status (measured through body mass index).

According to study results, farmers repeatedly spray pesticides on cotton crop to control insect/pests attack and often they have to spray even during the cotton pickings. Majority of the females (83%) reported that they had to perform cotton picking even where the field is recently sprayed. whereare they eat food items in the field during interval in the picking without proper washing of hand with soap. Only 35 percent females had little knowledge about side effects of pesticides on their health. Majority of the women don't use any protective measures such as wearing of face masks, gloves or field shoes during picking. This is perhaps due to their low literacy level and meager incomes. Majority of the female (85%) perceived themselves as healthy. However, in accordance with Body Mass Index (BMI), 63 % female were in the healthy range of BMI. The average earning of women was Rs.281/day with significantly higher amount among healthy weight category. Average picking days in a season was 58 days which was significantly higher among healthy women. These

results imply that better work performance of healthy weight category women may be due to good immunity that leads to less impact of pesticide residues. The association between health status (calculated on the basis of BMI) and work performance on the basis of daily earning and picking days was highly significant. It is, therefore suggested that serious efforts are needed for creating awareness among cotton pickers regarding health hazards of pesticide, proper hand washing with soap before eating and use of protective measures during picking, through government organizations and NGOs. Moreover, special campaigns may be started to educate females to use balanced and healthy diet. Particular focus on underweight, over weight and obese categories of female is needed to boost their work performance.

### **An Assessment of Yield Differential in Maize Crop by Local Hybrid and Multinational Hybrid Seeds**

Maize is the third important cereal crop in Pakistan and is mainly used for food, feed and fodder. Its area, production and yield have increased tremendously overtime in the country. The increase in area is attributed to introduction and later spread of spring maize while yield increase mainly results from the adoption of imported hybrid varieties. The present study was undertaken in the year 2022 to assess the adoption and yield performance of local hybrid maize seed versus multinational companies' (MNCs) hybrid seed. A total of 80 farmers were interviewed from two maize growing districts (Faisalabad and Chiniot) of the Punjab province through structured questionnaire. The data collected through formal survey was edited and analyzed using descriptive statistics in conjunction with relevant literature to provide useful insight about adoption and yield performance of maize cultivars in the selected districts of Punjab.

It was found that almost all the farmers grow MNCs hybrid seed in both the seasons. The MNCs seeds give good results in terms of yield and quality as compared to local hybrid seeds. The results revealed that Pioneer Company maize varieties (P1429 and P4040) were the major cultivars grown in spring and autumn season respectively. The 100 percent respondents reported that MNCs maize hybrid seed gave higher yield in comparison with local hybrid seed. The price of local hybrid seeds was lower as compared to MNCs seeds. There is need to develop local hybrid seeds with higher yield and quality characteristics.

### **Study of Dietary Patterns and Nutritional Status: The Case of Employees Working at Ayub Agriculture Research Institute (AARI) Faisalabad**

According to concerns of Government of Pakistan on overweight and obesity and the resultant negative effects of bad health on working capacity of the labor, present study was conducted to estimate the general body health status of public sector employees working in agriculture sector. As the individual's diet plays a central role in determining nutritional status, therefore, primary data on daily consumption of different food items during 2022 was collected from 325 adult employees comprising both male and female employees at AARI, Faisalabad. The objectives include the study of knowledge about healthy foods and foods eaten in reality, the estimation of dietary diversity scores and body mass index, a common measure of body health derived through height and weight.

Results revealed that overall average weight of respondents is 74 kg while average height is 1.66 meters which translates to overall BMI of 27. According to WHO guidelines for adults, the estimated BMI value implies that both the genders are at least over-weight. Although majority falls under healthy BMI category yet combined percentage of overweight and obese employees is worrisome enough to invite attention of public health and nutrition experts to overcome problems of overweight

and obesity. Females of non-officer rank and males of officer rank are in the danger zone on account of poor health and more severity of over-weight and obesity. Both the genders, out of 7 defined food groups, ranked cereals and cereal-based products as the healthier dietary food group followed by vegetables and meat/pulses/eggs groups. However, in reality, eaten food groups show that cereals, meat and vegetables are first, second and third food groups in their daily dietary pattern. Consumption of items under fruit group is meager.

Overall dietary diversity score (O-DDS) is almost same but dietary diversity scores estimated for breakfast and dinner timings are different for males and females with males having relatively better mean DDS for dinner time and females having relatively better mean DDS for breakfast time. Another finding is that BMI and salary variables move in the same direction implying that as salary is improved, health status may be ameliorated (by eating healthy foods) and vice versa. Similarly, study concludes that as diets are improved (diets become healthy), there may be less chances of being obese (by declining BMI). Hence, public health and nutrition departments should attend public sector employees to guide them about healthy foods and healthy life styles from working to night sleeping.

### **Adoption and Prospects of Sugarcane Planter in Punjab**

Sugarcane is a tropical crop that is cultivated mainly in Punjab followed by Sindh, and Khyber Pakhtunkhwa. It provides raw materials to the 2nd largest agro-based sugar industry in the country. On one hand, sugarcane sowing is a labor-intensive and time-consuming activity and on the other side, the cost of labor in the country is growing rapidly, and farmers even face labor shortages. Moreover, the manual sowing of sugarcane did not follow the recommended sowing protocols, such as row-to-row distance, proper placement of seeds, and fertilizers, which ultimately reduce the per acre yield, posing a loss to the national economy. Farmers need to alter sugarcane production methods from manual sowing to mechanical sowing to harness the available potential in sugarcane. Keeping in view the role of farm mechanization, the federal government supported the supply of imported and local farm machinery and equipment in the country. Mechanized sowing of sugarcane helps in the timeliness of operations and dependence on human labor decreases the cost of operation, helps in enhancing the quality of work, and guarantees effective exploitation of resources. The present study was designed to explore the adoption and prospects of a newly introduced sugarcane planter in selected areas of Punjab. The results of the study suggest that sugarcane planter sowing saves crops from lodging and saves irrigation water by approximately 20-30 percent as compared to traditional sugarcane sowing methods.

Moreover, this technology also helps farmers perform better and easier intercultural practices due to proper line sowing of the crop. Most adopter farmers reported that this technology improves the quality of the cane manifold owing to proper ventilation of the crop. Adopter farmers reported comparatively more yield of 150-200 mounds and less irrigation time per acre. Thus, sugarcane planter saves time and overcomes the labor shortage problem by reducing the sowing cost up to 30-40 percent and ensures 100 percent planting of seeds compared to traditional manual sowing methods. The shortfall of this technology reported by farmers is that the row-to-row distance should be 2.5 feet instead of 4 feet because it leaves lots of empty space around the side of the field as the farmers plant this area manually after sowing with a planter. Second issue is the requirement of tractor with high-power (approximately 385 HP) to drag the sugarcane planter owing to the heavy weight of the planter. Moreover, the cost of the sugarcane planter also increases manifold in current inflation as most of the parts of this machine are imported, so this technology is only limited to progressive farmers for their personal use. It is suggested that government should facilitate the agricultural service providers in the sugarcane growing areas to

purchase and provide services to subsistence sugarcane growers by reducing at least fuel prices.

### **Economic Analysis of Different Cob Harvesting Mechanism in Pakistan: A Case Study of Sahiwal**

Labour and machines can be substituted for one another, but farm technology is comparatively has more power to finish farm activity on time. The adaptation of agricultural technology brings positive impacts in productivity and can change the economic condition of the farmers. Maize is an important staple cereal crop in Pakistan. Area for corn production in Pakistan has risen due to hybrid varieties and increased yield. With greater demand for maize, agricultural labor has been unable to meet the needs of traditional corn production with the rapid development of the social economy and urbanization. Therefore, the mechanization of the entirety of corn production is the inevitable future of the corn industry. With increased area for maize crop, labour is a serious issue during cob picking. To solve the issue, cob picker technology has been introduced in Pakistan and being used for harvesting corn in maize producing areas i.e. Sahiwal, Okara and Pakpattan. So, the present study was conducted in maize growing areas to observe the prospects of cob picker machinery and to estimate grain yield variability between manual and newly introduced cob picker. The farm level data was collected through well designed questionnaire during the maize harvesting season from the farmers picking cobs manually and using cob picker machinery. The data consisted 40 percent adopters and 60 percent non-adopters.

Results show that on an average 1.83 percent yield is comparatively high in mechanical cob picking than manual picking. Similarly, 1.37 percent grain loss was observed by adopters that is less than non-adopter of cob picker machinery. On an average 1.97 hours were consumed for adopter as compared to non-adopters on an average 10.5 hours. Likewise, average 12 men as labour joined for non-adopters which are more than adopters, therefore, it is observed feasible particularly for large farmers due to time and labour saving. It is also observed, machine was feasible for those farmers who followed the recommended and required pattern of sowing for cob harvesting machinery. Mostly, 85 percent owner cum tenant farmers are significantly adopting agriculture mechanization for harvesting. Through cob picker machinery stalk is chopped but could not be collected as animals feed. Due to this demerit of machinery, small farmer was not agreed to adopt cob picker. However, it was also observed that cob picker machinery was not easily available to farmers. Therefore, Government should provide cob picking in modified mode as per the need of adopters. The cob picker machinery is successfully recommended for those farmers who adopt required pattern of sowing.

### **An Analysis of Crop Diversification among Smallholder Farmers in Khyber Pakhtunkhwa of Pakistan**

Pakistan's agriculture is diversifying towards high value commodities. Crop diversification has multidimensional importance and is regarded as the re-allocation of some of farm's productive resources into new farm activities. This study was carried out during financial year 2022-2023 in two districts, Charsadda and Peshawar of Khyber Pakhtunkhwa, Pakistan. A total of 90 vegetable growers were randomly interviewed with the objective to find out crop diversification of smallholder vegetable farmers. Based on the study results, the surveyed farmers were young and educated (6.81 schooling years). Agriculture was their main source of livelihood and majority have informal agricultural knowledge. Fellow farmers were their main source of information/knowledge. Majority of the sampled respondents were not registered with model farm services centers and they availed credit mainly from informal sources.

The average operational farm land of sampled respondents was 4.18 acres. About three-fifth were lessee and 21 percent were tenants. Tomato crop during kharif season was grown on majority of the total land followed by maize, bitter-gourd, sugarcane, pumpkin, sponge-gourd, bottle-gourd, cucumber, brinjal, musk mellon and lady finger. Wheat crop during rabi season was grown on majority of the total land followed by cauliflower, fresh-beans, shaftal fodder, turnip, peas, spinach, onion and strawberry. The magnitude of transformed Herfindahl index or Berry Index on acreage proportion was 0.70, revealing that the study area exhibited higher crop diversification while Modified Entropy and Composite Entropy indices were 0.46 and 0.44 respectively, enlightening moderate crop diversification. The high value of crop diversification index and low value of entropy's index inferred that the number of area under different crops was decreasing and the farmers were moving towards essential crops and hence resulting believe in crop diversification overtime.

The diversification in cropping pattern in the study area was mainly towards tomato, maize and bitter-gourd during kharif season and wheat during rabi season as covering 58 percent of the operational land. The study suggested that the government and non-government organizations need to facilitate and strengthen farmers by providing them infrastructure, new markets, transportation and processing facilities for high value crops. Farmers should be trained regarding the requirements and other formalities of new markets in order to export their produce to these new markets.

### **Fruit Flies: Management and Losses in Vegetable Crops in Central Khyber Pakhtunkhwa**

Fruit flies are polyphagous insect pests of fruits and vegetable which are considered among top ten most severe agriculture pests worldwide, particularly in tropical and subtropical regions. Fruit flies have a major impact on global agriculture yields, affecting both local and export markets and pose significant threats worldwide in terms of quantitative and qualitative losses in horticultural crops. Recognizing the importance of this issue, this research study was conducted in Charsadda and Peshawar districts of Khyber Pakhtunkhwa. A total of 87 vegetable growers comprising of sixty (60) growers from district Charsadda and twenty-seven (27) growers from district Peshawar were interviewed. The main aim of the study was to determine the existing practices of farmers for controlling fruit flies and to measure the production losses in vegetable crops in the study area.

The salient findings of the study revealed that majority (63.2%) of the sampled vegetable growers acquired the land on lease basis for vegetable cultivation. The mean net operational landholding of the sampled vegetable growers was 4.36 acres. Tomato was the major Kharif vegetable that the sampled respondents allocated 1.93 acres of land, obtaining a yield of 26,132 kg per acre. Bitter gourd was allocated 1.07 acres of land, resulting in a yield of 26,975 kg per acre. Bottle gourd cultivated on 0.86 acres of land and yielded 25,528 kg per acre, Sponge gourd was grown on 0.86 acres and produced a yield of 23,358 kg per acre. Cucumber, with an allocation of 0.82 acres, yielded 25,377 kg per acre. Squash (Tinda), grown on 1.11 acres, had a yield of 20,188 kg per acre. Brinjal cultivated on 0.87 acres, produced a yield of 29,280 kg per acre, Muskmelon fruit, allocated 1.06 acres, obtained a yield of 15,077 kg per acre. Long bean grown on 0.43 acres received a yield of 10,698 kg per acre. The findings exhibited that 47.1% and 34.5% of the sampled vegetable growers obtained information regarding improved agricultural production technology from fellow farmers and input dealers, respectively. The data reveals that the majority (90%) of the sampled vegetable growers were aware of pheromone traps from different sources. The findings reveal that fruit flies are a significant dilemma and causing substantial production losses in vegetables in the study area. The data

shows that 34.5% of the vegetable growers reported that fruit fly infestation was the greatest contributor to low production, while 32.2% of the growers reported a loss of fruit quality. The data shows that vegetable fruit fly infestation intensity was more common in the months of June and July. The empirical findings reveal that the highest fruit fly production losses were recorded in bitter melon, estimated as 31.48%. The second highest fruit losses, as 24.3% were noted in sponge melon, followed by 22.69% fruit losses in brinjal, 17.59% fruit losses recorded in cucumber, 14.92% fruit losses estimated in bottle melon, 14.5% fruit losses estimated in muskmelon, 12.76% fruit losses were calculated in tomato, 11.48% fruit losses were observed in squash (Tinda) and least fruit fly losses were observed in long bean, calculated at 7.75% in the study area.

The vegetable growers applied excessive insecticides/pesticides on vegetables to control insect pests. Majority (47.1%) of the sampled vegetable growers applied only pesticide/insecticide spray to control fruit flies. While 32.2% of the sampled vegetable growers used both pesticide/insecticide sprays and fruit fly traps to control fruit flies. Other combinations of techniques were also observed to control fruit flies in vegetable farms in the study area. Cleaning and properly disposing of infested fruit, using pheromone traps and growing crops as traps and repellents were the major environment friendly techniques adopted by 98.9%, 42.5% and 21% of the sampled vegetable growers for control of fruit flies in their vegetable farms.

High prices of inputs, lack of improved knowledge and adulteration in inputs were the main constraints faced by the vegetable growers in the study area. The study suggested that agricultural extension department should launch awareness programs and training programs, control the prices and quality, provide subsidy on inputs, develop a fruit fly monitoring system and identify fruit fly species of fruits and vegetable growing areas in Khyber Pakhtunkhwa.

### **Assessment of Potato Crop In Project Area of Kurram and Orakzai, Merged Districts of Khyber Pakhtunkhwa, Pakistan**

Agriculture Research (Merge District), Khyber Pakhtunkhwa, Pakistan executed a project entitled "Virus Free Seed Potato Production Using Tissue Culture Technology at High Altitudes of Kurram and Orakzai" with the aim to develop a system of virus free seed potato production. The project was designed with the aim to develop a system of virus free seed potato production. A cadre of potato seed growers were trained, exposure visit was given and were provided with necessary kits for virus free seed potato production. Their skills in seed potato production were developed and they grouped in seed potato enterprise association. Moreover, attempts were made to develop linkages with prospective seed potato buyers. The empirical findings revealed that surveyed farmers were young and educated that might be more productive and play a vital role in sustainability of food security. Agriculture was their main income source. The family size of sampled farmers was relatively larger than the average family size of Khyber Pakhtunkhwa and Pakistan.

More than half of the sampled respondents were fond of high yielding potato varieties. Majority have received training at Hazara Agriculture Research Station (formerly Potato Research Centre), Abbottabad along with exposure visit to Sahiwal, Punjab. The knowledge level of sampled respondents was improved with overall training index of 0.84. The Eta squared value shows that the important improvements included Knowledge of Crops outlook, Number of Days, Improvement in Agriculture Knowledge, Knowledge of Quality of produce and Helped in Skill development etc. Majority of the sampled respondents were given to grow Kuroda variety that yielded 99.03 mounds per acre followed by SM Kaghan variety yielded 184.67 mounds per acre and Asterix variety yielded 73.33 mounds per acre. Majority of the sampled respondents were satisfied with the quality of

potato seed provided by Agriculture Research Institute and they may produce their own potato seed. Major share of the potato produce of improved seed were sold (75 percent) by the sampled respondents, 12 percent stored for seed purpose, 7 percent exchanged and 6 percent of the potato produce consumed at home. Major share of the potato produce of local seed were sold (46 percent), 23 percent stored for seed purpose, 16 percent for home consumption and 15 percent of the local seed was exchanged with fellow farmers.

Percent of quantity of home consumption to total potato produce, percent of potato exchange to total production, selling quantity of potato production and percent of potato selling to total produce were significantly different. The BCR was 1.60 for potato production using improved seed while the BCR was 1.02 for potato production using local seed last year. Major problems perceived by sampled respondents were wild animals followed by less germination, low yielding varieties, mixed varieties erratic rain fall, wind, storm and flood. Based on empirical results, the study suggested for replication of said model in other districts and for other crops. More adaptive and verification trials, awareness campaign, provision of scientific guidance, facilitation of true farmers, studying market behavior of potato producers and control of wild animals need to be addressed according to socio-economic and climatic conditions of the area.

## DIRECTORATE OF SCIENTIFIC COMMUNICATIONS AND PUBLICATIONS

Directorate of Scientific Communications and Publications (DSC&P) progress report during 2022-23 is as under:

### Media Activities

DSC&P provides scientific and functional media coverage, as well as photographic services, to PARC/NARC scientists and their subsidiaries. DSC&P developed YouTube channels titled "PARC Official" and "PARC Archive" with links available on the PARC website. There is also an official Facebook page. During 2022-23, the



directorate developed and published 07 documentaries on YouTube, coordinated 05 TV and news reports, and captured 73 key functions and events. The Directorate created two videos that documented PARC field research efforts and provided 22 audio facilities to various programmes. For field/lab experiments, 5710 pictures were taken, and 63 important events were covered.

### PARC Website

PARC Website has been redesigned from Joomla 2.4 version to latest PHP technologies with cooperation of National Information Technology Board (NITB). New website is dynamic, interactive and user friendly. Day to day issues of the website are being resolved in consultation/coordination with NITB and NTC.



Data is being uploaded in the relevant pages of website as and when received from PARC, NARC and different institutes/outstation centers working under PARC. Pictures, tenders, latest news, tickers, notifications/circulars/OMs and other data is being updated and uploaded on daily basis. About 80% data has been uploaded and other is in pipeline.

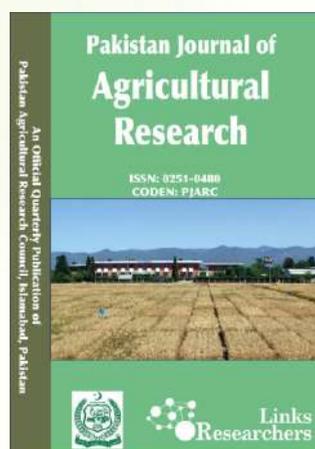
### NARC Library

NARC library is the central information resource for scientists, researchers and students in the field of agriculture and allied subjects. Library users can find a wealth of knowledge, either in print or online. The library has collection of over 29,500 books covers a wide range of different agricultural subjects.

Resources of HEC Digital Library and CABI information products are accessible at NARC Library and access is provided on PARC Local Area Network. During 2022-23 157 books were added to library collection and 23 reprints were supplied to foreign agencies/scientists and 27 to local scientists during the year.

### Pakistan Journal of Agricultural Research

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



<http://researcherslinks.com/journal/Pakistan-Journal-of-Agricultural-Research/24>.



### ANNUAL REPORT 2022-2023



During the year 02 issues of Volume34 (2022) and 02 issues of 35 (2023) were published and available online on PARC website.

### Annual Report

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

### PARC Newsletter

PARC Newsletter is being published quarterly, uploaded on PARC website and widely circulated to national as well as international partners. During the year 02 issues of Volume 34 (2022) and 02 issues of 35 (2023) were published and available online on PARC website.





# AGRICULTURAL ENGINEERING

## AGRICULTURAL ENGINEERING DIVISION

The division's key focus is to design, develop, adapt and promote energy-efficient and precision agricultural machinery with a particular focus on introduction of farm mechanization and postharvest technologies for cereal, fruits, vegetables and other crops. Division is also playing an important role of coordination among the stakeholders related with the promotion of agricultural mechanization in the country. The division is also providing technical inputs for development of National Standards for agricultural tractors & machinery and establishing facilities for testing of agricultural machinery.

Agricultural Engineering Division has executed a number of research projects during the reported period on development, testing, commercialisation and promotion of agricultural machinery for local farmers. Some salient achievements during the reported period are given below:

1. Combine Seeder and Pak Seeder machines for rice residue management  
For sowing of wheat in combine harvested paddy fields is a challenge due to handling of heavy rice residue to avoid delay in crop sowing. Agricultural Engineering Institute (AEI) of Pakistan Agricultural Research Council (PARC) with technical collaboration of M/S Greenland Engineers, Daska has developed a rice residue management technology called as "Combine Seeder", which is the next version of "Pak Seeder" technology. This technology chops the paddy straw and stubbles, incorporates it in the soil and plants wheat crop in a single operation. This technology not only improves soil biological and physical health, but also increases wheat and rice yields from 10-15%. This is a resource conservation technology that can enhance crop yield, reduce nutrients loss of the soil and save environment from smoke pollution. These technologies will help reduce the SMOG problem in the country. Wheat planting trials were carried out at different locations in the Punjab to see the performance of the machine. Results were compared with the conventional wheat sowing practices. The working capacity of the machine is 0.75-01 acre/h depending upon the residue density in the field.



Pak Seeder, Combine Seeder and other rice residue management machinery

Agricultural Engineering Institute, NARC, PARC organised a national seminar in Gujranwala on technological solution of rice straw burning. Every year about 16 million tonnes of paddy straw is produced in Pakistan, out of which about 60% is burnt. A large number of farmers, officials of the Punjab Agriculture Department, agricultural machinery manufacturers, representatives of companies providing machinery services to farmers and other stakeholders participated in the event. Relevant package of straw management machines was demonstrated to participants.



Seminar on rice residue management machinery.

### Promotion of rice production machinery

Pakistan is the world's 10th largest producer of rice. Pakistan's exports make up more than 8% of world's total rice trade. It is an important crop in the agriculture economy of the country. In Pakistan, rice is grown manually by sowing rice seedlings and then transplanted manually in the puddled soil using labour force. The plant population achieved by manual transplanting is around 35,000-40,000 plants per acre while recommended plant population is around 80,000-85,000 plants per acre. This difference in plant population results in low productivity of rice crop in Pakistan.

Agricultural Engineering Institute, NARC provided technical assistance to farmers / service providers for rice nursery raising and mechanical transplanting. The calibration of rice nursery raising and tray filling was demonstrated to the farmers in Gujranwala, Sheikhpura, Sialkot and Hafizabad field areas for efficient use and promotion of the technology. Rice transplanters were also tested to compare the results of new and reconditioned / used rice transplanters. Data for the performance evaluation of new and used rice transplanters was recorded from Gujranwala, Sialkot and Hafizabad field areas. Based on the results of the machinery, recommendations will be given to farmers for using the appropriate machinery to maximize their yield and profit.

An awareness field seminar on "Rice planting and harvesting machinery" was organized at Daska, Sialkot. Around 150 farmers, manufacturers, service providers like Meskay & Femtee Trading Company, Gujranwala, BMITCO Agro Services, Sialkot, Chairman Sons Zarai Corporation Gujranwala, extension and agricultural officers, policy makers and Assistant Commissioner of Daska attended this seminar. Director General, Agricultural Engineering Division, PARC was the Chief Guest of the event. Speakers from the Punjab and Federal Government trained the participant about using rice specific machinery to enhance rice productivity and reduce losses. The AC of Daska encouraged farmers to focus more on rice crop as it is the main staple food of our country. He further stressed farmers to increase productivity by using modern machinery so that we could earn precious foreign exchange by exporting this crop.

Training to about 120 farmers were provided to farmers / service providers about the key parameters to be understood and noted while using rice machinery. For example, during rice harvesting, the farmers were suggested to check rice straw behind the machinery and check the extent of grain losses in the straw. If there are more losses in the straw, he should convey this to the operator of combine harvester. To control these shattering losses, the operator should reduce the travel speed and increase engine speed. The stationary type rice nursery raising machinery was optimized for local conditions and was demonstrated to the rice machinery service providers for its efficient utilization.



Glimpses of field activities to promote rice mechanization

### Regenerative agriculture

The climate-smart production system that requires significantly less cost outlay and far less inputs is applied to regenerative agricultural practices. This production system is based on natural process of soil fertility. Main elements of this production system include growing crops on raised beds, zero or far less tilling, sowing of crops with precision planter and mulching of sown crop. The system is well known and has been practiced globally for decades, but individually and sporadically. For proper application of regenerative agricultural practices, all these cultural practices should be integrated in the field in a sequence by using proper mechanisation and implements. This production system has already been practiced by many individual farmers in the country and have reported impressive results in higher yields, significantly reduced use of irrigation water and virtually no application of chemicals. However, none of public sector research and development institutions has

experimented this system. Agricultural Engineering Institute with active support of Ministry of National Food Security and Research and Planning Commission of Pakistan has conducted a trial on wheat crop and found encouraging results. The bottlenecks in implementation of regenerative agriculture system is the availability of customised agriculture machinery suited to this system from planting to harvesting. The technology is under development phase and needs more field tests and evaluations for its sustainable development.



### List of Publications

1. Naveed M., Liu Y., Munir Z., Zhang Y. and Niazi, B.M.K. 2022. Effects of hot air assisted radio frequency drying on heating uniformity, drying characteristics and quality of paddy. *LWT - Food Science and Technology* 158 (2022) 113131.
2. Munir, Z., Roman F., Niazi B.M.K., Mahmood N., Munir A. and Hensel O. 2022. Thermal analysis of a solar latent heat storage system using Scheffler concentrator for agricultural applications, *Applied Thermal Engineering*, Volume 218, 119230.
3. Submitted the patent titled “Improved portable precision planter” to IPO, Pakistan.
4. Mehdi, R., Naqvi, S. R., Khan, A. A., & Mirani, A. A. (2023). Optimization of olive oil extraction from olive pomace using solvent extraction and response surface methodology analysis of oil yield. *Fuel*, 348, 128633.
5. Kazmi, B., Taqvi, S. A. A., Naqvi, S. R., Mirani, A. A., Shahbaz, M., Naqvi, M., ... & Eldesoky, G. E. (2023). Techno-economic assessment of sunflower husk pellets treated with waste glycerol for the Bio-Hydrogen production—A Simulation-based case study. *Fuel*, 348, 128635.
6. Nasir, A., Zia-Ul-Haq, M.Y., Iqbal, T., Ansar, M., Yaseen, G., Karim, F., Mirani, A.A., Saad, A. and Zaman, M.A.U., (2023.) Testing of tractor mounted groundnut pods collector and its comparison with traditional method. *Pure and Applied Biology (PAB)*, 12(1), pp.342-348.
7. Meghwar, B. L., Khan, A., Lakhiar, I. A., Mirani, A. A., Daper, M. S., & Kalroo, M. W. (2023). Comparison Between Solar Tunnel, Solar-Cum Gas Dryer, and Open Sun Drying Methods for Drying Red Chilies. *Pakistan Journal of Agricultural Research*, 36(1), 63.
8. Ali, A. M., Waheed, A., Shahbaz, M., Mirani, A. A., Shahzad, K., Al-Zahrani, A. A., ... & Mahpudz, A. B. (2023). Synergistic evaluation of co-torrefaction performance of rice husk and coffee bean ground blends for biosolid production for industrial fuel sustainability. *Fuel*, 343, 127891.
9. Khawaja, A. S., Zaheer, M. A., Ahmad, A., Mirani, A. A., & Ali, Z. (2023). Advances in limitations and opportunities of clean biofuel production to promote decarbonization. *Fuel*, 342, 127662.

10. Hashim, S., Waqas, M., Rudra, R. P., Khan, A. A., Mirani, A. A., Sultan, T., ... & Saifullah, M. (2022). On-Farm Composting of Agricultural Waste Materials for Sustainable Agriculture in Pakistan. *Scientifica*, 2022.
- Javaid, M.A., Haq, Z.U., Mahmood, H.S., Iqbal, T., Ansar, M., Mehmood, T., Yaseen, G., Asam, H.M., Husain, M., Islam, M.A. and Ali, I. 2003. Design, development and testing of different shapes of flails for Pak-Seeder. *Pure and Applied Biology*, 12 (4): 1587-1600



# **PLANNING & DEVELOPMENT**

## PLANNING AND DEVELOPMENT DIVISION

### Introduction:

The Planning & Development Division (P&DD) of PARC was upgraded in March, 2012 having following three directorates:

1. Competitive Grants and MoU projects (CG&MOU)
2. Public Sector Development Program (PSDP)
3. Planning, Monitoring and Evaluation (PM&E)

The progress report of these Directorates for the year 2022-23 is given as under:

### 1. Agricultural Linkages Program (ALP)

The Agricultural Linkages Program (ALP), established in the year 2000, receives funding from the Agricultural Research Endowment Fund (AREF). This endowment fund is a collaborative effort between the Government of Pakistan and the Government of the United States of America through an agreement signed in February 1999. The primary purpose of this fund is to support and promote agricultural research and development activities in alignment with Pakistan's long-term development goals. Additionally, it aims to foster long-term scientific collaboration and cooperation between Pakistan and the United States within the agricultural sector. The management of this fund falls under the purview of the Board of Directors (BOD) of the Agricultural Linkages Program (ALP). This board oversees the allocation and utilization of the funds in various agricultural research projects. The selection of projects to be funded is done on a competitive basis within the framework of the National Agricultural Research System (NARS). The Technical Advisory Committee (TAC) is responsible for recommending projects for funding, and the final approval for funding these projects rests with the Board of Directors of the ALP.

During the fiscal year 2022-23, one meeting of Technical Advisory Committee (TAC) and one meeting of Board of Directors (BOD) was conducted. The details are as follows:

- a. TAC meeting was held on December 6, 2022, in which a total of 26 projects were presented belonging to four technical sectors. Out of these, TAC recommended 15 projects, while 06 projects were deferred. Sector-wise details of the projects are given below:



*Technical Advisory Committee (TAC) Meeting (Dec 06, 2022)*

Sectors	No. of Projects			
	Presented	Recommended	Not Recommended	Deferred
Animal Sciences	04	02	01	01
Agri. Engineering	04	03	00	01
Natural Resources	10	05	03	02
Plant Sciences	08	05	01	02
<b>Total</b>	<b>26</b>	<b>15</b>	<b>05</b>	<b>06</b>

b. A meeting of Board of Directors (BOD) was arranged on September 22, 2022, in which a total of 26 projects were presented of five sectors. Out of these, BOD approved 24 projects, while 02 projects were deferred for further consideration. Sector-wise details of projects are given below:

During the fiscal year 2022-23, 88 projects were actively underway benefitting from funding provided through the Agricultural Linkages Program (ALP). The combined approved budget of ongoing projects amounted to Rs. 534.440 million



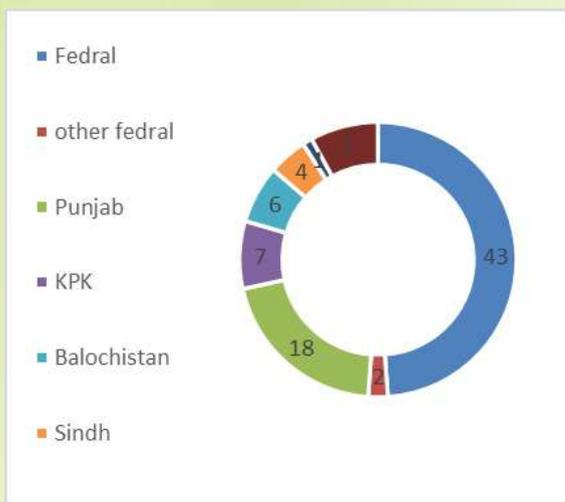
Technical Advisory Committee (TAC) Meeting (Dec 06, 2022)

Sectors	No. of Projects		
	Presented	Approved	Deferred
Animal Sciences	03	03	0
Agri. Engineering	0	0	0
Natural Resources	04	04	0
Plant Sciences	18	16	02
Social Sciences	01	01	0
<b>Total</b>	<b>26</b>	<b>24</b>	<b>02</b>

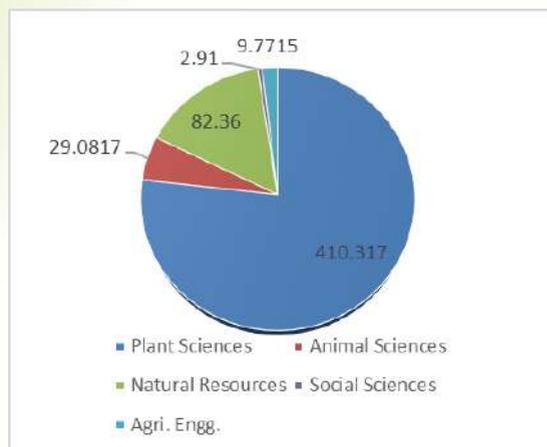


Board of Directors (BOD) Meeting (Sep 22, 2022)

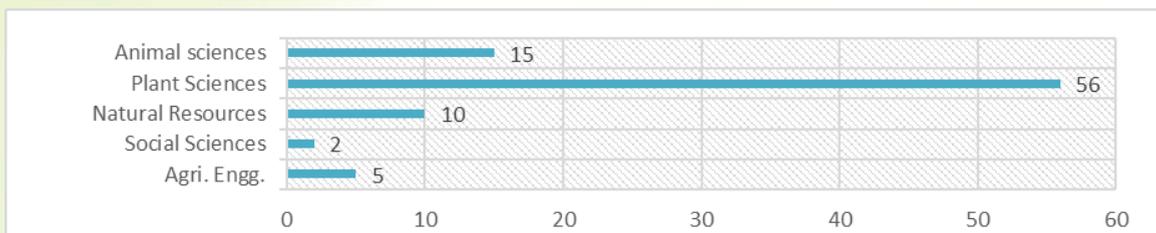
During the fiscal year 2022-23, 88 projects were actively underway benefitting from funding provided through the Agricultural Linkages Program (ALP). The combined approved budget of ongoing projects amounted to Rs. 534.440 million.



Region-wise distribution of ongoing projects



Discipline-wise approved budget of ongoing projects



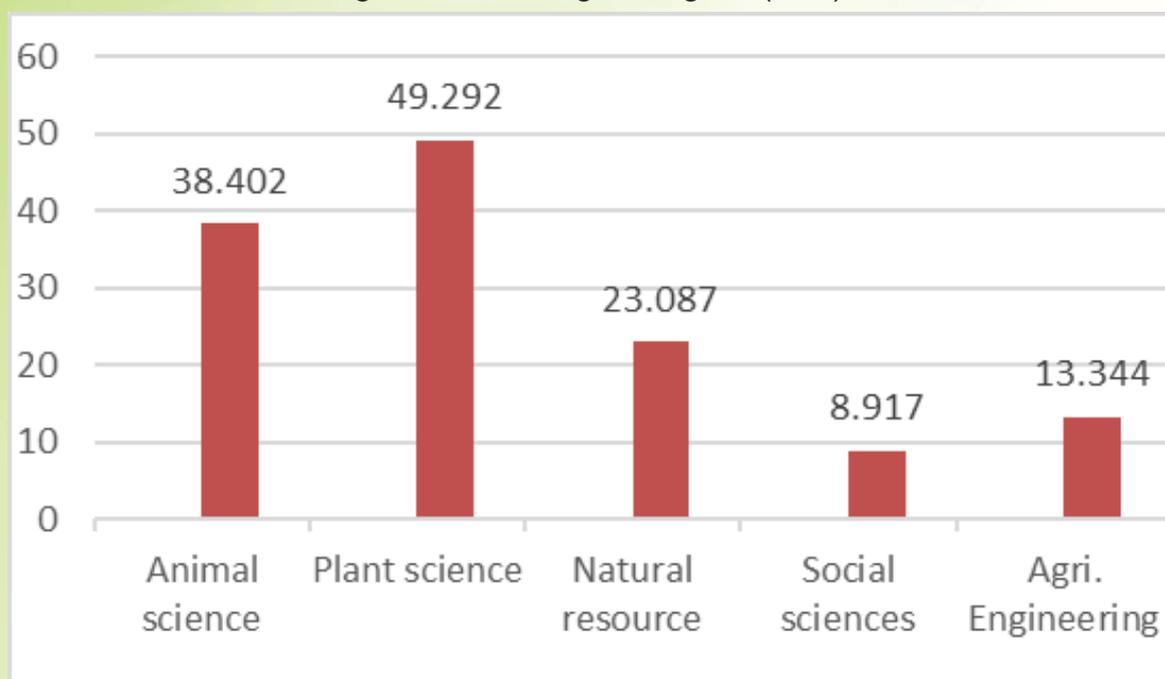
Discipline-wise distribution of ongoing projects

During the fiscal year 2022-23, following projects were successfully completed:

Sr. No.	Project Title	Duration
<b>Plant Sciences Sector</b>		
1.	Exploitation of genetic variability for the development of promising advanced lines of indeterminate tomato through breeding. <b>(CS-190)</b>	01-10-2019 to 30-09-2022
2.	Quality characterization of Dephytinized wheat; In vitro bioavailability of micro-nutrients and their effects on end use quality of wheat products. <b>(CS-542)</b>	15-02-2020 to 14-02-2023
3.	Cultivation and promotion of Ispaghul ( <i>Plantago ovata</i> ) in lesser Cholistan and Bahawalpur Division through Germplasm Evaluation with Value Addition. <b>(CS-556)</b>	01-02-2020 to 31-01-2023
4.	Development of local sunflower hybrids and their seed production. <b>(CS-102)</b>	01-05-2020 to 30-04-2023
5.	Development of a system, based on preventive approach to address food safety concerns in the export of Pakistani rice. <b>(CS-410)</b>	01-09-2019 to 18-08-2022
6.	Molecular Identification, Characterization and Development of Resistance against Sugarcane White Leaf Disease (SWLD). <b>(CS-435)</b>	01-02-2020 to 31-01-2023
7.	Processing and Sustainable Value Addition of Selected Medicinal and Aromatic Plants” <b>(CS 046)</b> .	01-09-2019 to 31-08-2022
<b>Animal Sciences Sector</b>		
8.	Evaluation of Crop Residues Based Total Mixed Fermented Rations for Ruminants. <b>(AS-073)</b>	18.09.2019 to 31.12.2022
9.	Mechanistic study of MRSA from bovine and occupational worker and its application in field condition. <b>(AS-042)</b>	17-09-2019 to 16-09-2022
10.	Isolation, Characterization and Utilization of Riboflavin (Vitamin B2) Producing Lactic Acid Bacteria for Preparation of Nutraceutical Yogurt. <b>(AS-006)</b>	10-03-2020 to 30-09-2022
11.	Optimization of Semen Cryopreservation and Artificial Insemination Techniques for Improving Reproductive Potential in Sheep. <b>(AS-035)</b>	24-09-2019 to 23-09-2022
12.	Development of Immuno and on-Site Lateral Flow Strip Assay Kit for Diagnosis of Infectious Bursal Disease in Poultry. <b>(AS-015)</b>	22-07-2019 to 21-07-2022
13.	Screening of Livestock population for Ticks and Ticks Borne Diseases in Some Selected Districts of Azad Jammu and Kashmir. <b>(AS-052)</b>	17-09-2019 to 16-09-2022
14.	Spatial Epidemiology, Molecular Identification and Detection of Ticks and Tick-borne Diseases in Punjab, Pakistan. <b>(AS-141)</b>	19-09-2018 to 18-09-2022
15.	Submission of Brief Overview/Summary of ALP Project Titled “Improvement of Kail Sheep Breed Through Estrus Synchronization and Artificial Insemination in Azad Jammu and Kashmir <b>(AS-159)</b>	27-07-2019 to 21-07-2022
<b>Natural Resources Sector</b>		
16.	Conservation of native bees through ecosystem approach for enhanced crop pollination. <b>(NR-191)</b>	10-07-2019 to 09-07-2022
17.	Assessing the Plant resources and Climate change impact to develop the Conservation Strategy of Cholistan Rangelands (Pakistan). <b>(NR-028)</b>	10-07-2019 to 09-07-2022
18.	Superior Quality Honeybee Queens Production through Non-Traditional Techniques. <b>(NR-047)</b>	25-08-2019 to 31-12-2022

19.	Development of Graphene Reinforced Wood-Plastics-Composites (WPC) Using Local Agriculture and Forestry-Based Residues for Construction, Furniture and Fruit Packaging Industries. (NR-062)	15-07-2019 to 14-07-2022
<b>Social Sciences Sector</b>		
20.	Crop-Livestock Integrated Farming Systems at Marginal and Small Farms in irrigated Punjab: Livelihood, Employment and Food Security Linkages. (SS-021)	05-07-2019 to 04-03-2023
21.	Recommended Technologies and Farm Practices of Major Crops in Context of Decreasing Profitability in Pakistan. (SS-031)	01-03-2020 to 28-02-2023
<b>Agricultural Engineering Sector</b>		
22.	Postharvest processing of chilies for producing quality produce. (AE-045)	01-02-2019 to 31-01-2023
23.	Develop an Innovative Technique for Processing the Olive Fruit Waste to Achieve Leftover Oil for Edible use. (AE-041)	01-07-2021 to 30-12-2022

The approved collective budget for completed projects amounted to Rs. 133.042 million, drawn from the Agricultural Linkages Program (ALP).



*Discipline-wise approved budget of completed projects*

Furthermore, during the year 2022-23, a web portal was developed for on line submission of proposals in response to the call made on 9th May, 2023 for 10th batch of Agricultural Linkages Program.

Apart from this, the Agricultural Linkages Program (ALP) has played a crucial role in reinforcing the National Agricultural Research System (NARS) by providing support to various research centers, institutes, stations, and universities through the following means:

- Provided research and lab. equipments, machinery and computers etc.
- Provided operational funds for research work in approved projects.
- New knowledge and information has been generated & disseminated in form of progress reports, research papers, brochures etc. and shared with relevant stakeholders through circulation, field days and seminars, workshops etc. Fifteen research papers from completed projects were published during fiscal year 2022-23.

- Human Resource Development as students, in their capacity building, especially in agricultural universities in conducting research for their degree program. Approximately, 66 students successfully completed their graduate and post graduate degrees during the fiscal year 2022-23 out of ALP funded projects.
- Being the competitive grant in field of agricultural research, enhanced the capabilities and skills of scientists to develop and win research proposals for funding and established national and international linkages and coordination among various research scientists and institutes.

**Directorate of PM&E**

**Research Agreement (MoU type) Projects:**

Overall, 19 research agreement projects (MoU type) were ongoing during 2022-23. The MoU section of PM&E has processed and revised administrative approval of 16 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), Royal Botanical Garden (RBG) UK, International Atomic Energy Agency (IAEA), Rural Development Administration (RDA) Republic of Korea through (KOPIA), South Asian Association for Regional Cooperation (SAARC), MGI Tech Singapore PTE.LTD, Joint Scientific Exchange Program of Pakistan Science Foundation (NSFC-PSF), Livestock & Dairy Development Board (L&DDB), Pakistan National Commission for UNESCO PNCU, Ministry of Federal Education & Professional Training, German Academic Exchange Service (DAAD).

**MoU type projects implemented in 2022-23**

The MoU section has also processed 22 projects proposals and concept papers to different local and international donors like Korean Rural Economic Institute, NSLP (PSF), German Academic Exchange Service (DAAD), Saudi Arabia etc. As the council has privilege to compete for financial assistance from the local and international donors of the world. Some of the research agreements with international organization are underway for implementation in the future.

**On-Site Evaluation of Projects.**

PM&E directorate evaluated the following two PSDP projects.

- i. Strengthening/Up-gradation of AZRI, Umerkot, Sindh.
- ii. Updation of Agro Ecological Zones of Pakistan through Satellite and In-situ Data Mapping.

On-site M&E conducted for project titled “Updation of Agro Ecological Zones of Pakistan through Satellite and In-situ Data Mapping” at (CWERI, NARC) on 12-06-2023 and M&E report prepared and submitted to Chairman, PARC. On-site M&E conducted for project titled “Develop an Innovative Technique for Processing the Olive Fruit Waste to Achieve Leftover Oil for Edible Use” at (NUST, Islamabad) on 13-06-2023 and M&E report prepared and submitted to Chairman PARC.

Plant Science	Animal Science	Natural Resources	Social Science	Agricultural Engineering	Total
12	01	03	03	0	19

**DIRECTORATE OF PUBLIC SECTOR DEVELOPMENT PROGRAM (PSDP)**

The PSDP projects are fundamental to any organization. To align with national and sectoral priorities, PSDP projects are developed accordingly. The Directorate of PSDP (P&DD) is responsible for processing new projects submitted by PARC scientists, presenting and defending these projects to secure approval from relevant PSDP forums, including DDWP, CDWP, and ECNEC. This includes preparing, presenting, and defending budget demands for upcoming PSDP allocations related to both ongoing and new projects.

Once the final PSDP allocation is determined, a Cash/Work Plan for each development project is prepared according to the approved budget. Revisions and extensions for the duration of ongoing projects are also processed and approved by the competent authority/forum. The Directorate assists PARC/NARC scientists in both the preparation and implementation of PSDP projects.

**I. Preparation, Scrutiny, and Processing of New and Modified Development Projects**

The following 18 projects were processed for approval by the competent forum for the fiscal year 2022-23:

Sr.#	Name of Projects	Proposed Duration	Proposed Cost
1.	Mainstreaming of Mountain Agricultural Research Centre (MARC) for the Promotion of High Value Agriculture in Gilgit-Baltistan	5 Years	288.200
2.	Promotion of Quality Honey Production Technologies Under Different Ecological Regions	3 Years	1107.593
3.	Cluster Based Transformation Program for High Value Horticultural Crops	5 Years	2000.000
4.	Production of Herbal Products from Different Agro-ecologies Zones of Pakistan	5 Years	600.000
5.	Genetic Improvement of Livestock for Productivity Enhancement	5 Years	1482.685
6.	Tea Cultivation and Promotion in Potential Growing Areas	5 Years	1717.952
7.	Transforming Agriculture through Climate Resilient and Water Smart Solutions in Thal Region, Punjab	5 Years	1610.500
8.	Kitchen Gardening: A Way to Safe and Nutritious Vegetables	3 Years	464.864
9.	Establishment of Microbial Bio-resource Gen Bank: National Microbial Culture Collection of Pakistan (NCCP)	4 Years	570.000
10.	Establishment of Arid Zone Research Centre Bahawalpur to Support Food Security and Poverty Alleviation in the Desert Area of Southern Punjab	5 Years	1198.520
11.	Enhancement of Plant Genetic Resources Conservation Facility at BCI, NARC for Food Security	5 Years	1086.400
12.	Establishment of National Disease Diagnosis/Surveillance & Treatment System for Fresh Water Fisheries in Pakistan	5 Years	317.000
13.	Indigenization, Local Manufacturing and Quality Testing of High Efficiency Irrigation System (HEIS) in Pakistan.	5 Years	1240.000
14.	Thar Community Actions for the Management of sustainable Ecosystem, Livestock, Land and Livelihood (Thar Camell)	5 Years	2000.000
15.	Research and promotion of Organic Agriculture in Pakistan	5 Years	3500.000
16.	Area-Wide Integrated Pest Management (AW-IPM) of Fruit Flies for Clean Production and Enhancing Exports of Fruits and Vegetables	5 Years	2300.000
17.	Area-Wide Integrated Pest Management (AW-IPM) Incorporating the Sterile Insect Technique for Eradicating Pink Boll Worm in Cotton	5 Years	2800.000
18.	White Fly Management, Critical for Reviving Cotton Crop in Pakistan	5 Years	1500.000

**II. The projects prioritized and recommended for budget allocation during FY 2022-23 are as follows:**

S.No	Name of Project	Duration (Years)	Execution Period	Approved Cost (Federal)	Allocation FY 2022-23
1.	Productivity Enhancement of Rice	5	2019-20 to 2023-24	15789.402 (3750.66)	270.000
2.	Productivity Enhancement of Sugarcane	5	2019-20 to 2023-24	4937.225 (1003.77)	130.000
3.	Productivity Enhancement of Wheat	5	2019-20 to 2023-24	30455.353 (5632.77)	350.000
4.	Promoting Research for Productivity Enhancement in Pulses	5	2019-20 to 2023-24	1437.358	400.000
5.	Commercialization of Potato Tissue Culture Technology in Pakistan	5	2020-21 to 2024-25	158.830	44.130
6.	Sino-Pak Agricultural Breeding Innovations Project for Rapid Yield Enhancement	4	2020-21 to 2023-24	433.936	99.598
7.	Updation of Agro Ecological Zones of Pakistan through Satellite and In-situ Data Mapping	3	2020-21 to 2022-23	60.450	20.000
8.	Strengthening/Up-gradation of AZRI, Umerkot, Sindh	6	2017-18 to 2022-23	528.592	145.000
9.	Mainstreaming of Mountain Agricultural Research Centre (MARC) for the Promotion of High Value Agriculture in Gilgit-Baltistan	5	2022-23 to 2026-27	288.200	40.000
TOTAL : (Rs. Million)				<b>54,089.346</b>	<b>1,498.728</b>

**III. Preparation of Public Sector Development Program (PSDP):-**

- Prepared the Public Sector Development Programme (PSDP) 2022-23 for the upcoming Standing Committee meeting of the National Assembly at M/o NFS&R.
- Prepared project profiles for 09 ongoing PSDP projects for submission to M/o NFS&R.
- Prepared the Full Year Review, First Quarter Review, and Mid-Year Review of PSDP 2022-23 for submission to M/o NFS&R.
- Prepared PSDP 2022-23 and projections for 2023-24, 2024-25, and 2025-26 for new unapproved projects for the Senate Standing Committee (SSC), National Assembly Standing Committee (NASC), and M/o NFS&R.
- Submitted budgetary proposals related to the Public Sector Development Programme (PSDP) of PARC to the Standing Committee of the National Assembly to make recommendations for the next financial years.

#### IV. Revision of New and Ongoing Revised Projects by CDWP /DDWP/ECNEC:-

Processed the revision of (02) two Ongoing revised projects by CDWP/DDWP. Both projects (Potato Tissue Culture & Sino-Pak) were revised in consultation with the respective PIs, concerned Technical Division, and Finance Division, PARC.

S #	Project Name	Original Cost (Rs. million)	Revised Cost (Rs. million)	Year of Completion
1.	Commercialization of Potato Tissue Culture Technology in Pakistan.	158.830	218.746	Closing (30.06.2025)
2.	Sino-Pak Agricultural Breeding Innovations Project for Rapid Yield Enhancement	433.936	611.090	Extended (31.12.2024)

#### V. Monitoring and Evaluation:-

Monitoring is a crucial component in achieving project outcomes. Therefore, PSDP has also been engaged in monitoring PSDP projects. During the year 2022-23, PSDP completed monitoring of two completed projects (Umerkot & Data Mapping).

S. #	Project Name	Original Cost (Rs. million)	Revised Cost (Rs. million)	Year of Completion
1.	Strengthening/Up-Gradation of Agriculture and Livestock Research System of Arid Zone Research Institute, Umerkot-Sindh	509.260	528.592	Closed on 30-06-2023
2.	Updation of Agro Ecological Zones of Pakistan through Satellite and In-situ Data Mapping	60.450	-	Closed on 30-06-2023

#### VI. Monthly Review Meetings of PSDP Projects at PARC, M/o NFS&R, and M/o PD&SI:-

Conducted and coordinated over 100 monthly, quarterly, and annual review meetings held at PARC, M/o NFS&R, and M/o PD&SI to update the physical and financial progress of ongoing projects. Followed up on decisions made in these meetings to ensure smooth execution of the projects.

#### Glimpse of On-going projects

##### I. Commercialization of Potato Tissue Culture Technology in Pakistan



**II. Productivity Enhancement of Rice**



**III. Productivity Enhancement of Sugarcane**



**IV. Productivity Enhancement of Wheat**



**V. Promoting Research for Productivity Enhancement in Pulses**



## VI. Sino-Pak Agricultural Breeding Innovations Project for Rapid Yield Enhancement



## VII. Updation of Agro Ecological Zones of Pakistan through Satellite and In-situ Data Mapping



## VIII. Mainstreaming of Mountain Agricultural Research Centre (MARC) for the Promotion of High Value Agriculture in Gilgit-Baltistan



## IX. Strengthening/Up-gradation of AZRI, Umerkot, Sindh





# COORDINATION & MONITORING

## COORDINATION AND MONITORING DIVISION

Coordination and Monitoring Division consists of two Directorates and one Institute namely; (i) Directorate of Coordination, (ii) Directorate of Human Resource Development and (iii) PARC Institute of Advanced Studies in Agriculture (PIASA), each having its own mandate and objectives. Recently, regional coordinating units were established in PARC outstation establishments at Quetta, Peshawar, Faisalabad, Tandojam, Muzaffarabad and Juglote-Gilgit to coordinate with all the Agriculture Universities and Livestock Departments of provinces, at regional level.

The functions of this Division mainly include; i) Coordination between PARC and national agricultural research systems of many countries (bilateral links), and UN/CGIAR/US based agricultural research agencies (international development partners), ii) Coordination and facilitation of research at national level, and iii) Assessment of training needs (local/foreign) for NARS and arrangement of pre-service and in service training along with budget & placement proposals. Furthermore, this Division is also involved in post-graduate education through PARC Institute of Advanced Studies (PIASA).

The main achievements of this Division are as under:

### 1. Strengthening of NARS

PARC has established Inter-Provincial Agriculture Research Coordination Committee (IPARCC) at national level to strengthen coordination among all research stakeholders in the country. To strengthen the coordination among research institutions/academia much deeper in each ecology, six regional coordinating units were established in PARC outstation establishments through Executive committee of PARC at: (i) Quetta, (ii) Peshawar, (iii) Faisalabad, (iv) Tandojam, (v) Muzaffarabad and (vi) Juglote-Gilgit; to coordinate with all Agricultural Departments/Universities and Livestock Departments of provinces, at regional level to address local issues.

### 2. Research Coordination with International Partners (CIMMYT, CABI etc)

#### 2.1 Coordination with South Korea through KOPIA Project

South Korea is executing multinational project in nine countries including Pakistan. PARC being a focal point for KOPIA project in Pakistan has provided space at NARC to the Project Director KOPIA and its staff. KOPIA project is transferring various technologies through following project activities:

- i. Aeroponic Greenhouse Technology; with State of the art Aeroponic Greenhouses installed at NARC, for virus free, high quality true to type potato seed production.
- ii. Advanced post-harvest machinery/drying technology for Chilli crop, to cater the Phytosanitary needs of high end markets for the Red Chillies Powder/flakes export with reduced aflatoxin level.
- iii. Ryegrass cultivars as a high yielding and nutrient rich winter fodder.
- iv. Pakistan-Korea Joint Program on Certified Seed Potato Production System' has been approved by the Governments of Pakistan and Korea, and Korean side has allocated USD 2.50 million for this project. The project will up-scale the production of virus free potato seed to meet the country requirement to maximum extent.

#### 2.2 Cooperation between PARC and CABI

- i. Project on pesticide residues on fresh tomatoes in Punjab through signing of

Agreement between PARC and CABI: Plant Wise Plus and Funding Contract. Through this project PARC will analyze the pesticide residue level of tomato produced in Punjab through Pesticide Residue testing Laboratory.

- ii. Establishment of Aflatoxin biological Control Laboratory at NARC to develop bio-pesticide through isolation and propagation of A-toxigenic *Aspergillus* fungi.
- iii. PARC is representing CABI Technical Working Group on Gender inclusiveness in agriculture.

### 3. National and International Linkages

#### 3.1 National Linkages

- i. PARC and Bank of Punjab join hands to support Agriculture research in the country. In this regard, Bank of Punjab has supported PARC for a pilot project on high quality potato seed production.
- ii. PARC and Winrock International –Pakistan office are producing virus free banana seedlings in PARC station Thatta for local farmers.

#### 3.2 International Linkages

Facilitated the visa processing of 30 foreign participants of Workshops/Seminars & Internationally Recruited Staff (IRS) of agricultural research organizations, posted in Pakistan.

PARC participated in following international bilateral meetings to assist Ministry of National Food Security & Research.

- i. Pakistan-Russia Inter Government Commissions Meeting on Trade, Economic, Scientific and Technical Cooperation.
- ii. Pak-China Joint Working Group meeting on agricultural cooperation.
- iii. 8<sup>th</sup> Session of Pakistan-Uzbekistan Joint Ministerial Commission Meeting.
- iv. 6<sup>th</sup> Session of Pakistan-Belarus Joint Ministerial Commission Meeting.
- v. 11<sup>th</sup> Session of Pakistan-Kazakhstan Inter-Governmental Joint Commission Meeting.
- vi. Pak-Italy Joint Economic Commission Meeting.

### 4. MOUs/Agreements

Three (03) MOUs/Agreements with international organizations and 09 national level MOUs/Agreements/LOIs have been signed with Universities/ Agri-tech companies/ NGOs/Public-Private Sectors and Public sector organizations for development and dissemination of research technologies. Following is the detail:

#### 4.1 International Level MOUs/Agreements

Sr#	Title	Parties	Focal Person	Signed in	Objectives
1.	Plant wise, plus work and funding contract for Analysis of Pesticide Residues in Tomato	PARC and CABI	Member (PSD), PARC	September, 2022	Develop work plans in integration with the project team members, allocate necessary resources required for completion of the project activities
2.	MOU on Scientific and Technical Cooperation in the field of Agri. Research	PARC and Agricultural Academy of Bulgaria	Member (C&M), PARC	July, 2022	Promote scientific and technical cooperation in soil science agro-ecology, Plant growing, Animal Husbandry, Aqua culture, Plant and animal protection and food safety
3.	MNP Tech on Canola Indication and Breeding	PARC and Wuhan QingfaHesheng Seed Company, China	Member (PSD), PARC	December, 2022	Jointly establish the MNP technology platform for crop germplasm breeding and indication

## 4.2 National Level MOUs/Agreements

Sr.#	Title	Parties Name	Focal Person	Signing Date	Objectives
1	MOU between PARC & Sprout Biotech Laboratories (SBL) Karachi.	PARC & Sprout Biotech Laboratories (SBL) Karachi.	Member (PSD), PARC	July, 2022	Implementation of climate smart agriculture in rural areas of Sindh.
2	Letter of Intention (LOI) between PARC and PARC-Agrotech Company (Private) Limited-PATCO.	PARC and PARC Agrotech Company (Private) Limited-PATCO.	Member (SSD), PARC	June, 2022	To establish cooperation in conducting a national survey of Agricultural Service Providers (ASP) limiting to agricultural machinery through Social Sciences Division (SSD),
3	MOU between PARC & Pro Nature Alliance (PNA).	PARC & Pro Nature Alliance (PNA).	Member (NRD), PARC	August, 2022	To provide nature based sustainable solutions to develop public policy, developing and implementing innovative initiatives on climate change and food systems
4	Letter of Intention (LOI) between PARC & (ACTED) Pakistan.	PARC & (ACTED) Pakistan.	Member (NRD), PARC	August, 2022	To strengthen collaborative ties and carry out cooperative research, scientific communication, technology innovation and transfer and capacity building in agricultural field.
5	MOU between PARC & Government College Women University Sialkot (GCWUS)	PARC & Government College Women University Sialkot (GCWUS).	Registrar (PIASA), NARC	Sep., 2022	Mutual scientific and technical cooperation to advance the state of science and technology within the country.
6	MOU between PARC & Zarai Taraqiati Bank Limited (ZTBL).	PARC & Zarai Taraqiati Bank Limited (ZTBL).	Member (C & M) PARC	January, 2023	To establish a collaborative relationship in promoting and adapting latest agricultural technologies, practices, techniques and agricultural mechanization for improving farm efficiency.
7	Agreement between PARC & Extension Service Management Academy (ESMA) AJK.	PARC & Extension Service Management Academy (ESMA) AJK.	Member (NRD), PARC	January, 2023	To enhance command area of small and Mini dam in Barani area of Pakistan
8	Letter of Intention (LOI) between PARC & Royal Cell Biotechnology Pakistan. (RCBP).	PARC & Royal Cell Biotechnology Pakistan. (RCBP).	Member (ASD), PARC	February, 2023	To conduct joint research and development on in vitro fertilization of buffalo, semen production units, milk value addition and dairy processing development.
9	MOU between PARC & the Bank of Punjab (BOP)	PARC & the Bank of Punjab (BOP)	Member (C & M) PARC	June, 2023	To establish a collaborative relationship in promoting and adapting latest agricultural technologies, practices, techniques and agricultural mechanization for improving farm efficiency.

## 5. Human Resource Development

PARC is striving all the time to train their scientists at far with International Level. In this regard, Human Resource Directorate of PARC has trained the following number of scientific manpower locally and abroad

S.No	Name & Designation	Department	Study Program	University	Country	Duration
01.	Syed Khaleeq Hussain Shah, UDC	PARC	BBA (4 Years)	AIU, Islamabad	Pakistan	08-05-2023
02	Ms. Saima Mumtaz SO	NARC	IRSIP Program (Six Months)	University of Florida,	USA	15-06-2023
03	Mr. M. Jawad Atif, ASO	HRI, NARC	Post Doc Fellowship	Chinese - Council	China	2023
04	Mrs. Rozina Naz PSO	CEWRI, NARC	Ph. D	University of Groningen	Netherland	2023
05	Mr. Muhammad Jamil, SO,	AZRC, D.I. Khan	Ph. D	Gomal University, D.I. Khan	Pakistan	23-01-2023

S.No	Name & Designation	Department	Study Program	University	Country	Duration
06	Dr. Barkat Ali, SSO	FSRI, NARC	Post Doc	Food Security	China	25-07-2022 to 24-07-2024
07	Mr. Rashid SO	ANP, ASI	MS	Public Health	Thailand	31-08-2022 to 30-08-2024
08.	Mr. Ashraf Khan SO	VPMP, NARC	Ph. D	Pesticide Sciences	Australia	05-12-2022 to 07-01-2026
09	Mr. Nisar Khan SO	IC, PARC	Ph. D	PMAS – AARI, Rawalpindi	Pakistan	03-10-2022 to 02-10-2026
10	Mr. Waqas Raza AD	NIGAB, NARC	MS	COMSATS University, Islamabad	Pakistan	12-09-2022 to 11-09-2024
11	Mr. Zulqarnain Zia ATO	BARDC, Quetta	MS Electrical Eng.	Baluchistan University of Information, Quetta	Pakistan	01-10-2022 to 31-07-2024
12	Dr. Rao Wali Director	Multan	MPA	Bahauddin Zakaryia University, Multan	Pakistan	2022-2024
13	Ms. Rabia Ikram SO	NIGAB, NARC	Ph. D	Quaid Azam University, Islamabad	Pakistan	2022-2024
14	Ms. Ghazal Assistant	Legal, PARC	M. Phil	Ripha International University, Islamabad	Pakistan	2022-2024
15	Ms. Anisa Wahab Assistant	HRD, PARC	MBA	AIOU, Islamabad	Pakistan	Sept. 2022 to Sept. 2024
16	Mrs. Irum Raza SO	SSRI, NARC	MS Data Science	Abasyn University, Islamabad	Pakistan	17-09-2022 to 16-09-2026
17	Mr. Bilal Ahmad Tech-II	AEI, NARC	MS	International Islamic University, Islamabad	Pakistan	01-08-2022
18	Syeda Fakhra Ali Scientific Asstt.	PMRI, Karachi	Ag & Agribusiness Management	Karachi University	Pakistan	March 2023 to March 2026
19	Ms. Wajiya Ajmal SO	NIGAB, NARC	Ph. D	Quaid-e-Azam University, Islamabad	Pakistan	12-02-2023 to 11-02-2026
20	Ms. Maria Saeed Lab Technician	NIGAB, NARC	M. Phil	University of Abasyn, Islamabad	Pakistan	2022 to 2024
21	Qazi Bashir Ahmed SSO	AZRI,	Ph. D	Islamia University, Bahawalpur	Pakistan	01-01-2023 to 28-01-2028
22	Ms. Sidra Majeed SO	SSRI, NARC	M. Phil	PMAS/AARI University, Rawalpindi	Pakistan	03-10-2022 to 02-10-2024
23	Mr. Muhammad Ehsan Elahi, SO	AZRI, D.I. Khan	Ph. D	Gomal University, D.I. Khan	Pakistan	13-09-2022 to 14-09-2026
24	Mr. Saleem Abid SO	SSRI, NARC	Ph. D	Islamia College, Peshawar	Pakistan	03-10-2022 to 02-10-2026

**Visit-Symposium-Meeting-Seminar-Conference**

1	Dr. Zaheer Abbas SSO	NIGAB, NARC	Workshop	1 <sup>st</sup> Central Asian Workshop on wheat Genetics and Genomics	Kazakhstan	30-01-2023 to 02-2-2023
2	Dr. Muhammad Zubair, SO	MSM, CSI, NARC	Workshop	1 <sup>st</sup> Central Asian Workshop on wheat Genetics and Genomics	Kazakhstan	30-01-2023 to 02-2-2023
3	Dr. Hafiz Sultan Mehmood,	ABEI, NARC	Meeting	HLPD on Trade Facilitation through International Standards and Mutual recognition of Agricultural Machinery testing	Bangkok	21-22 February, 2023
4	Dr. Nadeem Akmal PSO	SSRI, NARC	Meeting Online	Online Invitation of APPARI-GFAR Project Kick off Meeting	Philippines	4-5 August, 2022

S.No	Name & Designation	Department	Study Program	University	Country	Duration
5	Dr. Abid Hussain PSO	SSRI, NARC	Meeting Online	Online Invitation of APPARI-GFAR Project Kick off Meeting	Philippines	4-5 August, 2022
6	Dr. Muhammad Qasim, Director	SSD, PARC	Symposium	Invitation to Participate in Asia Pacific Symposium on Agri. food System Transformations	Rome	5-7 October, 2022
7	Dr. Nouman Rashid Siddiqui, Director	FSRI, NARC	Symposium	Invitation to Participate in Asia Pacific Symposium on Agri. food System Transformations	Rome	5-7 October, 2022
8	Dr. Sikandar Khan Tanveer,	CSI, NARC	Online Symposium	Participation in online International Symposium on Establishment of an Intelligent Production System for Seeds and Seedling	Bangkok	10 November, 2022
9	Armaghon Shahzad PSO	NIGAB, NARC	Online Symposium	Participation in online International Symposium on Establishment of an Intelligent Production System for Seeds and Seedling	Bangkok	10 November, 2022
10	Dr. Asif Ali, PSO	AED, PARC	Online Session	18 <sup>th</sup> Session of the Governing Council of the Centre for Sustainable Agricultural Mechanization	Thailand	09 December, 2022
11	Dr. Imtiaz Hussain Member(PSD)	PSD, PARC	Workshop	Participation Consortium for Scaling up Climate Smart Agriculture in South Asia (C- Success) Project Consultation Workshop	Kathmandu, Nepal	23-24 March, 2022
12	Dr. Ghulam Muhammad Ali, Chairman	PARC	Conference	CABI's 21 <sup>st</sup> Review Conference	U.K	27-28 Sept, 2022
13	Dr. Imtiaz Hussain Member	PSD, PARC	Conference	CABI's 21 <sup>st</sup> Review Conference	U.K	27-28 Sept, 2022
14	Dr. Naila Siddiqui SSO	NRLPD, NARC	Workshop	Workshop Bioinformatics for Genomic Epidemiology	Abu Dhabi, (UAE)	25-29 July 2022
15	Dr. Imtiaz Hussain Member	PSD, PARC	Meeting	7 <sup>th</sup> Eco Ministerial meeting preceded by 6 <sup>th</sup> high level expert meeting on agri	Uzbekistan	5-6 July, 2022
16	Dr. Zia ul Hassan Member	ASD, PARC	Online Session	Invitation to the 12 <sup>th</sup> Session of the Intergovernmental Technical Working Group on Animal Genetic Resources for Food and Agriculture	Singapore	18-20 Jan, 2023

**1. Promotion of Higher Education Promotion in Agriculture through PARC Institute of Advanced Studies in Agriculture (PIASA)**

In view to even increasing skills and expertise gap in the advanced agricultural sciences and to capitalize on its rich knowledge base and infrastructure, PARC established PARC Institute of Advance Studies in Agricultural (PIASA) in 2008, to embark upon a unique postgraduate academic program at the campus of NARC.

PIASA has been affiliated with University of Agriculture, Peshawar since 2010 and has been offering MPhil and Ph.D programs in the following disciplines:

- i. Animal Geonomics & Biotechnology (AGB)
- ii. Applied Economic (AE)
- iii. Plant & Environmental Protection (PEP)
- iv. Plant Geonomics & Biotechnology (PGB)
- v. Natural Resource Management (NRM)

**List of Passing out Students of PIASA during report period 2022/23**

Sr. No.	Name	Degree	Thesis Title	Department	Session
1.	Muhammad Yasin	PhD	Sequence and Expression Analysis of Shattering Cascade Genes in canola ( <i>Brassica napus L.</i> )	Plant Genetics & Biotechnology	Spring 2015
2.	Khansa Jamil	PhD	Extraction Chemical Characterization of anti Diabetic Vindoline and its Effect on Inhibition of Protins by In-silico Study	Plant Genetics & Biotechnology	Spring 2014
3.	Nazir Ahmad	PhD	Phenol degrading potential of bacterial strains at different environmental conditions	Plant Genetics & Biotechnology	Spring 2013



# FINANCE

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

The annual accounts of the Council are audited by independent Chartered Accountants as well as the Auditor General of Pakistan under the PARC Ordinance 1981.

### An Overview of PARC's Budget:

(Rs. in million)

Budget Head/Funding Source	2021-22 Actual Expenditure	2022-23		
		Budget	Revised Budget	Actual Expenditure
Current Expenditure Budget (A)	4304.163	5383.005	5312.489	5312.141
Research Budget (B)	0.000	467.500	187.000	187.000
<b>Total (A+B):</b>	<b>4304.163</b>	<b>5850.505</b>	<b>5499.489</b>	<b>5499.141</b>
Development Expenditure (PSDP)	1404.396	1498.728	1082.322	1068.412
Memorandum of Understanding (MOU's)	40.003	73.615	32.748	32.748
Agricultural Linkage Program (ALP)	182.129	345.643	345.643	129.352

### **I. Current Expenditure Budget**

(Rs. in million)

Objects	2021-22 Actual Expenditure	2022-23		
		Budget	Revised Budget	Actual Expenditure
Employee Related Expenses (ERE)	2644.380	3000.000	2917.748	2917.401
General Expenses	331.609	470.305	446.790	446.789
Employee Related Benefits (ERB)	1229.450	1800.000	1800.000	1800.000
<b>Total Grant-in-Aid (A)</b>	<b>4205.439</b>	<b>5270.305</b>	<b>5164.538</b>	<b>5164.190</b>
Add: Own Source	98.724	112.700	147.951	147.951
<b>Total Current Expenditure Budget</b>	<b>4304.163</b>	<b>5383.005</b>	<b>5312.489</b>	<b>5312.141</b>
Research Budget (B)	0.000	467.500	187.000	187.000
<b>Total (A+B):</b>	<b>4304.163</b>	<b>5850.505</b>	<b>5499.489</b>	<b>5499.141</b>

**Development Expenditure Budget****a) PSDP**

Development Expenditure budget of Rs.1498.728 million was allocated for the following on-going PSDP Projects for the year 2022-23 which was subsequently revised to Rs. 1082.322 million surrendering Rs.416.406 million the detail of projects is as under:-

**On-going Project:**

(Rs. in million)

Sl. No.	Title of the Projects	Approval Date/Forum	Total Cost	Budget 2022-23	Revised Budget 2022-23	Actual Expenditure 2022-23
1.	Main Streaming of MARC for the promotion of High Value Agri. In G.B	DDWP 20-05-2021	288.200	40.000	32.054	32.054
2.	Strengthening/Up-Gradation of Agriculture and Livestock Research System of (AZRI) Umerkot, Sindh	DDWP 03-05-2017	528.260	145.000	140.801	134.316
3.	Productivity Enhancement of Wheat	ECNEC 28-08-2019	5632.774	350.000	254.257	254.054
4.	Productivity Enhancement of Rice	ECNEC 28-08-2019	3750.660	270.000	153.100	199.912
5.	Productivity Enhancement of Sugarcane	ECNEC 28-08-2019	1003.773	130.000	104.800	103.079
6.	Pulses Project	ECNEC 29-11-2019	1437.358	400.000	216.697	216.686
7.	Commercialization of Potato Tissue Culture Technology in Pakistan	DDWP/04- 05-2020	158.830	44.130	43.626	43.343
8.	Sino-Pak Agricultural Breeding Innovation Project for Rapid Yield Enhancement	DDWP/04- 05-2020	433.936	99.598	74.983	72.701
9.	Upgradation of Agro-Ecological Zones for Pakistan through Satellite and in-situ Data Mapping	DDWP/24- 02-2020	60.450	20.000	15.003	12.266
	<b>TOTAL</b>			<b>1498.728</b>	<b>1082.322</b>	<b>1068.412</b>

**b) Memorandum of Understanding (MoU)**

A total of 15 projects at a total cost of Rs.73.615 million were approved under MOU's with different national and international organization for the year 2022-23. An over view of two years is as follows:

(Rs. in million)

Objects	2021-22 Actual Exp	2022-23		
		Budget	Revised Budget	Actual Exp
Budget	40.003	73.615	32.748	32.748
No. of Projects	14	15	15	15

**c) Agricultural Linkage Programme (ALP) Budget**

Keeping the principal amount Rs.1300.000 million of the Endowment Fund

intact, the funds generated through income from such investments are used to finance the research activities/program under ALP. Payments were made on time and merit. The position of utilization of ALP funds has been tabulated hereunder: Province wise allocation of projects is given in table below:

(Rs. in million)

Sr. No	Location	2022-23		
		Total Number of Project Executed	Budget	Revised Budget *
1	Federal	49	88.563	112.938
2	Punjab	40	45.472	61.666
3	KPK	13	37.299	42.927
4	Sindh	05	10.882	12.344
5	Balochistan	08	19.809	22.139
6	AJK	05	2.170	4.743
7	PARC, H.Qtr.	01	41.448	46.091
8	Block Allocation	Block Allocation	100.000	42.795
9	Sponsoring of Short Term Exchange of Agri. and Scientist and Experts		0.000	0.000
10	Scientist Award		0.000	0.000
11	Membership Fee to Foreign Agencies		0.000	0.000
	<b>Total :-</b>	<b>121</b>	<b>345.643</b>	<b>345.643</b>

It is note worthy that due to efforts of Finance Division, budget allocation to PARC has been increased and old issues related to pension, commutation, hiring etc have been resolved. At the same time income generation through own source have also been increased.



Federal Minister for National Food Security Mr. Tariq Bashir Cheema, Ambassador of South Korea Su Sung Pyo, and Dr. Ghulam Muhammad Ali, Chairman, PARC are inaugurating the latest aeroponics technology for potato seed at NARC



Dr. Ghulam Muhammad Ali, Chairman, PARC alongwith H.E. Donald Blome U.S. Ambassador to Pakistan and Dr. Shehzad Asad Director General, NARC during the launching ceremony of “Fertilizer Right” project at NARC.



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