

PARC

Annual Report

2017-18



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Malik Shakir Bashir Awan, MNA/ Chairman, National Assembly Standing Committee on NFS&R is chairing 44th meeting of the Standing Committee held at PARC HQs, Islamabad. Mr. Sikandar Hayat Khan Bosan, Federal Minister for M/o NFS&R, Mr. Fazal Abbas Maken, Federal Secretary for M/o NFS&R, Dr. Yusuf Zafar T.I., Chairman PARC and other members of NA Standing Committee on NFS&R are also present in the meeting. (5th April 2018)



Mr. Sardar Sikandar Hayat Bosan, Federal Minister for M/o NFS&R, Islamabad is presiding over the 43rd Meeting of PARC-Board of Governors (BoG) held at PARC Hqs, Islamabad on 24-05-2018 Mr. Fazal Abbas Maken, Federal Secretary for M/o NFS&R, Dr. Yusuf Zafar, T.I., Chairman, PARC and other dignitary Members of PARC-BoG are also present on the occasion.

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FOREWORD FROM THE CHAIRMAN

I completed my first year with PARC as its Chairman. It is my immense pleasure to share the information that the year 2017-18 for PARC has been the year of improvements in every discipline. This all happened because of untiring team efforts to bring back the real face of PARC for which it was mandated.

The biggest achievement was the historic withdrawal of the CDA Summary by the then Prime Minister of Pakistan regarding 1400 acres land of NARC. We at PARC are sincerely thankful to Standing Committee of Senate, the Honorable Supreme Court of Pakistan, our Minister of National Food Security & Research (Sardar Sikandar Hayat Bosan) and all the scientific and civil societies who supported our just cause to save this (NARC) national asset.



The Plant Sciences Division (PSD) has made remarkable achievement in terms of developing new approved varieties of 03 Oilseed (NARC-Sarson, PARSUN-03 Sunflower & NARC-2017 Groundnut), 02 Maize (NARGAS & NARC-Sweet-2018) 01 each Sugarcane (YT-55-Thatta) & Oat (PARC-Oat). Moreover, PSD came up with national development projects on pulses and oilseed which were presented to higher government fora for productivity enhancement in these two crops.

The Natural Resources Division (NRD) has not only improved its products like Biozote but excelled” in its branding and marketing. Similarly, every year PARC honey is being improved and now being sold as brand “PARC Honey”. Moreover, NRD has done great efforts to conserve medicinal plants which have an increasing role.

The Animal Sciences Division (ASD) is working hard for combating various livestock diseases with the research on the development of different vaccines. Improvements have also been made in terms of animal nutrition and milk production. The ASD has a very strong past for its contribution in management of viral diseases of poultry through accredited laboratories at National Agricultural Research Centre (NARC). Fishery is being improved aiming at bringing in new fish kinds to country. ASD has also produced lot of forage crops with maximum production and experimented new combinations for animal ration.

The Social Sciences Division (SSD) has been taking up case studies for the critical decisions in the country, bringing up new policies and maintaining the communication gap narrower between all stakeholders in the national agricultural research system. The eminent scientists of SSD of PARC led the team who developed first “National Food Security Policy” (29 May, 2018). Agricultural Polytechnique Institute and newly restructured Directorate of Scientific Communication & Publication are carrying out excellent outreach task of promoting modern agriculture in the country.

The Agricultural Engineering Division (AED) has mandate to make the agriculture easy by their supportive newly developed machines as well as their improved structure and performance according to local demand and situation. This year newly developed machines include portable solar dryer for dates and other fruits, palm oil extraction machine, multipurpose nursery raising plant, klonji thresher and onion seed stationary thresher.

The Coordination and Monitoring (C&M) Division continues to develop linkages with various national and international development partners. Moreover, a liberal policy resulted in enhanced number of foreign trainings (short and long-term). Our national and international development partners which include CIMMYT, USAID, USDA, Pak-Italian, Dow-Agro Sciences, ACIAR, ILSI Research Foundation, IDS-IFPRI, COMCEC, FAO, JICA, CABI Bioscience, Koica and many others continued their valuable and vital support in various R&D endeavors.

Ministry of National Food Security & Research has no doubt a much greater role in PARC advancements and progress. The strong support of the Ministry enabled us to improve our working. We at PARC are making all out efforts to have a “Food Secure Pakistan”.

Our reform agenda is progressing well. NARC has undergone through a smooth transition of right-sizing with institutes reduced from 22 to 15 and number of directors from 32 to 20. The process of much needed reforms in Social Sciences Division is making steady progress by closing down non-productive liaison office in Lahore and redistribution of human resources. Few chronic and disputed issues of recruitment are moving towards logical and just settlement while majority of pending cases of arrears/liabilities were resolved. Now organization is marching forward with renewed strength and commitment

DR. YUSUF ZAFAR T.I
CHAIRMAN

Plant Sciences

Plant Sciences Division (PSD) is focusing on sustainable improvement in productivity and quality of crop commodities to ensure food security in the wake of population increase, malnutrition, and climate change. Major activities towards achieving this goal are highlighted in the following sections of the report:

A. Coordination Activities

i. Germplasm acquisition and distribution

To ensure the availability of plant genetic resources to National Agricultural Research System (NARS) stakeholders, the germplasm of following commodity crops was acquired from international sources for distribution to relevant national research programmes.

Commodity wise germplasm acquired and distributed

Crop	Acquired	Distributed
Wheat	20432	20432
Rice	195	195
Maize	306	154
Sugarcane	900 Gram Fuzz (Local NSTHRI, Thatta)	900 Gram
Pulses	74	74
Fodders	45	107

ii. National uniform yield trials (NUYT)

NUYTs of following crops were conducted to ascertain the potential varieties/hybrids:

Commodity wise National Uniform Yield Trials (NUYT)

Crops	Entries	Locations
Wheat	60	52
Rice (Hybrids / Coarse / Fine)	82/15/15 = 112	18
Maize	246	39
Millet	05	07
Fodder Crops		
Sorghum	06	07
Guar	03	07
S.S. Hybrid	17	10
Oat	09	13
Baerseem	07	07
Lucerne	05	05
Sugarcane	21	8
Lentil	14	17
Chickpea	34	27
Mungbean	16	17
Mash	6	12
Oilseed (6 crops)	6-22	7-18

iii. Meetings and special Initiatives

- On recommendation of Variety Evaluation Committee (VEC) for rice, wheat, maize, potato, sugarcane and oilseed crops candidate lines were evaluated and the promising ones were released as commercial cultivars. These include 35 maize hybrids, 14 rice hybrids, 15 varieties of potato, one each of wheat, sugarcane, ground nut & Oat. PARC got 03 Oilseed (NARC-Sarson, PARSUN-03 Sunflower & NARC-2017 Groundnut), 02 Maize (NARGAS & NARC-Sweet-2018) 01 each sugarcane (YT-55-Thatta) & Oat (PARC oat) varieties approved this year after competing with stakeholders.

- Standard operating procedures were set up for management of NUYT as per obligation under Seed rules 2016. Targets of yield and process for selection of check variety for each crop was also fixed after mutual consultation with the seed companies to import climate resilient high yielding genotypes to increase productivity and profitability of the farmers.
- Establishment of National Forums of Plant Clinics for capacity building of the extension staff on diagnostics, data management and transfer technologies with major focus in Baluchistan, Federally Administrated Tribal Areas and Gilgit Baltistan.
- Establishment of National Platform on invasive species (parthenium weed, tomato Leaf miner etc.) for their management at national level. Supported a dedicated activity in Punjab against eradication of parthenium with CABI as partner. In addition, sex pheromones against tomato leaf minor were installed in FATA areas to track
- Initiated rice productivity program through hybrid promotion in cooperation with China to have experience sharing exchange visits, understanding the requirement of high yielding rice hybrids.
- Crop diversification & maximization of under-utilized crops like soybean, winter wheat for northern areas, MAPs and Floriculture for AJK promoted.
- A dedicated project on post quarantine requirement has been planned to upgrade Institute of Plant Introduction Karachi and will be submitted with the concurrence of Department of Plant Protection Karachi.
- National oilseeds plan presented before a high level committee at Ministry of National Food Security & Research, Consequently, national mission on oilseeds, national oilseeds policy and restructuring of Pakistan Oilseeds Development Board (PODB) approved. Draft national oilseeds policy was submitted with the support of PODB, while, re-structuring plan is in process.
- National pulses plan was also presented before the high level committee for sustainable production in pulses. A mega project costing Rs 2599 Million is ready for productivity enhancement through exploring new areas under pulses, best genotypes/varieties, seed production and mechanization. Salient points of National Pulses plan were made part of PC-I to execute with the passage of time as deemed fit.
- Prepared a major vegetable critique for MNFSR to supply critical vegetables like tomato, onion, garlic and chillies round the year.
- Prepared a concept paper to supply true to type plants to the farmers as per 22H of seed rules 2016 as per BoG decision and passed to FSC&RD for further necessary action.
- Strengthen the national coordination program through up gradation of TORs of the positions and tasking mandatory tasks to prompt diversification and national coordination. A dedicated project was also prepared at the cost of Rs 352 Million. In addition, two new subjects of biotechnology and plant protection added in national coordination to meet the burgeoning demands.
- Prepared a business plan for successful operation of commercial black tea plant installed at Shinkiar with the help of Caykur tea company Turkey. A plant of Rs 150 million was also installed within the meager resources to promote tea and reduce the burden on imports.

B. Research Activities

I. At National Agricultural Research Centre (NARC)

a) Bio-resource Conservation Institute (BCI)

Under BCI, PhD students (18), M. Phil students (17) and research internees (76) from various universities and academic institutions trained in the fields of agro-morphological characterization/evaluation of crop germplasm under field conditions and laboratory work regarding biochemical/ molecular analysis, in-vitro conservation, seed viability testing, seed processing, gene-bank management of PGRs, identification of herbarium specimen and isolation/ characterization of microbial genetic resources.

High level 15 national and international delegates/dignitaries, researchers and groups of university students/trainees visited BCI particularly NGP. Over all 513 visitors were briefed and students lectured about PGR and gene bank management as well as other activities of BCI. Two national seminars on “Role of Plant Genetic Resources in Varietal Development and Seed System” and one workshop on “Plant Genetic Resources & Gene bank Management System” were also arranged.

Salient achievements of various programs at BCI are as follows:

i. Plant Genetic Resources Program (PGRP)

- Registered total of 3,738 new entries to the PGRP's Gene Bank through local collection and acquisition from overseas sources. This year special attention was given to vegetables and crop wild relatives (CWR), hence a reasonable number of vegetables and CWR was acquired.
- The National Gene Bank of Pakistan provided 12,415 plant germplasm accession's samples to breeders, researchers and universities across the country. Cereals followed by legumes and oilseeds were major crop germplasm requested by the stakeholders. The seed requests were highest from Punjab followed by Khyber Pakhtunkhwa, AJ&K, Gilgit-Baltistan, Sindh and was lowest from Balochistan.
- Quality of the conserved material is assured through regular monitoring of viability at specific intervals.

This year 3,056 accessions were tested for viability, including the 55 seed entries commercially tested for PATCO.

- Total of 743 accessions of brassica oilseeds, 282 of guar, 161 of rice, 293 of safflower, 168 of wheat, 120 of maize, 530 of barley, 639 of lentils, 50 of mungbean, 144 of cowpea, 49 of moth bean, 46 of faba bean, 94 of lathyrus, 98 of peas, 150 of radish, 150 of carrot, 92 of onion, 12 of cucumber, 105 of capsicum, 5 of exotic garlic, 54 of cucurbits and 9 of MAPs germplasm were regenerated and characterized for traits of interest as per IPGRI descriptors.
- Total 13,515 plants produced through tissue culture including potato (11674), orchid (885) and other medicinal and fruits plants (956). Medicinal plants (*Asparagus adscendens* Roxb, *Acacia catechu*, *Otostegia limbata*, *Buxus papillosa* were collected from Margalla Hills, Islamabad for in-vitro propagation.

ii. Microbial Genetic Resources Program

- Out of 26 novel bacterial species, 7 Novel Species and one novel genus identified and validated.
 - Novel genus *Caldovatus sediminis* gen. nov., sp. nov. (validated – 2017)
 - *Microvirga pakistanensis* sp. nov., (published – 2016, validated – 2017);
 - *Streptomyces caldifontis* sp. nov., (validated – 2017);
 - *Thermus caldifontis* sp. nov., (validated – 2017);
 - *Nocardioidesthalensis* sp. nov., (validated – 2017);
 - *Phenyllobacterium deserti* sp. nov., (validated – 2017);
 - *Tepidimonas sediminis* sp. nov. (published – 2017);
 - *Tepidimonas alkaliphilus* sp. nov., (published – 2017)
- *Zafariasolitudinis* gen. nov. sp. nov. (under review process – 2017-18): For the first time in history of PARC research, the novel species of bacteria from Pakistani ecology have been validated by “International Committee on Systematics of Prokaryotes (ICSP)”.
- During 2017-18, more than 114 DNA sequences of 16S rRNA gene of bacteria submitted to International DNA Data Bank.

iii) National Herbarium

- Herbarium specimens of native flora i.e. medicinal/aromatic, edible and ornamental plants collected from different areas of Gilgit Baltistan, Baluchistan, Southern Punjab and Sindh and added to conservatory.

b) Crop Sciences Institute (CSI)

i. Wheat Program

- Two high yielding and disease resistant advance wheat lines, NR 449 and NR 443 have shown outstanding performance in NUYT under rainfed conditions for two years. NR 443 has 8 ppm higher Zn contents than the standard check variety. These candidate varieties were planted for spot examination in national, regional and station trials and expert subcommittee nominated by PSC evaluated candidate lines on April 9, 2018 at PSC-Farm Perowal, Khanewal. These lines will also be presented in VEC and PSC Experts committee meeting during the current cropping season to release as commercial varieties.
- 162 diverse recombinants and 712 segregating populations at different filial generation have been planted and maintained.
- Based on the performance at various stages of testing, seven advance bread wheat lines were planted in the national uniform wheat yield trials (NUWYT) under rainfed as well as irrigated conditions.
- One durum advance line has been included in NUDYT for first time.
- Reduced tillage and retention of crop residues have shown positive effects on grain yields of the crops and produced 8.2 and 4.5% more grain yield as compared with the conventional tillage and residue removed treatments.
- During Rabi season 2017-18, planted seed increase of released varieties (NARC-2009, NARC-2011, Pakistan-2013, Zincol-2016 and Borlaug-2016) on 245 acres. It is expected that more than 200 tons seed of different categories (i.e. pre-basic, basic and certified) will be available for distribution among farmers through PSC, NRSP, AKRSP and different seed companies.

ii. Oilseeds Program

- The groundnut variety Pothowar has been approved by the Punjab Seed Council for commercial cultivation in Punjab during 2017. 400 kg seed of Groundnut varieties Pothowar and BARD-479 produced during Kharif 2017.
- In F6 Generation (Groundnut), 24 desired uniform lines of 13 crosses were planted. Dry pods yield varied between 2342 and 3998 kg/ha kg/ha. In preliminary yield trial 12 entries were evaluated and highest dry pods yield of 3965 kg/ha was recorded in entry PG-1280. In advance yield trial 12 entries were tested and highest dry pods yield of 3637 kg/ha was obtained in entry PG-1221. In advance yield trial of eight short duration lines, highest dry pods yield of 2816 kg/ha was recorded in PG-1058.

- A total 54 sunflower inbred lines in different developmental stages were planted for generation advancement. Forty four inbred lines (A, B and R) were maintained and purified. Nineteen hybrid combinations were developed.
- 410 canola A, B lines and 8 restorer lines were maintained. 39 new canola hybrid combinations made. About 200 acres are planted under canola seed production.
- A total of 18 Sesame crosses were made. Progenies of different filial generations were planted for generation advancement. In preliminary and Advanced Yield Trials, ten entries (each) were evaluated and all genotypes produced higher seed yield than check TS-5 in both trials.
- 216 Soybean lines including local germplasm, exotic accessions from PGRI gene bank and NIBGE, Faisalabad were evaluated at NARC in kharif, 2017. In Preliminary Yield Trial of 20 entries, NARC PGRA-91 produced higher seed yield of 1382 kg/ha. In Advanced Yield Trial, maximum yield among 12 entries was recorded in Ajmeri (1678 kg/ha). Moreover, 150 tons seed was produced during Kharif 2017.

iii. Pulses Program

- 45 mungbean genotypes (acquired from AVRDC) and 33 cross combinations in different filial generations were multiplied and characterized during Kharif 2017. In preliminary yield trial, among 33 genotypes MSPS 120 produced higher yield (468 kg/ha). Sixteen promising genotypes were evaluated in advance yield trial, NCM 11-5 was the highest yield of 474 kg/ha as compared to check (212 kg/ha).
- In mash preliminary yield trial, 40 genotypes were evaluated. 12 lines were selected as high yielding and 17 lines as erect plant type and stiff stem. 22 lines were evaluated in advance yield trial and 12 high yielding lines were selected for further evaluation. Under Mechanized harvesting trial 18 entries were evaluated, 13 entries with erect type of plants were found suitable for combine harvesting.
- Seven chickpea diverse parents were used in hybridization and 12 combinations were selected with targeted traits (Blight resistance, bold seed size and early maturity). In Advance yield trial, 25 genotypes are being planted for evaluation at three locations. In advance trial 11 plants are selected on the basis of bold seed size and erect plant type. 250 genotypes of Kabuli chickpea from ICARDA and evaluated during current rabi season with Noor-2013 as a check variety. Seed multiplication block of pre-basic and basic seed is planted on 3 acres.
- In lentil crossing block 5 diverse parents were used. 43 segregating populations from F4 and F5 were planted to attain homozygosity. In Lentil Adaptation, trial 18 genotypes are planted. In Lentil, advance yield trial 29 lines are planted and the data recording is in progress. In Lentil international nurseries acquired from ICARDA, 105 lines are under evaluation. Pre-basic and basic seed production block is planted at 8 acres.

iv. Rice Program

- Eighteen rice varieties/elite lines were screened against leaf folder (LF) white backed plant hopper (WBPH) and brown plant hopper (BPH) at Kala Shah Kaku. Maximum LF population (4.64%) was observed on Basmati-370 followed by Basmati-515 (4.24%) and KS-282 (3.48%). The highest (27.4) WBPH population/plant was recorded on Chenab Basmati followed by Super Basmati (20.6) and Basmati-370 (20) and lowest (11.6) on Basmati Pak and KS-282. Maximum paddy yield (6.90 t/ha) was recorded from NIAB IRR1-9 followed by KS-282 (6.74 t/ha) and KSK-434 (6.53 t/ha).

v. Maize and Fodder Program

- Two SS Hybrids "NARC-Shahtaj" and "NARC-SS hybrid" (with yield potential 140 t/ha) have been put in the process of sale and showcasing for interested companies. The purity of parental lines of both fodder hybrids are being maintained.
- An improved line of oats NZ-0034 having high fodder yield potential (70 t ha⁻¹), lodging resistance and capable to provide green fodder up to June was developed. Its proposal is under process and will be submitted in VEC meeting during 2018.
- Two candidate lines of oats (Oats-Sel-1, No.11xS-81) and a line of sorghum (F-9603) selected for multi-location testing based on Preliminary Yield trials

c) Horticulture Research Institute

- 2000 Seed kits & 150, 000 Seedlings of summer and winter vegetables provided to kitchen gardeners with regular advisory services.
- 15 Internees from different universities supervised,
- 20 Lectures delivered in different training courses and 15 Radio talks given on various aspects of vegetable cultivation.
- Agronomic Practices for Garlic Cultivar NARC Garlic 1 standardized: Planting time 15th October gave maximum number of cloves (10) per bulb with maximum yield 23.7 t/ha. Application of NPK @ 12:90:80 kg/ha gave maximum bulb yield of 24.3 t/ha. Plant spacing at 30×10 cm gave highest bulb yield of 23.1t/ha.
- Evaluated suitable and early maturing grapes cultivars (Superior seedless, Crimsons seedless, Red globe,

TarakayaIlkeren, Early green, Early white, Exotic Selection 1, Exotic Selection 2 and Alphanso Lavallee). Early sprouting and bud initiation was recorded in superior seedless followed by early white and early green.

- Guava 500; Citrus rootstock (Sour Orange), 600; Loquat, 350; and Avocado, 300 number of plants produced from seed. Fig 3800 (Black Mission and Turkish Brown cultivars), Grapes 5000 (King's Ruby, Flame Seedless and NARC Black cultivars), Mexican Lime 1300 and Sweet Lime 500 true-to-type plants were propagated through cuttings and shifted in polythene bags. Citrus 800, Peach 200, Avocado 110, Apricot 100 and Pear 150 number of plants produced by grafting/budding
- 34 potato clones resistant to late blight and viruses received from International Potato Centre (CIP), Lima, Peru were multiplied by tissue culture techniques by IABGR for micro tuber production. 28 clones were selected and 300 kg basic seed was produced, 400 kg mini tubers of 105 clones were also produced from local crosses.
- Five new exotic flowering species were added to the repository: 4 geranium species and 1 Hedera helix species
- 40 students completed internship research on floriculture



Gladiolus crop

d) Institute of Plant and Environmental Protection (IPEP)

i. Integrated Pest Management Program (IPMP)

- Twelve (12) open pollinated, 41 White hybrids, 83 and 04 Sweetcorn Maize hybrids planted under National Uniform Yield Trials in Kharif-2017 were evaluated for their comparative resistance against Maize Stem Borer and Corn Ear Worm.
- Ten (10) entries of maize provided by CIMMYT were evaluated at NARC by giving them artificial infestation of maize stem borer, reared in IPMP Labs. Entry No. TZBR-E1D-3-YC2 and BR-9943-DMRS RC1 showed the least injury of leaves (injury score 2.40 and 3 respectively) and stem damage 30% and 33 % respectively. Entry TZBR-E1D-3-WC2 and BR9928-DMRS RC1 found moderately resistant with 4.50 and 4.00 leaf injury score respectively, stem damage 40% and 44% respectively.
- Six sorghum fodder hybrids planted under National Uniform Yield Trials Kharif-2017 were evaluated for their comparative resistance against stem borer. The highest infestation was observed in hybrid # 1 (25.8%) and lowest in the hybrid # 4 (9.8%).
- Laboratory and field cage trials on fruit flies female response to baits showed that protein baits with additional source of ammonia nitrogen attracted more number of females of Bactrocera zonata, Zeugodacus cucurbitae and Bactrocera tau than protein baits without nitrogen and the commercial female bait.
- Two (02) PhD and 03 M.Phil and 17 BS students completed their research on biological control of insect pests. Training to 46 Agriculture Officers/Staff from Punjab Extension Department was given for upgrading Bio-control labs in Punjab.
- Training on botanical insecticides and their bioassays against different insect pest species was given to scientists and staff from Gilgit Baltistan



Active burrow of rodent in groundnut crop

ii. Vertebrate Pest Management Program (VPMP)

- For improving palatability of existing baits for effective and sustainable control of rodents, millet-maize and millet-rice (cracked form) in 50:50 ratios were used as bait bases. Results on the basis of Average Daily Intake (ADI) indicated that millet-maize was maximum consumed (334 g) followed by millet-rice (283g).
- In multi-choice feed preference test, four additives namely eggshell, milk (powder), peanut butter and peanut (powder) in 2 & 4 % concentration were tested in bait base of millet-maize in two separate experiments. In case of 2% additives, results indicated that peanut butter (352.48 g) was most preferred on the basis of average daily intake (ADI). In case of 4% additives, results indicated that again peanut butter (381.2 g) was most preferred followed by peanut powder (330g), eggshell (221.5g) and milk (178.5g). Peanut butter as an additive has made the texture of bait base more attractive and palatable than peanut powder.
- 3984 burrows were treated in wheat, pulses, fallow land, ground nut and fodder field areas at NARC by means of burrow baiting, underground baiting, fumigation and trapping, science certain methods are

better suited for different rodent species. Fumigation and zinc phosphide biscuit bait was applied deep inside active burrows. Whereas racumin grain bait (slow poison) was applied in PVC bait stations. Overall 80-90% reduction in burrow activity was achieved covering a total area of 690 acres.

- Overall 06 Wild boar control operations were conducted by using acute and chronic poison. In case of acute poison a pre-baiting (without poison) of 3 days was conducted followed by 2 days poison baiting. The baiting at all points continued for 15 nights. No consumption was recorded after 15 days from any established bait station indicating a good control.

iii. National Insect Museum (NIM)

- Out of 1500 insect specimens collected in 25 surveys, 120 were identified at species level and 30 species are new records for Pakistan.
- 1050 university students and officials visited NIM and 25 students were supervised in research on insect systematic.
- Insect pest samples from winter and summer vegetables grown at NARC were investigated. Most of the winter vegetables did not encounter any new pest species except *Pieris brassicae* and *P. rapae*. Summer vegetable e.g. Okra was attacked by *Earias vittella*, Brinjal was mostly attacked by brinjal fruit borer i.e. *Leucinode sorbonalis* and Brinjal leaf roller *Eublemma olivacea*.
- The study regarding predatory efficacy of odonata naiads against mosquito larvae is first of its kind ever conducted in Pakistan. In-vitro and in-vivo metamorphosis of two Anisoptera (*Crocothemise rythraea*, *C. servillia*) and one Zygoptera species (*Ceriagrion coromandelianum*) is being studied.
- A total of 9000 insect specimens were collected from Killa Saifullah (Balochistan) using bee bowl traps. Collected specimens were identified up to specific epithet. All the pollinators were classified under 05 families. Apidae, Megachillidae, Halictidae, Andrenidae, Collectidae. Family Halictidae emerged as most abundant and diverse family followed by family Andrenidae. Among all, genus *Lasioglossum* was most diverse and abundant with 10 distinct species and 92+2% of pollinator population at Killa Saifullah, Balochistan.
- Total 530 specimens housed at NIM were studied and 28 weevil species under 10 genera belonging to five subfamilies identified which are important pests of agricultural commodities including vegetables, stored grains and fruits. Out of 28 species, 12 species are new to Pakistan and the specimens are available as reference collection at National Insect Museum for researchers, farmers and other stakeholders.

iv. Ecotoxicology Research Program (ERP)

- Optimized chromatographic methods for the determination of three pyrethroids Alpha cypermethrin, Lambda-cyhalothrin and Deltamethrin on GC-uECD and GC-MSD. The recoveries were in the range of 77-97%, 74-104%, and 63-138% respectively.
- Developed analytical method for the determination of Acetamiprid, Emamectin Benzoate, Carbosulfan, Imidacloprid, Lufenuron, Metalaxyl and Spinosad on LC-MS/MS.
- Recovery studies were conducted by spiking Guava samples at the level of 5 & 10MRLs and found 94% for Cypermethrin, 120% for Chlorpyrifos, 104% for Dimethoate and 110% for Trichlorofon by GC-uECD. Recovery studies of polar pesticides (Acetamiprid, Imidacloprid and Spinosad) are in process.
- Documentation has been done for 21 pesticides analysis in apple and 13 pesticides in mango. A data sheet has been compiled for determination of 47 compounds with different analytical methods on GC-uECD and GC-MSD.
- Standard Operating Procedures (SOPs) were prepared for extraction of fruit samples for pesticides residues analysis and LC-MS/MS. Analytical method was developed and optimized for 19 compounds (Macrocyclic Lactams, Organonitrogens, Organophosphates and Pyrethroids) on LC-MS/MS.
- A protocol was developed for screening of phytoconstituents of petroleum ether, ethyl acetate, methanolic and aqueous extracts of *Moringa oleifera* leaf. Antifungal activity was determined for these extracts against two fungal strains i.e. *Rhizoctonia solani* and *Fusarium oxysporum*. Pet-ether extract was found highly active against both plant pathogens.
- Optimized analytical methodology to explore the phytochemical constituents from different extracts of *Moringaoleifera* by GC-MSD. Identification of extracted compounds was done by matching with NIST Library. High efficacy of pet-ether extract against fungal strains were perhaps due to active component Phytol, Campesterol and Tocopherol.
- Optimized extraction and analytical methodologies for -Cypermethrin, Chlorpyrifos, Dimethoate, Profenofos and Trichlorofon in guava matrix with recoveries in the range of 70-130% with GC-MSD.

II. Southern-Zone Agriculture Research Centre (SARC), Karachi

- a) **Crop Diseases Research Institute (CDRI):** Wheat nurseries for 2017-18 cropping season screened/evaluated for rust diseases. It includes National Uniform Wheat Yield Trial (NUWYT) consisted of 60 lines/entries, National Wheat Diseases Screening Nursery (NWDSN) comprising 495 lines/entries, 7th BRS Set comprising 171 lines and Stem Rust Screening Nursery consisted of 136 lines/entries planted at different locations of Sindh. Resistant elite Germplasm identified.

- b) **Institute of Plant Introduction (IPI):** 04 varieties of coconut 02 varieties of chikku, 02 varieties of tamarind, 02 varieties of ber and, different date palm varieties being maintained at IPI farm, Karachi. More than 800 coconut seed nuts acquired from different sources were tried for germination and around 454 plants were developed and maintained
- c) **Pest Management Research Institute (PMRI):** The invasive mealybug species, *Paracoccus marginatus* reported first time from Pakistan on papaya and other ornamental plants in coastal areas of Sindh and Balochistan. Most efficient and host specific parasitoid of papaya mealybug known as *Acerophagus papaya* is being reared @ 100,000 to 250,000 annually at PMRI Karachi for bio-control of papaya mealybug through provincial agriculture extension department.
- d) **Vertebrate Pest Control Institute (VPCI):** Two rat species i.e. Norway rat and Roof rat and one Mice species (*Mus musculus*) found in poultry farms of Karachi, damaging poultry eggs (1250 egg/day) and loss to poultry feed (219 Kg/shed). For effective management of rodent population in poultry farms, PARC Rat bait blocks containing zinc phosphide (2%) and brodifacoum (0.005%) proved very effective and rat mortality was recorded 75% and 86% respectively.

- e) **Food Quality and Safety Research Institute (FQSRI):** Essential metal uptake by radish was studied the highest accumulation of copper and zinc was found in leaf (1025.3 ppm) and stem (2369.8 ppm) respectively. Molecular characterization of chilli leaf curl virus had been undertaken. Chilli plants infested with whitefly were planted and DNA were isolated and confirmed by gel electrophoresis. Micro-propagation methods (multiplication and rooting protocols) of bread fruit treated with Kinetin (from 0 to 6.0 mg L⁻¹ of BAP (13 Treatments) and Auxin (from 0 to 4 mg L⁻¹ of IAA (9 Treatments) BAP @ 1 mg L⁻¹ produced maximum no. of shoots (16.0) and shoot length (5.5 cm). While, IAA @ 1 mg L⁻¹ produced higher no. of roots (6.0) with maximum root length (5.0 cm). For acclimatization, plants kept in autoclaved peat moss, covered with transparent polythene bag and kept in growth room with temperature of 26°C showed 100% survival.



Micro-propagation of Bread fruit (*Artocarpusaltilis*) being examined by Secretary MNFS&R and Chairman PARC

III. PARC National Sugar and Tropical Horticulture Research Institute (PNSTHRI), Thatta

- One sugarcane variety i.e. YT-55-Thatta (high yielding with high sugar recovery) recommended by VEC.
- One promising sugarcane variety SLTh-1510 being evaluated under NUYT-2018-2020.
- More than 08 kg fuzzi collected and preserved for future utilization in variety development and 911 gram fuzzi was sent to two NARS institute at Faisalabad and Larkana.



Collection of sugarcane fuzzi at Thatta

IV. PARC National Tea And High Value Crops Research Institute (PNTHRI), Mansehra:

- Managed 30 acres tea garden with regards to cleaning, fertilization, pruning and plucking.
- Plucked 7446 kg fresh tea leaves and processed 1490 kg green tea.
- Raised tea cuttings nursery having 28000 plants of eight different tea varieties.
- Established fruits nurseries at PARC NTHRI Shinkari and on farmer fields on three locations in District Mansehra and Swat under ALP project "Production of Quality Stone Fruits Nursery Plants for the promotion of fruits cultivation in Hazara Division".
- Budded/grafted 17500 plants of various fruits species i.e. apricot (5000 plants), peach (4000 plants), plum (5000 plants), almond (1000 plants), cherry (2000 plants) and nectarine (500 plants) to produce plants for the growers.
- Provided 6000 true-to-type plants of different fruit species i.e. apricot, peach, plum, almond, cherry, walnut, fig and pomegranate to the local growers.
- Propagated 2200 rootstock plants of apple, pear and cherry through stool bedding
- Produced about 800 kiwi seedlings through kiwi cuttings and application of IBA and 500 kiwi plants of 7 different genotypes (60 to 150 plants per genotype) by grafting method.
- Introduced kiwifruit on farmer field as Demo-plots by planting about 600 kiwi plants in 10 Demo-plots in different union



Olive Nursery

council of District Mansehra.

- Raised olive nursery from 46000 cuttings at NTHRI. Management of nursery plants is continued and sprouting of olive cutting has been started. The plants will be ready for plantation during next year plantation season.
- Raised 1200 olive plants at olive nursery NTHRI and planted on farmers' fields.
- Planted olive plants on 40 acres on famers' fields

V. PARC Research And Training Station (PRTS) Multan:

- Two natural enemies are being augmented, one parasitoid species (*Trichogramma chilonis*) and other predator species *Chrysoperla carnea*.
- Out of 22336 *Trichogramma* egg cards production, 20958 cards distributed to growers of cotton and vegetables.
- Out of 2671 *Chrysoperla carnea* egg sheet cards produced, 2120 egg sheet cards distributed to vegetable growers.
- *Chrysoperla carnea* cultural plates (149) prepared. 4751 adults emerged during the year.
- 756 farmers trained on IPM of different insect pests, 4 students completed their intern shipon rearing techniques of natural enemies and 372 university students exhibited to bio-control Lab.



Inauguration of Seed Processing and Storage Complex by Honorable Federal Minister, Mr. Sikandar Hyat Khan Bosan at NARC, Islamabad, (23rd May 2018)

Natural Resources

Natural Resources Division (NRD) has been involved in conducting research on issues related to land, water, rangelands, agro-forestry and honey bee management for improved and sustainable agricultural production. During 2017-18 major emphasis was given to enhance the resilience of vulnerable farming communities by climate smart natural resource management practices, land and water resources management, arid horticulture, range management and mountainous agriculture. The major achievements of NRD during the year 2017-18 are:

Up-scaling Biozote Fertilizer Technology: The Biozote technology was introduced and scaled up in various areas. 7500 acres were brought under cultivation with Biozote. 1000 bags of Biozote were distributed for wheat and maize crops for demonstration in Chakwal, Hafizabad, Sheikhpura, Nankana Sahib, Multan, Bahawalpur, Sahiwal, Okara, and Rahim Yar Khan. Three farmer field days (FFDs) were conducted at Village, Mulhal Mughalan, Sohawa Road, Chakwal, Kaly Ki Mandi, Hafizabad and Chak No. 2-8 AR, Mohsinwal, Mian Chunnu. Total 230 farmers participated in FFDs.

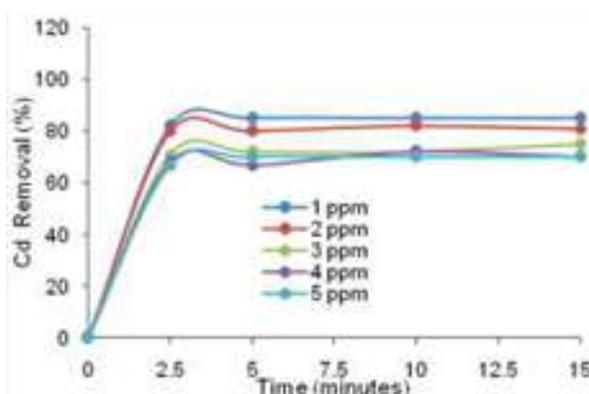


Rhizobial strains with ACC-Deaminase Activity: Evaluated different Rhizobial inoculation methods on growth and yield of rice (*Oryza sativa*) cv. Basmati-385 under natural salt-affected soil (pH= 8.55, E_{Ce}= 5.32 dS m⁻¹ and SAR=25.46). Seeds of rice were inoculated with four rhizobial strains (RPR-32, RPR-33, MW-20 (PSB) and SBCC (M8) in three ways i.e. rice seeds inoculated for direct seeding and nursery and dipping seedling roots in the solutions of these Rhizobial strains. Maximum tillering was observed with all strains under different inoculation methods. Although, the strains performed better as compared to control, however, dipping of nursery roots produced significantly higher yield followed by seed inoculation for direct seeding. Overall, among all the Rhizobial strains, MW-20 (PSB) and SBCC (M8) produced comparable paddy yield. The highest paddy yield (291 g m⁻²) was harvested with SBCC (M8) seed inoculation which was 19% more than un-inoculated (control).

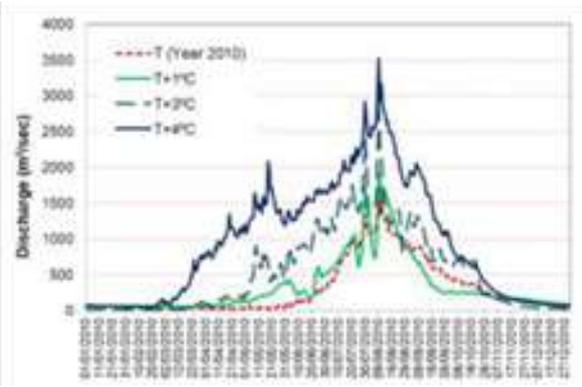


Bio-sorption of Metal Ions on Lignocellulosic Materials: Batch and Continuous-flow Process: Different physico-chemical techniques – lime precipitation, membrane processing and electrolytic methods, ion exchange, adsorption by sorbents are being used for removal and recovery of inorganic contaminants from municipal and industrial effluents. Adsorption, among these techniques, is an efficient, cost-effective and relatively easy method.

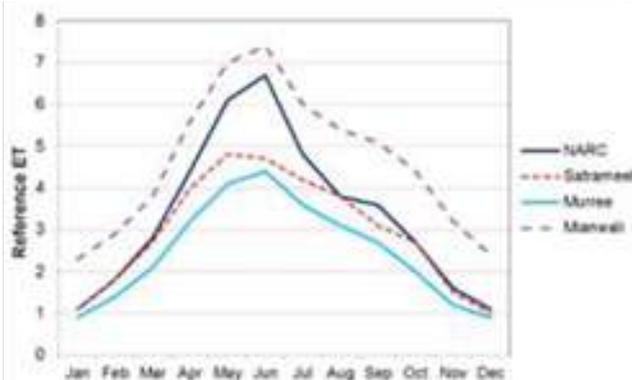
Removal of Heavy Metals Ions using Zerovalent Iron Nanoparticles: Heavy metal ions are considered as serious threat to the environment and human health due to high toxicity and non-degradable characteristics. Application of iron nanoparticles reduced the heavy metals concentration in the aqueous solution. The adsorption of heavy metals onto the zerovalent iron nanoparticles increased with increase in initial metal concentration and time. The removal percentage was high where initial metal concentration was low. Kinetics sorption rate showed that the heavy metals adsorption increased with time and equilibrium was attained within 5 minutes. The 100% removal of added metal within 5 minutes demonstrated the high binding energy and metal adsorption capacity of the synthesized nano-particles. These results suggested that zerovalent iron particles possess strong sorption capacity for heavy metals and hence can be used successfully for remediation heavy metal contaminated water; particular these nano-particles are more suitable for continuous flow process where the resident time is a crucial factor.



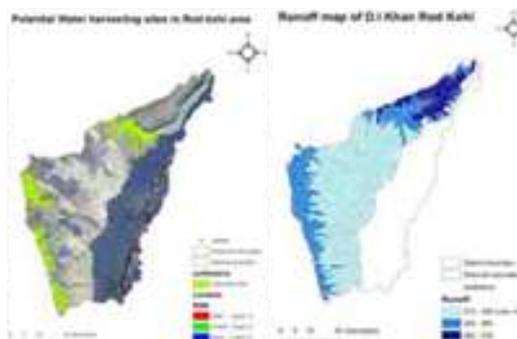
Gilgit River Flows under Climate Change: Most significant and maximum discharge contribution was recorded from 4000-5000 m elevation zone. With an increase in temperature by 1°C, annual and summer flows indicated 9% and 13% increase by the year 2030, respectively. Similarly, rise in temperature by 3°C result in 75% and 95% increase in the annual and summer flows by the year 2050. The river discharge showed a significant increase from April to July during year 2030, whereas during recession period the rate of river flows was lower than that of the base year. Shift in snow melting period was observed from April to March.



Estimation of Reference Evapotranspiration (ET) in Soan River Basin: The reference ET determined for various stations in the Pothwar region indicate extremes during the month of June. For wheat, this ratio becomes 1 during the reproductive cycle (heading to grain formation) otherwise it remains less than 1 bearing minimum values during the early age of the crop and at maturity. During the vegetative stage (November-January), due to low temperature, moderate humidity and calm conditions, the ETo remain lower than in early summers in most of the upper parts of the watershed. With shortage of rainfall water demand increases and most of the time crop yield may suffer in this part of the basin.



Runoff Water Harvesting Potential in D.I.Khan Area: Overall 533 sites were identified in the rod kohi area. About 84% of the total sites lie below 300m elevation while 16% were identified within 300-700m elevation range. Total runoff water potential estimated in the 533 catchments at 50% rainfall probability was about 0.155 million cubic meter. There are 28 sites selected for runoff water harvesting in the rod-kohi area of D.I. Khan. The surface runoff potential can be harvested for irrigation and domestic use through construction of reservoirs/ponds.



Productivity and Carbon Stock in Silvo-Pstoral System: the integration of grass (Elephant grass) and legume tree (Ipil Ipil) resulted maximum dry forage production on 2.43 ton ha⁻¹ during monsoon season at NARC. The carbon pool estimated was 1.22 Mg ha⁻¹. Maximum carbon stock of 2.10 Mg C ha⁻¹ was estimated in the upper soil layer (0-20 cm). higher biomass production and proper utilization is important for the below ground carbon stock.

Community Based Range Management: Seven new grass species introduced and tested on brackish water (>2200 ppm) in Umerkot. More than 25000 plants were planted in 6 villages with community participation (Kerlo Rahimoo, Maroohar Ratnore, Nasarullah Sand, Noroje Dhani, Mithriyo Charan). One hundred and fifty farmers trained on range management and agro-forestry in Umerkot. Established progeny orchard of 50 native and exotic grass species on sand dunes of Cholishtan desert for seed multiplication and propagation source.

Effective Control of Vespa Species in Honey bee, *Apis mellifera* L. Colonies: Three hornet traps with baits (Fermented honey + brewer's yeast + grape syrup and yeast liquid culture) in combination with mechanical control were investigated. The results showed that three hornet species i. e. *Vespa orientalis* L., *V. velutina* Vecht. and *V. tropica* Beq. were found preying upon honey bees. The population of these hornet species increased gradually from the second week of August to the first week of November. The wooden plastic bottle trap in combination with the fermented honey + brewer yeast + grape syrup showed the best results. Four training workshops were arranged for beekeepers and more than 400 persons were trained.

Arid Horticulture with High Efficiency Irrigation System: Twelve thousands plants of olive were provided among framers in (Quetta, Zhob, Khuzdar) of Balochistan along with improved management practices. Water

productivity experiment of olive, grapes and almond is under progress at BARDC, Quetta and Tomagh Station. One hundred and forty five thousand nursery of arid horticultural plants (olive, grapes, almond, pistachio, pomegranate, fig) were raised. Orchard of grafted Ber established with HEIS on 17 acres at Umerkot for research and demonstration. Fifteen thousand grafted seedlings of Ber were developed and distributed among farmers. Mother orchard of fourteen varieties of date palm (local and exotic), total 250 plants established at Umerkot are showing excellent results. Eighty plants stated fruit bearing and suckers production. Mother orchard of promising varieties of date palm (Dhakki, Aseel, Zaidi, Basra) are maintained at AZRI, Bahawalpur and suckers are being provided among Cholistan desert framers. Eight thousand true to type nursery of low delta plants (Ber, Pomegranate, Fig) raised and provided among framing community. Five different genotypes of Banana (William, Basrai, B-10, G-9, Pisang) are evaluated under agro-climatic conditions of Bahawalpur. MARC has propagated and distributed eight thousands true to type fruit plants of apricot, cheery, peach and apple on subsidized rates to farmers, NGOs and Govt. Organization of Gilgit-Baltsistan.



Arid Horticulture

Post-Harvest Management of Dates: Mother orchard of twenty six varieties of date palm is being used for further propagation of quality suckers. One hundred suckers were distributed among framers. Post harvest management of eight date palm varieties (Gulistan, Shakri, Basara, Zahidi, Dhakki, Baitullah, Muzavti, Shakri yellow) was studied under green class house with variable temperature and humidity levels for early and safe ripening of dates under controlled temperature and humidity levels. For ripening of the dates +35°C temperature & +80% relative humidity and for drying +45°C temperature and +30% relative humidity levels were kept as constant factors. The moisture contents were reduced to the recommended water activity level of 23-25% for shelf life stability in all varieties. Data depicted that fresh date produce ranged from 39% to 59%; however minimum (39%) fresh date were recorded in cv. Gulistan and maximum produce was recorded in fresh dates of Shakri variety (59%). Similarly, the minimum and maximum produce recorded in dry dates was 32% (Basara variety) and 50% in Zahidi. The maximum and minimum size observed was 5.2cm and 2.5cm in case of Dhakki and Basra varieties respectively. Farmer can fetch more from their produce if they process fresh dates rather than dry dates in case of most of the popular varieties.



Post-Harvest of Dates

Conservation and Propagation of Medicinal and Aromatic Plants: Twenty one different species of medicinal plants having high market value are being conserved at MARS, Astore. Among these medicinal plants, production technology of three species (Kuth, Black Cumin, Wild Thyme) developed and demonstrated. Thirty species of medicinal and aromatic plants are being maintained at BARDC, Quetta. Two varieties (Sarghul, Morga) of Saffron are managed for further bulb propagation. Value added products of Rosemary, English Thyme, German Chamomile and Oregano are introduced through PATCO in ICT.



Medicinal and Aromatic Plants

Animal Sciences

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

A. Research Activities:

1. Development of models for the control of peste des petits ruminants (PPR) in Pakistan and PPR vaccine using local isolates

Peste des Petits Ruminants (PPR) is considered as a major threat to the profitable livestock production. It is estimated that PPR causes annual losses of more than USD 342 million through high levels of morbidity and mortality beside depletion of genetic stock.

Salient achievements:

- Pathogenicity trial was conducted to check the best passage level for vaccine development. The 40th and 60th passage on Vero cells were found suitable for vaccine development.
- Age specific vaccination was conducted in target tehsils to maintain critical flock immunity.

2. Control of Foot-and-mouth disease virus

Foot-and-Mouth Disease (FMD) is an extremely transmissible viral sickness of domestic and wild cloven-footed animals caused by Aphthovirus belonging to family Picornaviridae. The disease is endemic in Pakistan and consequences of disease are on production, food security, milk yield and reduced growth.

Salient achievements:

- Technique of real-time loop-mediated isothermal amplification (RT-LAMP) and multiplex PCR was standardized for diagnosing FMDV and its serotypes.

3. Evaluation and protective efficacy of different stabilizers on shelf life of live heterotypic Haemorrhagic Septicaemia Vaccine

Haemorrhagic septicemia (HS) caused by *Pasteurella multocida* is an acute, fatal, septicemic disease of cattle and buffaloes in Pakistan and other south Asian countries. Pakistan ranks HS as of considerable economic importance and 34.1% of all deaths in susceptible animals are caused by HS.

Salient achievement:

- Live aerosol HS vaccine was prepared using trehalose as stabilizer.

4. Establishment of PARC Veterinary Clinic

The project aimed to establish a veterinary clinic at NARC premises with collaboration from PATCO to provide diagnosis and treatment facilities to the livestock in Islamabad Capital Territory (ICT) area.

Salient achievements:

- Provided diagnostic and treatment facilities to the farmers. In this regard, 1,480 milk samples, 2,618 serum samples and 1,683 fecal samples were analyzed for mastitis, brucellosis and gastrointestinal parasites respectively.
- More than 5,000 brochures were published and distributed among the farmers. Farmer's days were organized for the awareness of farmers regarding livestock diseases and One-Health issues.



Farmer's days

5. Occurrence of Shiga toxin-producing Escherichia coli (STEC) O157 from slaughtered animals in Pakistan

Shiga toxin-producing *E. coli* (STEC) O157 are considered important food-borne pathogens of zoonotic importance causing a variety of clinical syndromes including diarrhoea, hemorrhagic colitis, hemolytic uremic syndrome and death in humans. Ruminants especially cattle, buffaloes, sheep and goats are considered important reservoirs of STEC-O157.

Salient achievements:

- The overall prevalence of STEC-O157 was 0.5%.
- One STEC-O157 isolate was recovered from positive samples.



Provision of veterinary services by PARC Mobile Veterinary Clinic

6. Epidemiology and control of brucellosis

Need and justification: Brucellosis is an important zoonotic disease in world. Further, increasing peri-urban dairy farming has increased the risk of brucellosis in farming communities and consumers manifold. The economic losses associated with brucellosis are huge as there are no cost effective treatment options for this disease.

Salient achievements:

- Identification of risk factors responsible for transmission of brucellosis. It was observed that in the presence of an infected animal in a herd, people around are 4 times more likely to contract brucellosis than general public.
- Developed collaboration with Global Health Development (GHD), Jordan and CDC, USA for surveillance of brucellosis in ICT.



Presentation of results of STEC studies in Safe and Secure Science conference, Malaysia

National Reference Laboratory for Poultry Diseases

Avian health issues have attained high significance due to increase in the commercial farming activities in the country. A National Reference Lab for Poultry Diseases (NRLPD) was established at Animal Sciences Institute of NARC in 2004. This laboratory is also designated as Regional Leading Diagnostic Laboratory (RLDL) for Highly Pathogenic Avian Influenza (HPAI) for SAARC countries by FAO. The laboratory has been accredited for ISO/IEC 17025:2005 by Pakistan National Accreditation Council (PNAC). The NRLPD is extending referral diagnostics and strategic surveillance for avian diseases at national level.

1. Extension of diagnostics to the referral samples received from the field

Poultry sector in Pakistan is one of the fastest growing sectors of livestock segment. A steady annual growth of 10-12% has been observed since 1990 in this sector. However, one of the limiting factors in further growth in this sector has been the intermittent introduction of infectious diseases.

Salient achievements:

- A total of 6,234 samples were received and analyzed for referral diagnostics for various diseases at NRLPD. In total 123 pathogens isolated including avian influenza virus (AIV), REO virus, New castle diseases virus (NDV), E. coli, Salmonella, Staphylococcus and Proteus.
- A total of 135 postmortems were conducted.
- A total of Rs. 0.83 million were deposited to PATCO as income generated through referral diagnostics.



Post-mortem of birds at NRLPD

2. Development of new research projects

Salient achievements:

- Developed and revised new PSDP funded project as Co-PI under Pak-Belarus Collaboration titled, "Development of recombinant (genetically engineered) avian vaccines".
- Revised proposal under PSDP titled, "Investigation of zoonotic avian pathogens for improving food safety & security".

3. Biological and molecular characterization of avian pathogens

Salient Achievements:

- Sequence analysis of AIV H14N3 was completed for presentation in Malaysia.
- A total of 28 bacterial pathogens were characterized for AMR including E. coli and Salmonella.

4. Sustaining Accreditation ISO/IEC-17025:2005 and maintenance of quality assurance system.

Salient Achievements:

- Coordinated 1st re-assessment of NRLPD by PNAC for ISO-17025 and got accredited for 2017-2020.



Certificate of accreditation

- Competence assessment in all the three sections of virology, serology and molecular biology.

Aquaculture and Fisheries Program

Aquaculture and Fisheries Program (AFP) was set up at Animal Sciences Institute (ASI), NARC with the vision to develop inland aquaculture on modern lines to meet national and international requirements. The mandate of program is to undertake strategic research on inland aquaculture to increase per unit fish production.

1. Mono-sex (all male tilapia) seed production and culture in Pakistan.

Need and justification: The fish farming in Pakistan is operating on extensive or limited level of semi intensive level and productions ranges from 1,000-1,500kg/ acre with 18 months growing period. In order to increase per unit area fish production there is need to introduce new species. Tilapia seems to be the best alternate for culture in the local condition as it is the second most important group of farmed fish after carps.

Salient achievements:

- Constructed temperature controlled tilapia fish hatchery, and a seminar room.
- Fish seed and feed was imported from Thailand and successfully acclimatized at fisheries program, NARC, Islamabad.
- Male and female tilapia was identified and separated by hand sexing.
- Sex reversed tilapia showed better growth performance.
- A study conducted to estimate the prevalence of microbial flora in Monosex Tilapia indicated high prevalence of Streptococcus species.

2. Aquafeed production in Pakistan for commercially important culture able fishes

In Pakistan per acre fish production is very low due to non-availability of aqua feed. Artificial feeding increases the carrying capacity of culture systems and can enhance fish production by many folds.

Salient achievements:

- The construction of building for aqua feed processing unit has been completed.
- Procurement of aqua feed unit is in progress

3. Acclimatization, growth and breeding performance of African catfish (*Clarias gariepinus*) in pond culture system of Pakistan.

Mainly low value fish species are being cultivated that results in low per unit fish production (2.5 ton per ha). There is a need to introduce fish species of high value and high growth potential to improve the fish production in the country.

Salient achievements:

- Fingerlings of African catfish were imported from Thailand and successfully acclimatized under local environmental conditions in two different systems (raceways and earthen ponds).
- After experimentation 30% protein level was found to be optimum and cost effective for feed formulation for African catfish.

4. Seed production of American Channel catfish

American Channel catfish was introduced in Pakistan by PARC scientists. Now due to high production, market price and consumer preference the demand for channel catfish is increasing day by day.

Salient achievements:

- American channel catfish brood stock was developed by sorting the shooter from already stocked fingerlings and it was fed on locally developed artificial aqua-feed.



Control temperature hatchery for Tilapia breeding



Seminar room for training of farmers



Building for aqua-feed processing unit



African channel catfish

5. Culture and breeding of ornamental fishes (goldfishes, koi carp and guppies)

Need and justification: Ornamental fish production is gaining popularity in the country and there is a growing need to work out the possibilities of its farming within the country.

Salient achievements:

- Brood stock was developed from both local and exotic ornamental fishes by feeding on artificial diets.
- Prevalence of microbial flora in Goldfish reared in earthen ponds indicated high prevalence of *Pseudomonas* and *Aeromonas* species



Ornamental fish

Animal Nutrition Program

Animal Nutrition Program (ANP) focuses research mainly on nutritive evaluation of feedstuffs, economical feed development using non-conventional feed resources, development of nutritional technologies for efficient livestock production and feed safety issues.

1. Effect of feeding calf starter with probiotics supplementation on growth and health of young buffalo calves

It is common practice in many tropical and subtropical countries to rear buffalo calves by allowing them on dam's milk for varying periods of time. The quantity of milk so consumed by the calf may range from 230 to 700kg.



Buffalo calves under experiment

Salient achievements:

- Calves fed calf starter with probiotics gained more weight (340g/day) compared to non supplemented group (300g/day).

2. Generation of reference values on available amino acid content of the locally available feedstuffs for poultry

Poultry feed formulators, both in Pakistan and abroad, have to formulate on the basis of individual amino acids for improving the quality of the protein supply to the birds. The amino acid values and their availability from the feed ingredients of Pakistani origin are not well known.



Inauguration of Amino acid analysis Service at ASI, NARC

Salient achievements:

- Over five dozen feed stuffs were collected and analyzed for amino acid contents.
- Under this project, a laboratory for amino acid analyses was setup in the year 2016.
- The commercial activity of the laboratory was inaugurated by the Chairman PARC.

3. National policy dialogue on Aflatoxin contamination of milk in Pakistan

- A policy dialogue on aflatoxin contamination of milk in Pakistan was conducted at NARC Islamabad
- The participants were presented with the data from two studies conducted by PARC in the year 2016-17 to assess the AFM1 contamination of milk in Pakistan.

4. Services offered

- The FTU, during July 2017 to April 2018, prepared following livestock feeds and sold to farmers, apart from experimental feeds for different programs of ASI.
- PARC Cattle Feed: 7,000 bags (50 kg)
- Milk Booster: 1,500 kg
- Urea-Molasses Blocks: 6,500 kg
- The laboratory of the ANP qualified two proficiency tests on aflatoxin and proximate analysis.
- A total of 200 samples of feed, fodder, silage, grasses, dung, and urine from farmers, students, research organisations, and industry were analysed using different laboratory tests.

Animal Reproduction and Genetics Program

The focus of the program is to improve reproductive efficiency and genetic potential of food animals. The cattle and buffalo both are important dual purpose (milk and meat) animals of Pakistan. Due to scattered livestock population and small holdings (1-7 cattle/buffaloes per farmer), application of AI is cumbersome at larger scale. Inducing heat in large number of scattered animals at one time in a particular area helps to make application of AI manageable in these animals.

1. Evaluation of fertility in Beetal and Jattal goats inseminated with frozen thawed semen of Saanen breed

The small ruminants in Pakistan are characterized by small flocks with random breeding. The sheep (Lohi and Kajli) and goats (Beetal and Kamori) breeds are most popular and maintained at Government livestock Farms.

Salient achievements:

- The indices of cryopreserved semen quality in Nukri bucks were found suitable for AI.
- The pregnancy rates were up to the mark with frozen thawed semen in Beetal and Jattal goats

2. Genetic improvement of selected indigenous Naked Neck (NN) chicken by crossing with exotic poultry breeds of Rhode Island Red (RIR) and Black Australorp (BAL).

The ever increasing population of Pakistan demands a 3 times increase in the production of animal protein in the next 20-30 years. Development of more efficient poultry breeds may partly help in solving the protein deficiency problems in Pakistan.

Salient Achievements:

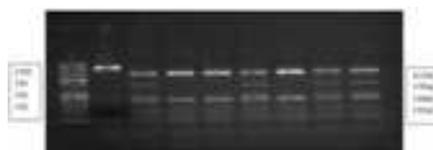
- The foundation stock consists of RIR, BAL, NN and several crosses between these bird types.
- Molecular study on Insulin like growth factor-I gene to investigate the existence of polymorphism in the pure line and their crosses has been conducted.

3. Extension Services:

- Offered one week training course on “Artificial Insemination in goats” for participants from Azad Jammu and Kashmir (AJK) in collaboration with, API, NARC and Islamic Relief International.
- Offered two weeks training on reproductive management under “Livestock Mangers” course organized by API, NARC and NAVTTC, Pakistan.
- Offered one week training on artificial insemination and ultrasonography in goats at ASI in collaboration with API, NARC.
- Prepared extension material on “AI in ruminants and factors affecting conception rate in animals”.



Cross-bred progeny born through artificial insemination at NARC



PCR-RFLP analysis of IGF-1 gene with Hinf-I enzyme



Naked Neck birds collected from villages

Animal Product Improvement Program

Dairy Sector plays an important role in the rural economy of Pakistan. A deeper analysis has shown that the monetary worth of milk is many times more than that of whole crop sector. Under this mandate the program is working, to develop better alternates of indigenous technologies and practices or make them more efficient and also organize result-oriented trainings thereby generating better economic opportunities.

1. Compositional analysis and detection of adulterants in market milk of Islamabad

Availability of nutritious and safe milk is very important for human health. However, there have been complaints of sale of sub-standard and adulterated milk in the local markets.

Salient achievements:

- Milk samples (n = 114) collected from local milk vendors, bakeries, farmers, dairy entrepreneurs and general public were analyzed for fat, total solids and presence/absence of adulterants.
- None of the sample was found adulterated with urea, neutralizer, starch, added sugar or hydrogen peroxide.
- However, 33% of the samples had total solids below 12% showing adulteration/dilution with water.



Milk adulteration testing for neutralizer, detergent, urea and cane sugar

SMALL RUMINANTS RESEARCH SECTION

Pakistan is rich in livestock resources. In addition to supply of proteins of high biological value, these animals are also contributing significantly in the socio-economic aspects of national economy. Small ruminants play an important role in the livelihood of landless and small farmers as well as in the overall national economy.

1. Antioxidant effect of glutathione and L-cystiene in extender on cryo-survival of Beetal buck spermatozoa

Cryopreservation process is an enormous technique to store semen for long periods, but its initiated injuries are also harmful for sperm survival. Glutathione is an antioxidant which is normally present in semen and has been reported to provide intracellular defense to sperm against the oxidative stress. Cysteine is the main component of glutathione, which plays an antioxidant role to prevent sperm injuries.

Salient Achievements:

- Co-supplementation of glutathione and L-cysteine in extender significantly improved cryo-survival of beetal buck semen by 10-15 % as compared to the control group.



Butyrometer showing the fat percentage of milk

LIVESTOCK RESEARCH STATION



Collection of semen from Beetal buck at Small Ruminant Research Section

1. Regular Farm management and research support activities:

Livestock Research Station (LRS) is maintaining a herd of 150 large buffaloes and cattle. The station not only serves as a demonstration site but also provides support to the research activities of the Animal Sciences Institute (ASI).

Sale of animals, milk and fodder at LRS

S.No. Particulars Amount (Rs.)

S. No.	Particulars	Amount (Rs.)
1	Sale of Animals	2,537,600
2	Sale of Milk	1,643,980
3	Sale of Fodder & Seed	74,460
Total		4,256,040

1	Sale of Animals	2,537,600
2	Sale of Milk	1,643,980
3	Sale of Fodder & Seed	74,460
	Total	4,256,040

2. Fodder production:

- Sowing of both Kharif & Rabi 170 acres
- Green Fodder Supplied 1,400 tons
- Grazing provided to the Animals 500 tons
- Silage prepared (Small bales) 60 tons
- Wheat straw collected 5 tons

3. Clinical activities:



Silage making

- Animals Treated 206 Nos.
- Vaccination: (against BQ, FMD & HS) 320 animals
- Tagging 115 Animals
- Pregnancy Test Performed 85 Animals
- Deworming (All herd) 320 Animals
- Spray (all herd) 12 times

1. Effect of substituting wheat straw with maize stovers or maize cobs in complete ration on fattening of buffalo calves

Hybrid corn cultivation trend is increasing and a significant amount of maize stovers (MS) and maize cobs (MC) is produced annually. MS and MC are cheaper than wheat straw (WS) and may replace wheat straw in fattening rations as well as in maintenance ration during fodder scarcity periods.

Salient Achievements

- The maximum weight gain/day (820 grams/day) was observed in the calves that were fed ration maize cobs 35%.

Social Sciences

COMPLETED RESEARCH STUDIES

1. Basmati Rice Trade Competitiveness between India and Pakistan

International trade plays an important role in the economic development of a country. The new multilateral trade regimes coupled with policy changes adopted by many nations towards globalization provide new opportunities as well as pose several challenges for expanding the trade in many agricultural products. The global trade of rice is very low. Only 7% of the rice production is traded and global rice exports are highly concentrated among top five exporters to the extent of 85% of global net trade. The international rice market is characterized as highly volatile with inelastic supply and demand.

During 2015-16, the average annual growth in the Indian rice exports were 9.01%, 19.16% and 10.37% per annum in terms of quantity, value and export prices, respectively. The mean annual growth in quantity, value and prices of India basmati rice was 14.28%, 22.47% and 8.19% per annum, respectively. The average annual growth in the exports of Pakistani rice were 5.65%, 15.58% and 9.93% per annum in terms of quantity, value and export prices, respectively; whereas the mean annual growth in quantity, value and prices of basmati rice was -1.24%, 9.98% and 11.22% per annum, respectively.

2. Profitability of Major Crops in Khyber Pakhtunkhwa

Khyber Pakhtunkhwa comprises four agro-ecological zones, namely Northern dry mountain zone, Central valley plains, Eastern wet mountain zone and Piedmont plains. Profitability analysis for wheat, maize and sugarcane crops was conducted in three agro-ecological zones, i.e., Central valley plains, Eastern wet mountain zone and Piedmont plains. Peshawar, Charsadda, Swabi and Nowshera Districts from Central valley plains; Haripur and Mansehra districts from Eastern wet mountains; and D.I. Khan District from Piedmont plains were purposively selected. Forty-two wheat growers, 60 maize growers and 30 sugarcane growers were randomly selected from all three zones for gathering the required data set.

In summary, overall, the farmers of the Khyber Pakhtunkhwa found producing wheat and sugarcane at nominal profits/40-kg while not-considering land rent and at considerable loss/40-kg in including land rent. Regarding maize crop, overall, the farmers were also earning nominal profit at excluding land rent, but incurring loss when land rent is included. The same can be observed for the growers of conventional maize varieties. However, for hybrid maize varieties growing farms, farmers were earning profit in both excluding and including land rent scenarios. Based on these results, it is suggested the provincial government should increase budget allocation to agricultural R&D, particularly for plant breeding research of major crops. Secondly, the adaptive research component of the provincial department of agricultural extension should work hard on developing regional commodity-specific management package for lowering cost of production per 40-kg of major crops (as well as minor crops) in the province.

3. Comparative Analysis of Modern Trench with Conventional Technologies of Sugarcane Crop in Punjab, Pakistan

Pakistan is 5th largest cane producer, 7th largest cane-sugar producer, 8th largest consumer of white-sugar, and 9th net-sugar exporter in the world (Pakistan Sugar Mills Association 2017 PSMA Annual Report, 2016). With a club of 89 sugar mills and daily crushing capacity of nearly 0.6 million tons, sugar industry is the 2nd largest agro-based industry after textile. Half of these mills are located in Punjab, while the province contributes as two-third of national cane production. During 2016-17, its total cultivated area and production were history high, attributed to the plantation at 1.217 million hectares and production as 73.6 million tons, and recorded a share of 3.4% in total agricultural value added and 0.7% of overall GDP of the country. The provincial sugarcane research institutes have devised a number of sugarcane sowing methods (e.g. planting in furrows, bed planting, pit planting, etc.) for achieving the required plant population per hectare with facilitating good light penetration and minimizing losses due to lodging. However, the furrow method of planting is still dominant practice at farmers' fields. Although the conventional method of sugarcane planting (60-75 cm spaced single row) does help achieving the desired plant population to some extent, but hinders carrying out many management practices necessary for good crop yield. Trench method of planting is relatively convenient and effective planting method which not only increased plant population, it saves irrigation water, allows good light penetration and intercropping of short-duration crops at earlier stages of plant growth and reduces lodging due to easiness in inter-culture and earthing-up operations. Under trench planting, 90 to 100 cm spaced, 30 to 50 cm wide and 25 to 40 cm deep trenches are made in the soil where sowing is done by two methods, i.e. in two rows of sets placed parallel to the trenches as well as placing the sets of 2-3 buds at 6 inches spaces at 90° angle to the trenches.

The title mentioned study survey was conducted in Faisalabad and Toba Tek Singh Districts by taking 50 adopters and 50 non-adopters of trench method of sugarcane planting. The gathered data were pertained to 2016-17 crop year. Majority of the sample farmers were tractor owners and the quality of underground water was also fit for irrigation. HSF-240 variety of sugarcane was relatively more common on sample farms by

occupying 47.9% of total sugarcane area. The average cane yield under trench method was 889 maunds/acre vis-à-vis 784 maunds/acre by conventional planting and this difference was highly significant statistically. The mean production cost under trench technology was Rs.98256/acre while the gross value of output was Rs.157351/ acre making net income as Rs.59095/acre. On the other hand, the mean production cost under conventional planting method was Rs.90200/acre while the gross value of output was Rs.134613/acre making net income as Rs.44413/acre. This implies that the returns per rupee investment by trench method of planting on sample farms were 60.14 paisa vis-à-vis 49.24 paisa for conventional planting method.

4. Mungbean Varietal Adoption and Gender Implications of its Mechanical Harvesting in Pakistan

Pulses are an important food crop worldwide, but especially in Pakistan where they are a major source of plant proteins and micro nutrients including iron for poorer sections of the population. Mungbean (*Vignaradiata* (L).Wilczek) is an important summer short-duration pulse, mainly grown in the Punjab province of Pakistan. Bhakkar followed by Mianwali and Layyah are its major growing districts in Punjab. At present, there is a little information about current rates of adoption status of various mungbean varieties in Pakistan leading to the need of generating an update on mungbean varietal adoption, together with agronomic and postharvest practices along with identify constraints to mungbean production in the country. The data for the study was gathered by a farmers' field survey of mungbean growers in Bhakkar District. The results indicate that twenty 28 varieties were released from 1983 to 2017 and certified and registered by the federal seed system. Varieties developed by the Nuclear Institute of Agriculture and Biology (NIAB), Faisalabad in collaboration with the World Vegetable Center had a major share of the released varieties. AZRI-06 and NM-11 were relatively more widespread varieties in Punjab due to their high yield and resistance against the diseases. AEM-96 was the most popular variety in Sindh while Dera-Mung and Sona-Mung are new varieties with increasing adoption rates in Khyber Paktunkwa.

On the other hand, the operations like weeding, harvesting and threshing are labor-intensive activities and mostly carried out by female labor. The World Vegetable Center in collaboration with various R&D institutions in Pakistan introduced mechanized harvesting in some parts of the country. The present study is aimed at gauging the gender-based effects mechanical harvesting of mungbean in Pakistan, particularly at smallholder farms by taking its non-adopters as control. Our results showed that mechanized harvesting of mungbean reduced the work burden of women, reduced their health risks - thus improved work-life balance among the females of farming families but not of the landless poor families. Some farmers also indicated mungbean area expansion implications of this technology as this activity takes lot of time - which is still worth investigating. On the other hand, some issues like the problems of grain shedding, breaking of grains attributed to lack awareness of proper adjustments/calibrations in the machine and loss of crop residue (straw) were also noticed in the study area.

5. Assessment of Diffusion Potential of Fertilizer Band Placement Drill (FBPD) Technology

In Pakistan, broadcasting method of seed sowing is used for many crops. It is relatively more common for wheat planting after crops like rice, cotton, sugarcane, etc. On the other hand, agricultural scientists recommend line sowing with placing the seed at the depths in accordance with moisture availability, soil type, etc. In Pakistan, phosphatic fertilizers are conventionally applied by broadcast method before sowing the wheat crop. The Fertilizer Band Place Drill (FBPD) not only performs line sowing, but also places fertilizer at nearly 2 inches below the place of seed dropped. Therefore, seed sowing with this drill improves seed germination by upto 30% along with fertilizer efficiency by upto 40% compared to the broadcast method - attributed to the concentrated availability of NP nutrients in the proximity of the seed needed immediately after its germination, causing kick start to the life of the plant. The study in hand was designed to assess the diffusion potential of FBPD sowing technology in the country.

In the study area of Chakwal district, it was observed that the distance between the two tines of FBPD is less than conventionally used rabi drill. FBPD puts more soil on the seed which affects its germination, particularly when the soil moisture is relatively low. The length of the frame of FBPD is lesser than conventional rabi drill, which increases the time of sowing operation per unit area by FBPD compared to the conventional drill. The width of the frame of FBPD is also more than the rabi drill which makes it heavier and difficult to operate with smaller tractors in the study area. Some manufacturers are of the view that the presence of rear wheel creates operational difficulties in the field. This wheel also makes it difficult to easily change the seed sowing depths, which affects seed germination. FBPD also requires more space and difficult to operate. The relatively higher price of FBPD than conventional rabi drill is another limitation in its fast diffusion in farming community. Attributed to these reasons, FBPD less popular among Agricultural Services Providers (ASPs) than the conventional rabi drill. On the other hand, due to higher production costs per drill, the local manufacturers are also least interested in making it for the farmers.

After discussion with farmers, machinery services providers and some implements manufacturers, it came out that: (i) the two rows of tile with front for the fertilizer should be 5 cm deep and the back with 5 cm away from the front line tiles, for seed sowing; (ii) the seed and fertilizer driving wheels should be on the sides instead of rear or front side of the drill, which shall also control the depth of seed sown. On the technology promotion side, the Department of Agricultural Extension need to be engaged for conducting demonstrations, farmer-field days

and seminars. Subsidies on FBPD and/or removal of sales tax on its manufacturing as policy support is also needed to make its price competitive with conventional rabi drill.

6. Economic Viability of Selected Soil Fertility and Soil Health Improving Technologies in Pakistan

Soils are a dynamic ecosystem that supports a huge diversity of life. A study was aimed at assessing economic viability of these technologies at farmers' fields - needed for anticipating their diffusion potential among farming community.

The study is based on the results from 6 demonstrated sites of micronutrient technology in citrus orchards in Sargodha and Toba Tek Singh Districts; 13 demonstration sites for vegetables (chilies, cucumber, bell papers and bottle gourds) grown in tunnels in Sheikhpura, Gujranwala, Sahiwal and Okara Districts; and 20 demonstration sites on biozote application in wheat production in Chakwal District. Economic viabilities of micronutrients and biozote technologies have determined through marginal analysis. Use of micronutrients in citrus orchards resulted in better fruit setting by 12.5%, more fruit productivity by 15%, 10% higher prices attributed to better quality of the fruit produced, and the cost-benefit ratio as 1 to 5.71. The use of micronutrients in vegetables production increased productivity of chilies by 31.9%, cucumber by 40.6%, bottle gourd by 29.9% and bell papers by 11.1% with respective cost-benefit ratios as 1:28.1, 1:17.4, 1:15.0 and 1:11.4. Similarly, the use of biozote for wheat crop resulted in augmenting its productivity by 10.8 percent, with a cost-cost ratio as 1:8.2. These results clearly indicate that the use of biozote and micronutrients enhances productivity of field and horticultural crops. Unfortunately, the use of biozote and micronutrients is not as popular as the application of fertilizers and pesticides. There is a need to educate farming community about the efficacy using these supplements by engaging the Department of Agricultural Extension as well as involving input dealers through appropriate incentives for the earlier popularization of these technologies in farming communities.

Turning to the productivity impacts of various soil health and productivity improving technologies in Chakwal District of Pothwar region, the results of biozote use on wheat productivity were not very encouraging - perhaps attributed to relatively less availability of organic matter in the soil. The farmers were quite aware about the productivity impacts of using FBPD, while the farm machinery services providers regarded it as heavier in weight compared to conventional rabi drill making it difficult to manage with small tractors they possess - hence little prospects for its diffusion. The results of using compost in kitchen gardening and nursery raising were quite encouraging. Host farmers were of the view that the use of compost can reduce fertilizer application. Regarding the adoption of green manuring technology, the farmers were cognizant with its benefits, but there are little chances of its rapid adoption/diffusion due to less availability of moisture in the soil or the rainfall followed by the dangers of animal grazing over it and non-availability of implements in the area for its proper burial in the soil. In conclusion, more concerted efforts are needed to popularize soil health and soil fertility improvement technologies in the country.

7. Insaf Food Security Program in K. Pakhtunkhwa: Farmers' Perceptions about Wheat Crop

The provincial Government of Khyber Pakhtunkhwa formally launched three-years long Insaf Food Security Program (IFSP) on 26th October 2015 costing nearly Rs.4 billion, through the provincial Agricultural Department under which 1.068 farmers would be benefitted and those possessing land from 1 to 3 acres would be given free-of-cost certified wheat seed of 50-kg per household. The study in hand examined farmers' perception about the wheat production impacts of Insaf Food Security Program in the province. Since wheat is grown in all four agro-ecological zones of the province, therefore, Swat district from Northern dry mountains region, Haripur from Eastern wet-mountains, Mardan from Central valley plains and D.I. Khan from Piedmont plains zone were selected. One hundred and twenty beneficiary farmers were randomly selected comprised 30 beneficiary farmers from each district.

The empirical results indicate that the average farm area of the sample farmers was 14.08 acres with a composition of irrigated and rainfed parcels as 81.47% and 18.53%, respectively. Nearly 45% of total farm area was allocated to wheat crop. Under IFSP, the sample farmers received 50 kilograms of wheat seed per farm (Faisalabad-2008 and Galaxy varieties) and sample farmers planted, on average, 1.08 acres with it. About wheat varietal spread, fifteen different wheat varieties were found planted on sample farms. More than two-fifth of total wheat area was planted under unknown varieties. The relatively more popular varieties found on sample farms were Faisalabad-2008 (18.28% of total wheat area in 2016-17 and 17.03% in 2015-16), Galaxy (11.60% of total wheat area in 2016-17 and 21.13% in 2015-16), Pirsabak-2013 (11.46% of total wheat area in 2016-17 and 10.96% in 2015-16). Other varieties occupying percent wheat area in single digit were Shahkar, Hasham, Ujala, Pirsabak-2005, Fakhra-e-Sarhad, Bhakkar, Sehar, Suleman, Miraj, Aas and Pirsabak-2008. The mean wheat yield of IFSP seed was reported as 26.79 maunds/acre vis-a-vis their own seed as 27.73 maunds/acre, and the difference was statistically non-significant. Therefore, only 27.5% of the sample farmers kept IFSP seed for next year plantation.

Regarding sample farmers' feedback about IFSP, 43.3% of farming community were aware about wheat seed distribution through IFSP program and 85.8% were able to easily get the seed under this program. Nearly 86% farmers reported that they had timely received the wheat seed as sufficient period was available with them to sow it timely. Majority of farmers (89%) were satisfied from the procedures adopted for seed distribution. The

underlying reasons of dissatisfaction reported were mainly because of lengthy procedures and distant location of seed distribution places. About the quantity of the IFSP seed, only 38.3% were satisfied (or 62% not satisfied) with the quantity per household basis (i.e. 50 kg) provided to them by IFSP. Nearly three-fifth of sample farmers (59.2%) showed their satisfaction over seed quality. Overall, the sample farmers rated the quality of IFSP seed as: very good as 18.3%, good as 40.0%, poor as 30.8% and no difference as 10.8%. The underlying reasons reported about the bad quality of seed provided to them were: disease attack (54.0%) followed by less yields (30.0%), grain shattering at maturity (2.0%), disease attack + low yield (8.0%) and low yield + less straw (6.0%). Those showed satisfaction over seed quality were on the basis of its attributes noticed like: better yielding (41.4%) followed by disease free + high yield (21.4%), disease free (14.3%), disease free + better yield + good chapatti taste (8.6%), disease free + good chapatti taste (5.7%), better yield + good chapatti taste (4.3%), good chapatti taste (2.9%), and disease free + more straw (1.4%). It is suggested that the concerns of IFSP seed recipients about dissatisfaction over seed quality and procedures adopted need to be rectified at the earliest. It is also proposed that while selecting varieties, the agro-ecological diversity of the province should be duly considered, so that the average yield of the beneficiary farmers should become significantly higher than the yield level of varieties available with the farmers.

8. Market Linkages for Value Added Products of Dates and Banana: Post-Harvest Management and Value Addition in Production Catchments of SAARC Countries (Pakistan Component)

Dates (Dates are consumed both in fresh and processed forms. The value added products of dates include dates blocks, dates energy drinks, dates syrups, date honey, date pickles, date paste, date spread, date dry powder, date sugar, date juices, date vinegar and date ethanol fuel. These value added products are highly viable commercially and has export potentials.) and banana (Banana is one of the most consumed fruit in the world and India is its largest producer on the globe. It is a highly perishable fruit, owing to its high moisture contents and climacteric nature. The post-harvest losses in banana can be reduced by applying appropriate processing techniques and converting them into semi- or least perishable products. Chips/crisps, banana fig, banana flour, banana powder, banana puree, banana RTS juice, banana biscuits, banana jams & jellies, banana drinks & baby food, alcohol/wine from banana are some of its value added products made in the world (ICAR).) are Pakistan's important horticultural commodities. Pakistan is 7th largest producer of dates in the world. There are considerable post-harvest losses and very little value addition in both crops. Dates and banana are also consumed a lot in SAARC countries. The SAARC Development Fund has financed the title mentioned regional project and its Pakistan component is managed at Agricultural Engineering Division (AED) of PARC. Its socioeconomic sub-component is implemented at Social Sciences Research Institute (SSRI), NARC. The project is implemented in Khairpur and Sukkur Districts of Sindh province of Pakistan. One of the prime objective of this project is to develop effective market linkages of dates and banana's value added products through existing and potential supply chain actors by establishing market linkages. It was found that traditional marketing system of both the dates and banana are dominated by commission agents and consisted of a long chain of market intermediaries. Absence of cold chain facility compel farmers to sell banana immediately after harvesting resulting in low returns to the growers. There are considerably large seasonal fluctuations in the supply and prices of banana from which the farmers are least benefited. The adoption of value added technology introduced by the project, the banana growers will have other marketing option by supplying to processor and own processing facility which leads to better returns and reduced price fluctuation along with controlling post-harvest losses. There is a need to provide timely and proper technical backup support to the farmers through Village Organizations (VOs) in order to maintain the quality and supply of the value added products. To enhance the consumption of banana value added products, multi-dimensional promotional efforts are required like introduction of various flavors of banana chips (sweet, salty etc.), attractive packing, branding, and advertisement at electronic and print media. Various products of value added banana may also be introduced to school children, as they are generally fond of consuming new items.

9. Comparing the Relative Efficiency of Two Experimental Designs in Wheat Yield Trials at NARC

The use of Randomized Complete Block Design (RCBD) is criticized by the researchers in advanced countries while dealing with large field experiments. Hence, the use of RCBD is considered unsuitable when the number of entries/genotypes exceeds beyond sixteen in number in single block. The precision of RCBD relies on controlling the heterogeneity within blocks. The study in hand estimated the relative efficiency of Alpha Lattice Design (ALD) with RCBD in a situation when there are 50 entries/ genotypes in single block. Experiments on wheat crop were conducted at NARC during, 2012-13, 2014-15 and 2015-16 in Alpha Lattice Design with 2 replications, 50 entries, 10 blocks and 5 plots per block. The results showed improvements in the precision level by adopting ALD measured in terms of decline in the mean square error, coefficient of variation and standard error difference, with relative improvements by 106 to 107 percent as compared to RCBD. Therefore, the stance of developed countries scientists for adopting ALD when number of entries in single block is more than sixteen, is confirmed in our case also. The biological scientists of the country are suggested to opt ALD than RCBD when the number of entries/ varieties of the experiment is quite large. The ALD also provides effective control within replicate variability in large blocks.

10. Dietary Diversity and Food Demand Analysis in Azad Jammu and Kashmir

A study was started with the salient objectives for determining the dietary diversity score for different food groups along with estimating the current and projected demand for different food groups in AJK.

The data for the study were collected from 1250 households covering all 10 administrative districts of AJK by following multi-stage sampling techniques through a comprehensive interview schedule. Eighty-three (83) commodities making 10 commodity groups (Wheat, Rice, Milk, Meat, Vegetables, Fruits, Pulses, Oil/Ghee, Tea and Other food found consumed in sample households. Linear Approximate Almost Ideal Demand System (LA-AIDS) model was used for estimating food demand elasticities through Zellner's Seemingly Unrelated Regression by using STATA software. The descriptive statistics revealed that average annual per capita consumption of 85 kg of wheat and wheat flour, 16 kg of rice, 90 liters of milk and its products, 13 kg of meat, 43 kg of fruits, 64 kg of vegetables, 8 kg of pulses, 11 kg of oil and ghee, 2 kg of tea and 4 kg of other foods. All the 10 food groups were found normal goods, except milk and fruits (income elasticity higher than unity), having positive income elasticity (wheat as 0.33, rice as 0.57, milk as 1.37, meat as 0.78, fruits as 1.45, vegetables as 0.89, pulses as 0.11, oil & ghee as 0.66, tea as 0.40 and other food as 0.87). This implies that in future demand for milk and fruits would increase more proportionately as income would increase. The own price elasticities of all 10-food groups were also found congruent to economic theory means was negative (Wheat-0.28, Rice-0.65, Milk-0.92, Meat-0.34, Fruits-0.61, Vegetables-0.21, Pulses-0.29, Oil and ghee-0.04, Tea-0.35 and Other food-0.32). The income and own price elasticities depicted that wheat, vegetables, pulses and oil and ghee are highly necessities as compared to other food groups. The cross price elasticity illustrated that rice could be used as substitute of wheat and wheat of rice in the State of AJK. Similarly other food groups exhibit substitution and or complementary effect for one another.

The Berry's Index (82.43) depicted that food was diverse on average with a minimum Index value of 61.31. The study of different factors in relation to Berry's Index depicted that education, income, location of household in urban or rural area do not affect diversification of food. However family size affects it negatively – smaller the size of family food was more diversified while food was specialized where family size was larger. The estimates of projected demand for the State of AJK in the year 2017 to 2050 depicted that wheat and wheat flour for the year 2017 was found to be 0.343 million tons while it would be 0.400, 0.485, 0.858 and 1.255 million tons in the year 2020, 2025, 2040 and 2050 respectively. The current and projected demand for meat was found to be 0.051 million tons in 2017 and 0.068, 0.129, 0.244 and 0.462 million tons in 2020, 2030, 2040 and 2050 respectively. The current and projected demand for milk was found to be 365 million liters, 1426 million liters, 3777 million liters and 10006 million liters in the year 2017, 2020, 2030, 2040 and 2050 respectively.

While calculating the supply and demand gap for major food groups, it was found that the State of AJK is deficit in wheat and wheat flour by 0.194 million tones currently while this gap would be more widened by the year 2025 at 0.306 million tons and 0.939 million tons by 2050. Similarly the supply and demand gap for rice was found to be 0.056 million tons while this gap would be increased at 0.102 million tons in 2040 and at 0.169 million tons in 2050. The state of AJK was found surplus in Milk and Meat production but it would in the year 2030 AJK would be deficit in both these food groups at figures of 214 million liters of milk and 0.029 million tons of meat. The State of AJK was found surplus in fruits production but deficit in vegetables currently but after 2030 gap in demand and supply would be turned deficit. Since, the purchasing power of the consumers in AJK is relatively better than many rural dominated districts of Pakistan, it is proposed that besides giving attention to increase production of food items in which AJK economy has comparative advantage, the food supply and value chains should be developed so that the availability of high value agricultural products (e.g. fruits, vegetables, milk and meat products) are available at cheaper rates.

11. An Analysis of Poverty Prevalence in AJK Using Multidimensional Poverty Index Approach

A focus on deprivation is fundamental to human development. Poverty is multifaceted and multi-dimensional issue, thus far beyond inadequate income. It involves poor nutrition and health, low education and skills, inadequate livelihoods, poor/bad housing conditions, social exclusion and lack of participation. Monetary and consumption based measures of poverty are important at their own places, but deprivations in other dimensions and their overlap also need to be considered, especially because households are facing multiple deprivations and are likely to be in worse situation than income poverty measures suggest. The Multi-dimensional Poverty Index is a composite measure of the percentage of deprivations that the average person would experience if deprivation of poor households were shared equally across the population. The prime objective of the study under consideration was to estimate multi-dimensional index of poverty prevalence in Azad Jammu and Kashmir. Such information is helpful in designing more comprehensive and impact generating poverty alleviation policies for the state.

The data for this study was gathered from 740 household in 3 Administrative Divisions of AJK. Alkire-Foster formula was used to estimate the Index with three dimensions i.e., Education, Health and Living Standards. The households heads education revealed that nearly two third of the respondents were educated at least matric or above. Most interestingly highest proportion of the educated household heads were graduate and/or post-graduate. At the same time about 17% of the household heads or any person were illiterate that contributed to poverty in education dimension. Only 5% of the sampled respondents replied that a child aged 5 to 8 years was not attending school. About 9% of the respondent verified infant mortality with highest figures in Muzaffarabad

district (13.5%). Vaccination record to children was found good and only 6.5 percent of the children did not completed vaccination course. On the living standards side, only one percent of the sampled respondents had no electricity facility, however about 40% of the respondents had no clean drinking water facility at home. Only 2% of the sampled respondents were without washroom facility at home. About 25 percent of the sampled households were found using wood as a fuel while only 5.5% of the respondents were having floor with mud. As per assets, it was found that about 10 percent of the sampled respondents were without television facility, about 10% without phone facility and about 72% without car facility. Overall, 33% of the population was deprived of all three major dimensions of poverty considered in the study: i.e., education, health and living standards. However, setting the cut-offs at 2, thirty-six percent of the sampled respondents were found below poverty line on overall bases. Interestingly district Muzaffarabad was highly poor (41%), followed by Poonch (34.5%), Kotli (35%) and Mirpur (23%) across all three dimensions.

Uni-dimensional poverty on education revealed that 8.4% of the sampled respondents were below poverty line in education with highest proportion in Mirpur district (13.6%), followed by Muzaffarabad. On the health dimension about 12% of the sampled respondents were found below poverty line with highest percentage in Mirpur district (19%). Exploring the poverty in living standards dimension, it was found that almost 13% of the sampled respondents were below poverty, with highest percentage in Muzaffarabad (19%), followed by Poonch (18.7%), Kotli (7.8%) and Mirpur (4.4%). Drinking water facility must be improved. Government (WASA) may launch a program for testing springs' water and make hygienic environment over these springs.

DIRECTORATE OF SCIENTIFIC COMMUNICATION & PUBLICATION

Directorate of Scientific Communication and Publication continued acquiring, processing, storage and dissemination of agricultural research and development information. Section wise Progress by Directorate of Scientific Communication and Publication during 2017-18 is given bellow:

1. PARC Website:

PARC Website (www.parc.gov.pk) developed in 1998 and formally inaugurated in August 2000 is being maintained and updated regularly. The major contents of website includes: Functions, Research Divisions, Research Establishments, Research Institutes, Research Coordination, Agricultural Maps, Publications, Information Services, Announcements, PARC Databases, Senior Staff, Related Sites, On-line Journals, Guest Book, Urdu Section, Agro-forum, Organizational Chart, News and Events, PIASA, ALP, RADP, PATCO etc. Website is regularly updated based on the information provided by different Centres, Institutes, Directorates and Programs of PARC.



2. Pakistan Agriculture Database:

For facilitating scientific community in review of Pakistani literature 1810 new records were added to abstracting data base" Pakistan Agriculture Database" which thus holds a total 91810(+) records with its access on internet under PARC Website.



3. Input to AGRIS database of FAO:

Information of 955 Pakistani published agricultural research articles/documents were shared with international scientific community by sending input of FAO AGRIS database.

4. NARC Library

229 new books/documents and 208 journal issues were added to library stock. Library has started building digital collections and during the current year, 1320 books/documents were added in digital library. 98 requests for literature search received throughout Pakistan were entertained and 11,252 abstracts/ references supplied.



5. Union Database of Journals in Agriculture Libraries of Pakistan

Internet based union database of journals in agricultural libraries containing information of 3029 journal/magazine titles with available volumes and issues in 36 libraries was updated with 318 new volumes besides its updation by participating libraries. 129



reprints were supplied to foreign agencies/scientists and 84 to local scientists.

6. Photographic Services:

DSC&P is providing scientific and functional photographic services to PARC/NARC scientists. Photographs are snapped for field/lab experiments and important events. Photographic coverage is provided for seminars, workshops, meetings, conferences, visits, etc. During 2017-18 10,236 photographs were snapped and 97 events were covered.



7. Digital Archive of PARC Research and Scholarly Work

Directorate of Scientific Communication and Publication created “Digital Archive of PARC Research and Scholarly Work” with the financial support of Research for Agricultural Development Program (RADP). The repository is developed using common standards and best practices to ensure its wide accessibility and retrieval/navigation in simple form to facilitate the users. The repository includes current and previous publications of PARC and PARC Scientists. AGROVOC and AGRIS standards are used for cataloguing, classification and indexing, etc. Repository is preserving PARC publications for future generation and helping in improving the accessibility, availability and use of PARC research outputs by researchers, research managers and farmers The Archive currently contain about 8500 full text publications which can be accessed online through PARC website (www.parc.gov.pk)



AUDIO VISUAL COMMUNICATION SECTION

Audio Visual Communications (AVC) is mandated to design and produce to project and promote PARC programmers, activities and various types of audio-visual materials and documentaries/programmers achievements. Therefore, in 2017 AVC provided the facility of video coverage and editing of more than 53 important functions, events and meetings including meeting of PARC BOG, IPARCC meetings, training sessions, conferences, important visits of dignitaries and different functions and event, AVC also provided the sound system and audio facility for different 47 Functions held in National Agricultural Research Centre. AVC also produced 1 documentary about Wheat.

Agricultural Engineering

The division's main thrust remained on design, development, adaptation and promotion of energy-efficient precision agricultural machinery with a particular focus on field and horticultural crops. Division is also playing an important role of coordination among the stakeholders related with promotion of agricultural mechanization, renewable energy technologies and post-harvest & food engineering in the country besides providing technical inputs for development of National Standards for agricultural tractors & machinery. The division's salient achievements during the reporting period are briefly described as under:

1. National Seminar on Ispaghol Processing Machinery

A national seminar on “Indigenous Ispaghol Processing Machinery” was organised on 8 January 2018 at Hasilpur. Farmers, processors, representatives of the multinational companies, chamber of commerce, line departments and parliamentarians attended the seminar and machinery demonstration. Honourable Sardar Sikandar Hayat Khan Bosan, Federal Minister for National Food Security and Research, Islamabad was the Chief Guest at the occasion while Honourable Riaz Hussain Pirzada, Federal Minister for Inter-Provincial Coordination and Muhammad Afzal Gill, Member of Provincial Assembly (Punjab) and Parliamentary Secretary graced the occasion as guests of honour. A presentation was given to the participants on traditional and innovative Ispaghol processing technologies. Demonstration of Ispaghol machinery was also conducted at the occasion.



Ispaghol processing machinery at Hasilpur

2. Solar date dryers

Functionalization of dates drying facilities:

During the dates harvesting season 2017, Eight (08) solar-cum-gas fired date dryers and seventeen (17) solar tunnel dates dryer were operated at the premises of twenty-one (21) village Organizations (VOs) in Districts Khairpur and Sukkur (Figures: 4 – 5). The members of VOs were satisfied with the performance of solar dates dryers. The total production of dates dryers was around 98 tonnes.



Dates Drying Season, 2017 at different sites in Khairpur and Sukkur

Functionalization of Banana Value Addition Facilities

The banana value addition facilities were functionalized in banana harvesting season (Sep-Dec) (Figures 6 – 7). The members of VOs under the guidance of Food Sciences Research Institute (FSRI), NARC and AED, PARC team produces banana chips, fig and powder.



Banana value addition at three field sites in District Khairpur

Trainings/Seminars/Field days

Training on “Operation and Maintenance” of Solar-Cum-Gas Fired Dates Dryers: Date growers, members of village organizations and workers were trained on operation and maintenance of solar-cum-gas fired date dryer (Figures 8 – 9). These trainings were conducted at Goth Mola Bux Mastoi, Chodahoo and Goth Muhammad Bux Veesar in District Khairpur and Sukkur from 5 - 9 July 2017. The lectures were attended by heads of the Village Organizations and members and they acknowledged the efforts made by the PARC engineers and scientists for the promotion of dates dryers in Khairpur and Sukkur areas.

Field Seminar/Demonstration:

A field day/seminar/demonstration on solar dates dryers (solar-cum-gas fired and tunnel date dryer) was held at village Bagh Pai, Taluka Pano Aqil, Sukkur on 10-08-2017 (Figures 10 - 11). The objective of organizing this field day seminar /demonstration was to disseminate these technologies to local farmers, date growers, date processor, agricultural machinery manufacturers, local and provincial administration and to convince them to adopt drying technologies instead of conventional drying method. More than



Field Day Seminar/Demonstration at different project sites

three hundred (300) date growers, date processors, members of village organizations, officials of agriculture extension, journalists and social workers attended the field day.

3. Portable solar dryer for fruit and vegetables

A small solar dryer was acquired from M/s JOBS Trust, an NGO manufacturing small-scale solar dryers for small growers of fruits and vegetables. The performance of this dryers was evaluated to drying different fruits and vegetables and with immense results. An improved version of this dryer was fabricated at AEI, which was tested to dry apples, mangos, apricot, ber, gourds and other vegetables. The dryer consisted of glass collector to trap solar heat, corrugated steel sheet for absorbing heat, drying chamber with trays for putting fruits/vegetable for drying, small fan that ensures hot air circulation, a solar panel to give power to the fan, temperature indicators and a small battery for storage of energy.

This technology also empowers the household women to produce value-added products from fruit and vegetables in their production catchments. The batch capacity of dryer is 30 kg in 2 days in summer and 3 days in winter. Maximum inside drying temperature rose to 70°C in summer and 50°C in winter. Cost of the dryer is Rs. 50,000.



Portable solar dryer for drying of fruit and vegetables at household level

4. Pak Seeder: direct sowing of wheat in heavy rice residue

PARC has developed a machine called Pak Seeder, which drills wheat in heavy rice residue without burning it just after combine harvesting the same day. This technology was demonstrated in rice-wheat areas with the financial support of ICARDA-USDA. The results of last two year's trials at five different locations on farmers' fields show that the average yield increased using Pak Seeder in heavy rice residue up to 600 kg/ hectare (6 Maunds/acre), which is more than farmers current practices (e.g. partial burning of residue + 2 to 3 times disk harrows + rotavator + manually broad casting seed + planking for seed covering). The main reasons for increased yield are: a) Timely sowing of wheat; b) Line sowing; c) The seed germination 19% was higher in heavy mulched field as compared to seed broadcasted field because the temperature remains moderate at night time under heavy residue; and d) The population of weed was less than 5% as compared to 23% in conventional method.



Demonstration of wheat plots

5. Palm oil extraction machine

As per directive of BoG, a small farm-scale palm oil extraction machine and stone breaker were identified and imported from China under the RADP Sub-Project entitled "Development and adaptation of farm-scale agricultural technologies for sugarcane crushing, maize stover harvesting, maize drying and palm oil extraction". These machines were laboratory tested at AEI, NARC. Palm fruit was arranged from Thatta area. Fruit bunches were threshed with stick beating and spikelet were separated manually from the fruit. The fruit was boiled in a pan. The boiled fruit was put in the palm oil press machine for oil extraction. The palm oil press machine squeezes the fruit to extract oil, whereas the beater machine is used to break palm kernels to extract kernel oil. Oil press released oil by rupturing oil-bearing cells. Oil was extracted in the form of slag.

Director General of Coastal Development Authority (CDA), Sindh visited AEI, NARC to witness performance of palm oil extraction machine. He was satisfied with the performance of oil extraction machines and showed interest to buy similar machines for their oil palm orchards in costrel area, Sindh. The Authority further showed to install a small palm oil extraction plant. In this regard, the specifications of palm oil extraction plant were prepared and provided them for promotion of this technology in palm growing areas of Sindh.



Laboratory testing and palm oil extraction at AEI, NARC, Islamabad

6. Multipurpose nursery raising plant

Multipurpose nursery raising plant is complete in all respects. It consists of compost grinding machinery and pot filling machinery. The complete plant is installed under a proper shed near Livestock Research Station, NARC (Figure 15). About 10 tonnes of compost was produced and distributed among scientists for research and evaluation purposes. First batch of 1100 pots was filled by pot filling plant and vegetables were grown. Pots

filled with compost and vegetables seedlings were sold through PATCO.

7. Development of a kalonji thresher

Kalonji (*Nigella sativa*) is a herb, which has very high medicinal value in our culture. Kalonji is grown in different parts of the country on small areas. It is mainly grown in Hasilpur and other parts of Southern Punjab. Threshing of kalonji is a problem for the growers. Traditionally, kalonji crop is threshed manually by beating it with sticks, which is a laborious and time-consuming process. This crop cannot be threshed with a regular thresher due to its tiny sized seed, which needs specially designed make. Kalonji thresher was designed and developed at AEI of PARC. Preliminary testing of this machine was carried out at AEI and Hasilpur. Good results were found using this thresher. Extensive testing of machine is required in future. This thresher is operated with a 2 HP electric motor having a Rasp bar type threshing drum. Two persons are needed to operate this machine. Threshing capacity was found to be 100 kg/h with Rs. 45/h electricity cost. Seed breakage was less than 5 percent with threshing efficiency of 96 percent.



Glimpses of nursery raising plant at NARC



Kalonji stationary thresher

8. Onion seed stationary thresher

Onion (*Allium cepa*, L.) is considered as one of the most important vegetable crops produced on large scale in the world. Onions are used in salads, soups, sauces and seasoning foods. Onion bulb is rich in phosphorus, calcium and carbohydrates. The pungency in onion is due to a volatile oil known as ally-propyl disulphide. Onion is consumed as green onion together with leaves as well as matured onion bulbs.

Pakistan is a large onion producer, where onion is grown in all provinces of the country in varied climatic conditions. Pakistan occupied 8th position with 2.28 % share of the world market. It is one of the important condiments widely used all over the country, which is an essential ingredient for curry making. Pakistan is not producing onion seed as per requirement of the country. Therefore, a major percentage of onion seed requirement is met through its import, which requires a lot of valuable foreign exchange. Reasons for low production of onion seed in the country are that the seed crop is mainly confined to some limited and specific areas due to their conducive environments for seed production. Furthermore, threshing of onion seed is another issue. Therefore, this project was focused on the development of onion seed thresher. Small thresher for onion seed was designed and developed as shown in Figure 17. Preliminary testing of onion thresher was carried out in the prototype workshop of AEI, NARC Islamabad with satisfactory performance.



Onion seed stationary thresher

Planning and Development

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 2017-18 is given as under:

1. Directorate of Competitive Grants and MoU projects (CG&MOU):

The Directorate of Competitive Grants and MOU Projects (CG & MOU) is responsible for operation of Agricultural Linkages Program (ALP) and appraisal/ processing of projects funding under memorandum of understanding.

A. Functions:

- i. Appraisal of detailed projects through national referees, technical divisions and ALP Secretariat, PARC.
- ii. Processing of projects for approval
 - a) Concept papers/ preliminary proposals received under 8th batch of ALP
 - b) Detail projects for appraisal after short listing.
 - c) Meetings of Technical Advisory Committee (TAC)
 - d) Meetings of Board of Directors (BOD)
 - e) Project Implementation Agreements of project proposals
- iii. Monitoring and review/ evaluation of ongoing projects.
- iv. Completion formalities of ALP completed projects.
- v. Preparation of reports and relevant information.
- vi. Follow-up actions for finalization of completion formalities of completed projects such as handing over/ taking over of capital assets purchased under ALP projects, final financial and progress reports etc.

B. Achievements:

- i. More than 1014 concept papers/ preliminary proposals received under 8th batch of ALP were evaluated through appraisal committees and short listed 358 proposals for development of details project proposals.
- ii. Detailed project proposals were evaluated by two national referees. These projects got revised/ modified and cleared for consideration of Technical Advisory Committee (TAC) and Board of Directors (BOD) meetings.
- iii. During the year 2017-18, four (4) meetings of Technical Advisory Committee (TAC) were held till April, 2018. In the TAC meetings, 101 project proposals were considered for final ranking and consideration of BOD.
- iv. Three (3) meetings of Board of Directors (BOD) of ALP were convened till April 2018 in which 43 project proposals were approved.
- v. The project implementation agreement in respect of 31 projects which were approved by the Board of Directors were finalized and signed between PARC and host institutes after the budget allocation of projects and negotiation with PIs as per BOD decisions and ALP criteria.

Implementation and Monitoring:

During the report period, 70 projects remained in operation throughout the country in various research agricultural research centre/ institutes and universities. The issues relating to the projects such as revision & re-appropriation of budget allocation, extension in duration, releases of funds, honorarium of PIs, change of PIs and transfer of equipments etc were timely addressed for smooth implementation of projects. The progress of the projects was regularly monitored through technical (mid years & annual) and financial reports.

MOU Projects:

During the report period, PARC has signed 20 MoUs and Agreement with international partners/donors like ACIAR, USDA through ICARDA, APN, AFPRI, and IDRC through ICIMOD. These 20 projects were started after approval of competent authority. While 46 foreign funded projects/concept papers were submitted to different donors' for approval. Furthermore, 35 concept papers were submitted to Pakistan Science Foundation for funding after clearance/vetting from concerned Technical Divisions and Chairman, PARC.

2. Directorate of Public Sector Development Program (PSDP):

The PSDP projects are the building blocks for any organization. These projects are prepared keeping in view the national and sectoral priorities. Directorate of PSDP (P&D Div.) is responsible for the processing of new projects submitted by scientists of PARC. Presenting and defending the submitted projects for getting approval

of respective PSDP forums including DDWP, CDWP and ECNEC. Preparation, presenting and defending budget demand for the forthcoming PSDP regarding ongoing and new projects. After final PSDP allocation to projects, The Cash/Work Plan for each development project is prepared as per approved budget. Revision and extension in duration of ongoing projects are also processed and get approved for competent authority/forum. The assignments conducted by the Directorate of PSDP (P&D Division) for the year 2017-18 are as under:

- i. Preparation, Scrutiny, and Processing of Twenty Five new and modified development projects.
- ii. Seven on-going, six new approved and fifteen new un-approved projects were prioritized/recommended for budget allocation in PSDP 2018-19.
- iii. Processed revision of Eight New and Eight Ongoing Revised Projects by CDWP/DDWP. All the Eight projects were revised in consultation with respective PIs, concerned Technical Division and Finance Division, PARC. The revised PC-Is of these projects were submitted to the M/o NFS&R for seeking approval of competent forum i.e. DDWP/CDWP.
- iv. Total Five projects were completed and seven projects were monitored during FY-2017-18.

Preparation of Public Sector Development Program (PSDP):

It is a regular exercise being conducted annually as per direction of M/o National Food Security & Research (NFS&R) and M/o Planning, Development, and Reforms (PD&R), GOP with the predetermined format. All the Technical Division and outside establishments of PARC were requested for new projects (if any) for inclusion in PSDP in addition to ongoing projects. The budget demand for PSDP 2018-19 and projected budget for 2019-20 and 2020-21 was prepared in consultation with the respective PDs/Pis of on-going projects, demand for new approved and new unapproved projects was also made as per project documents. The same was submitted to the M/o NFS&R after approval of Chairman PARC.

The meeting of Standing Committee of National Assembly on National Food Security & Research was held on 27th February, 2017 at PARC Headquarters to discuss/scrutinize budget proposals of the M/o NFS&R for PSDP 2018-19. The total Thirty Eight projects of PARC including twelve on-going, seven new approved and nineteen new un-approved projects with a demand of Rs.19729.098 million for PSDP 2018-19 were agreed in the meeting. All the submitted projects were recommended by the Standing Committee with certain modifications in the projects. Before presenting the budget to the Parliament of Pakistan, allocation of PSDP 2018-19 was presented and defended at all required forums including Priority Committee meetings and Annual Plan Coordination Committee (APCC) meetings. After accomplishing all procedural channels, Parliament of Pakistan finally approved an allocation of Rs. 1190.800 million for PARC PSDP 2018-19 for seven on-going and two new un approved projects.

After having final allocation of Rs.1261.919 million in PSDP 2017-18 reflected in the Pink Book, Cash/Work Plan for FY 2017-18 as per allocated budget to each project was prepared in consultation with respective PDs/Pis and submitted for approval of M/o National Food Security & Research (NFS&R), M/o Planning, Development & Reform (PD&R) and the M/o Finance accordingly.

Monthly Review Meeting of PSDP Projects at PARC, M/o NFS&R and M/o PD&R:

The monthly, quarterly and annual review meetings were conducted/attended held at PARC, M/o NFS&R and M/o PD&R to help in updating physical, financial and technical progress of the on-going projects. Follow up the decisions taken in the meetings for smooth execution of the projects.

3. Directorate of Planning, Monitoring and Evaluation (PM&E):

Directorate of PM&E is responsible to organize and conduct the in-house review, on-site M&E and impact assessments of on-going as well as completed projects of PARC funded under different sources. PM&E is also responsible to develop, prepare and update PARC Five Years Research Plan linked with Sustainable Development Goals (SDGs) and Pakistan vision 2025. It also developed institute level Annual Work plan (AWP) in the light of PARC Five Years Research Plan and compiled/edited the institutes level Annual Progress Reports.

Salient Achievements:

i) Development/Compilation of P&DD Progress Reports:

Edited / compiled the progress reports of P&DD for submission to 41st& 42nd Board of Governors (BOG) of PARC, PARC Annual Progress Report, Prime Minister Secretariat, Islamabad (three Years Performance of the Govt. of Pakistan) and , NFS&R Year Book in Pursuance of rules 25 the rules of business 1973.

ii) Institutes Level Annual Work plans Annual/ Progress Reports:

Edited / Compiled Institutes level Annual Work plans (2017-18)and Annual Progress Report (2016-17) of all PARC's Centers / Institutes in the light of PARC's Five Years Business Plan (2013-18). Plans and progress reports were published and circulated to all concerned quarters.

iii) Review & Evaluation:

- a) In-house Review of On-Going Projects: Three monthly in-house review meetings of PSDP on-going

projects were arranged during the months on February, March, and April, 2018. Minutes of the meetings were developed and circulated to the PIs/PDs and other stakeholders for compliance.

- b) On-site Monitoring & Evaluation: On-site Monitoring and Evaluation (M&E) of nine ALP and one PSDP on-going projects being implemented at Punjab, Sindh, KPK and Gilgit-Baltistan was conducted. The evaluation reports were developed and circulated to the concerned quarters for compliance.

iv) Projects and Reports Appraisal:

- a) Reviewed/Examined the PC-I of “Federal Nutritious Program” developed by M/o Science and Technology. The findings of the appraisal were forwarded to M/o NFS&R for onward submission of M/o S&T.
- b) Reviewed / Examined the PC-I of PSDP project on Pulses. The observations/ findings were forwarded to the concerned quarter
- c) Review/Examined a report on training “Hybrid Rice in Pakistan” conducted in China and Pakistan by Plants Sciences Division (PSD).The observations/findings were conveyed to PSD after the approval of Chairman, PARC.
- d) Carried out an evaluation of the PSDP project “Kitchen Gardening” on the direction of the Secretary, M/o NFS&R. The evaluation report was developed and submitted to M/o NFS&R for further necessary action.

v) Development of PARC Five Years Research Plan (2018-2023):

PM&E is in process of developing PARC Five Years Research Plan (2018-23).First Draft in respect of AED, PSD, ASD, NRD, SSD, C&M, PRMC and P&DD has been prepared and submitted to Chairman, PARC for perusal/approval. The plan will be finalized at the end of April, 2018.

Coordination and Monitoring

One of the main mandate of PARC is to coordinate agriculture research at national and international level. For this purpose Coordination and Monitoring Division was created in PARC in 2012. The aim of this division is to develop well coordinated National Agriculture Research System in the country as well as to link it with international CGIAR system. The division is involved in establishing linkages with national and international institutes, private companies, universities and NGOs through MoUs/agreements and also by holding/facilitating national and international workshops/meetings/conferences. The division is also striving for human resource development of the council and NARS system. The main achievements of the Division are as under:

A. International Cooperation

Areas identification for bilateral Cooperation with foreign countries: /Briefs/Talking Points

Identified the areas of cooperation between PARC and National Agricultural Research System (NARS) of many friendly countries including Azerbaijan, Belarus, China, Japan, Kazakhstan, Korea, Tajikistan, Turkmenistan and Uzbekistan and forwarded to Ministry of Foreign Affairs, Economic Affairs Division, Ministry of Climate Change and M/o National Food Security & Research.

Preparation of Briefs/Talking Points

Prepared brief & talking points for meetings related to the agricultural research & development, for the Federal Minister, National Food Security & Research (NFS&R), and other high government officials with foreign ambassadors and delegates of above mentioned countries.

Facilitated in holding Meetings with Foreign delegates

- Chinese delegation from Lanzhou University with PARC Management.
- Chinese delegation from Gansu Fisheries Research Institute with PARC Management.
- Nigerian Ambassador with Chairman, PARC.
- Korean Ambassador with Chairman, PARC.
- Uzbek diplomats/senior officials with Chairman, PARC.
- Turkish diplomats/senior officials with Chairman, PARC.
- Delegation from Central Asian Republics with PARC Management.
- Fourth Session of Pak-Belarus Joint Working Group.

Renewal of PARC's Membership in international organizations:

PARC revived the membership of Asia-Pacific Association of Agricultural Research Institutions (APAARI), The Royal Agricultural Society of the Commonwealth (RASC), CAB International (CABI), Centre for Sustainable Agricultural Mechanization (CSAM) and Centre for Alleviation of Poverty through Sustainable Agriculture (CAPSA)

Visa Processing Facilitation:

PARC facilitated the visa processing of 47 foreign participants of Workshops/Seminars & Internationally Recruited Staff (IRS) being posted in Pakistan. These include; ICIMOD (23); China (19); CIMMYT (04) and ILRI (01).

Signing International MOUs/Agreements:

- Memorandum of Understanding between Pakistan Agricultural Research Council (PARC) and Tunisian Institute of Agricultural Research and Higher Education (IRESA).
- Research collaboration between Pakistan Agricultural Research Council (PARC) and Sustainable Development Policy Institute (SDPI) for implementation of activities of International Development Research Centre (IDRC) under Window Opportunity Synergy Fund (OSF).
- Research collaboration between Pakistan Agricultural Research Council (PARC) and World Vegetable Centre for Improved Mungbean harvesting and seed production system for Pakistan.

B. National Coordination

Inter Provincial Research Coordination Committee

The aim of establishment of IPARCC is to develop formal coordination linkages with provincial research system including Gilgit-Baltistan. Two (02) meetings were conducted and discussed the role of all stakeholders. It was emphasized to develop collaborative linkages by sharing their strength to mitigate Mountain Agriculture Research issues in Gilgit Baltistan and recommended to establish a Vaccine Production Laboratory under Livestock Development Department, Balochistan.

- **Vice Chancellors Forum**

The main objective of Vice Chancellors Forum is to interact with universities keeping in view their strengths and bring their research activities in line with national agenda. During the reported period one meeting was conducted. The forum recommended that the process of awarding project(s) under Agriculture Linkages Programme may be shorted. Further decided that the ORIC office of the respective universities may be taken on board while awarding project(s) to the university teachers out of ALP funds.

- **Signing of MoUs/Agreements**

Around 14 MoUs/Agreements have been signed with Agri-tech companies/ NGOs/Public-Private Sectors for development and dissemination of research technologies.

- **Organizing International Conference**

A three days international conference titled “Drug Discovery” with the collaboration of Abdul Wali Khan University, Mardan was organized at NARC. Prominent scholars/ researchers from foreign and across the country delivered /presented their presentation and research papers.

C. Directorate of Human Resource Development

The following cases have been processed and finalized:

Category	Local	Foreign	Total
Degree Program	18	05	23
Short Term Training	182	27	209
Visits/Workshops/Conference	-	80	80
Grant Total	200	112	312

Other Events

Organized Baluchistan Farmer's Event and Baluchistan Livestock Farmer's conference with collaboration of FAO & Govt. of Baluchistan. Both the events were chaired jointly by Federal Minister MNFS&R and CM, Baluchistan. High level PARC officials attended the events and delivered their inputs for the uplift of agriculture and livestock sectors of Baluchistan.

DIRECTORATE OF HUMAN RESOURCE DEVELOPMENT

- Five scientists were sent abroad for Ph. D, M. S and Post-Doctoral Programs during reported period.
- Twenty seven scientists availed short term training from abroad in different disciplines and themes during the reported period.
- Eighty scientists participated in the international workshops, conferences, meetings and seminars on different themes and description during the reported period.
- Eighteen scientists were given opportunity for local degree programs in the national universities.
- One hundred and eighty two scientist/staff were trained in local institutions in different disciplines.
- About three internees received training in different disciplines under National Internship Program.

Budget and Finance of PARC

Budget of PARC Highlights

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

- Grants made by the Federal government and the Provincial governments.
- Grants, donations, endowments, contributions, aid and assistance given by other organizations.
- Foreign aid and loans obtained or raised with the approval of the Federal Government.
- 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	2016-17 Actual	2017-18	
		Budget	R.E
Current Expenditure (GOP Grant)	2896.070	2687.360	2687.360
Own Sources (PARC)	67.450	80.000	80.000
Total :	2963.520	2767.360	2767.360*
Development Expenditure (PSDP)	426.574	1261.919	1010.671
Agricultural Linkage Programme (ALP)	50.519	214.709	214.709
Memorandum of Understanding (MOU's)	78.566	206.700	232.058

*In addition to Rs.2767.360, Rs.855.582 million demanded as supplementary grant is under process in Ministry of NFS&R

Current Expenditure

(Rs. in million)

Objects	2016-17 Actual	2017-18	
		Budget	R.E.
Establishment Expenses	2633.728	2424.339	2424.339
Operational Expenses	329.792	343.021	343.021
Total :	2963.520	2767.360	2767.360

Development Expenditure Budget

Development Expenditure budget of Rs. 1261.919 million was allocated for the following on-going PSDP Projects for the year 2017-18 which was subsequently revised to Rs. 1010.671 million surrendering Rs. 251.248 million the detail of projects is as under:-

On-Going Projects

(Rs. in million)

Sr. No.	Location	Budget 2017-18		Revised Budget 2017-18	
		Total Number of Project Executed	Total Amount	Total Number of Project Executed	Total Amount
1	NARC	19	27.031	19	58.859
2	Punjab	25	27.141	25	33.751
3	KPK	22	17.755	22	39.229
4	Sindh	9	9.138	9	13.054
5	Balochistan	6	7.549	6	9.199

Sr. No.	Location	Budget 2017-18		Revised Budget 2017-18	
		Total Number of Project Executed	Total Amount	Total Number of Project Executed	Total Amount
6	PARC, H.Qtr.	1	18.715	1	26.470
7	AJK	3	0.880	3	0.980
8	Block Allocation	Block Allocation	90.000	-	16.667
9	Sponsoring of Short Term Exchange of Agri. and Scientist and Experts		15.000	-	15.000
10	Scientist Award		1.500	-	1.500
	Total :-	85	214.709	85	214.709

MoUs

A total of 29 projects at a total cost of Rs.232.058 million was approved under MOU's with different national and international organization for the year 2017-18. An over view of three years is as follows:

(Rs. in Million)

Objects	2016-17 Actual	2017-18	
		Budget	R.E.
Budget	78.566	206.700	232.058
No. of Projects	14	29	29



Advisor to Prime Minister of Pakistan for NFS&R Ch. Nasir Iqbal Bosal presiding over a opening Ceremony of “2017 Training Course on Hybrid Rice in Pakistan” held at NARC Islamabad. Whereas Counselor (Economic & Commercial) Dr. Wang Zhihua, Vice President, Director of International Training Institute China Zhou Dan, Chairman PARC Dr. Yusuf Zafar (T.I.) and Chairman Gaurd Rice, Shahzad Ali Malik also present on the occasion. (Dte. Sep. 2017 of PR&P) PARC



Dr. Yusuf Zafar T.I., Chairman PARC is holding a meeting with the H.E. Mr. Andrie Ermolovich, Ambassador of Belarus in Pakistan on his visit at PARC HQs, Islamabad. Other PARC High Officials and Belarus also present in the meeting. (24th November 2017)



Mr. Fazal Abbas Maken, Federal Secretary for M/o National Food Security & Research, Dr. Yusuf Zafar T.I., Chairman PARC, Mr. Khurram Zia, Business Manager, Nestle-Pakistan, Dr. Ghulam Muhammad Ali, Director General NARC, Mr. Waqar Ahmed, Regional Manager, Nestle-Pakistan and Dr. Munir Ahmed, Member (NRD) PARC are sitting on the stage during Inaugural Ceremony of Solar Pump and Water Saving Technologies organized by Climate, Energy and Water Research Institute (CEWRI), NARC with Collaborating of Nestle-Pakistan. The Ceremony was held at Community Centre, NARC. (11th April, 2018)

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