

Name of Project: **Pond Culture and Reproductive Performance of Seengharee, *Aorichthys aor* (Hamilton, 1822)**

Name of PI/Institute: **Mr. Muhammad Ramzan Ali,**
Scientific Officer,
Aquaculture & Fisheries, NARC, Islamabad.

Duration: 22. 08. 2008 to 30. 06. 2011

Financial Status: Total Cost: Rs.5.628 million
Funds Released: Rs.4893100/-
Funds Utilized: Rs.4893100/-

Objectives:

- To study performance of Seengharee, *Aorichthys aor* in pond culture system.
- To study reproductive cycles and breeding performance of Seengharee, *Aorichthys aor*.

Achievements:

Survey of different water bodies of Punjab, Sindh and AJK was conducted to identify various habitats of Seengharee. It was found that this fish can be collected from Head Baloki and Head Rasool in Punjab, Sajawal in Sindh and Mangala Dam in AJK. Collection of fingerlings and adults of Seengharee from above mentioned areas were tried with the help of drag nets, gillnets and cast nets. Dragnets and gillnets were successful for the collection of fish; however, it was found that Seengharee can not be collected with cast net. Physico-chemical parameters of water were also examined at the collection site.

Growth performance of Seengharee in cemented raceways and ponds were studied. Survival and growth of Seengharee was better in earthen ponds as compare with cemented raceways. The mortality observed in earthen ponds was 40% whereas in cemented raceways it was 50%. Monthly average weight gain was 15.5g in ponds and 6.45g in cemented raceways.

During the acclimatization and experimentation it was observed that the number of live fish in cemented raceways was decreasing with out any mortality. It was concluded from the experiments that this decrease in number of fish was due to cannibalism behavior of this species. This behavior was first time studied in this species. This problem was successfully overcome by grading and sorting fish according to different sizes. Water quality parameters were within normal range.

In another experiment growth performance of Seengharee fed on diets containing different ratio of animal and plant proteins were determined. This experiment was conducted in circular fiberglass tanks. Three diets having different ratios of animal and plants proteins were fed to the fish. The Diet (F₃) containing 10% fish meal and 20% soybean meal showed better results

followed by Diet (F₁) with 30% fish meal and 10% soybean meal and least by Diet (F₂) with 20% fish meal and 20% soybean meal. Weight gain by fish fed on F₃ was 22.5g followed by 16.0 by F₁ and 14.0g by F₂. Water quality parameters were within normal range.

During study seasonal reproductive cycle of Seengharee, breeding habits were recorded for first time. Species breeds in months of April-May, they build nests amongst rocks in beds of river. The nests are circular pits in sand and slit behind and projecting slides of rocks. For determination of major sex hormones, blood samples of both male and female fish were collected on bimonthly basis and the concentration of major hormones (Estradiol, progesterone and testosterone) were determined.

Two papers are in process to be published. A student of Department of Zoology of PMAS Arid Agri. University, Rawalpindi completed M. Phil dissertation. Another student (PI) is doing Ph. D under the project.

Name of Project: Identification of Molecular Markers for Fecundity in Goat Breeds of Pakistan

Name of PI/Institute: Dr. Masroor Ellahi Babar,
Professor,
Department of Livestock Production, University of Veterinary
and Animal Sciences, Lahore

Duration: 24. 07. 2008 to 30. 06. 2011

Financial Status: Total Cost: Rs.7.080 million
Funds Released: Rs.6083800/-
Funds Utilized: Rs.6085108/-

Objectives:

- To find Single Nucleotide Polymorphisms (SNPs) in BMPRIB gene.
- To test the SNPs in BMPRIB gene as markers for fecundity in local goat breeds.
- Screening of goat populations available at Govt. livestock farms to identify more prolific animals.

Achievements:

The project aim was identification of molecular markers for fecundity in goat breeds and screening of goat population available at Govt. livestock farms to identify more prolific animals. Blood samples were collected from selected animals and then DNA was extracted. For fecundity in goat breeds, three different types of genes were studied: (BMPRIB (Bone morphogenetic protein receptor type-1B), BMP15 (genes bone morphogenetic protein 15) and GDF9 (Growth differentiation factor 9). For these three genes, primers were designed, synthesized, optimized, amplified and sequenced in goat breeds as well as sheep breeds. The sequencing results of BMPRIB gene were analyzed and SNPs were found at 1840, 1797 and 1798 changing nucleotide from Kamori and Lehri goat breeds with confirmed twinning or triplet history. These SNPs were not found in the animals of Beetal, Teddy, Barbari, Kamori and Lehri goat breeds with confirmed single history, while no SNP was found in sheep breeds in BMPRIB gene.

The booroola phenotype is associated with a mutation BMP15 gene located in the X chromosome which encodes protein expressed exclusively in oocyte of the developing follicle which plays an essential role in mammalian fertility. Codon modifications of BMP15 gene in teddy and beetal goat presented one synonymous and three non synonymous substitutions were observed. Non synonymous substitutions were Glycine>Serine at codon 301, Tyrocine>Histidine at codon 331 and Asparagine>Serine at codon 347. A synonymous substitution at position 6280 (codon #276) was also identified. Thirty polymorphisms were

detected in teddy and beetal goat breeds which were observed common among these two goat breeds. Out of thirty polymorphisms, seven were transversions; the remaining twenty three transition polymorphisms in the intronic region of the BMP15 gene. A total of sixty six (66) polymorphisms were detected in Balochi and lohi sheep breeds which were observed common among the two breeds. Out of sixty six polymorphisms, thirteen were transversions; the remaining fifty three were transitions polymorphisms in the intronic region of the BMP15 gene. Sequencing data analysis revealed that in Balochi sheep an insertion of three nucleotides CTT at nucleotide position 171, 172, 173 and a deletion of three nucleotides TGA at nucleotides position 3477, 3478, and 3479 of BMP15 gene was present.

Another important GDF9 gene expressed in oocytes, and is thought to be required for ovarian folliculogenesis was selected for studying its role in the fecundity in sheep and goat breeds. After analyzing the sequencing results for the GDF9 gene, single nucleotide polymorphisms showed nine C↔T, nine G↔A, nine A↔G and four T↔C transitions and one G↔C, on A↔C, four T↔C, on G↔T, one C↔G and one C↔A transversions.

The ratio of transition to transversion was 3:1. Polymorphism at position 1893 and 1978 were exon1 and SNPs at positions 3381, 3625, 3810, 3872, 4071 and 4146 were found in exon2 of GDF9 gene. Where at position P1893, Transition of T to C caused no change in amino acid it remained Threonine, at position P3381, Transition of G to A caused no change in amino acid (Leusine) and transition of C to T at position P3872 also caused no change in amino acid so these all SNPs was found to be silent. At position Gly1978Glu Transition of G to A caused change of amino acid from Glycine to Glutamic acid and transition of C to T at position Arg4071Trp changed amino acid Arginine to Tryptophan. SNP found at position Arg3810Cys resulted in change of Arginine into Cysteine and Glycine changed into Arginine by SNP at position Gln4146Arg. BMP15, BMP15 and GDF9 genes can be used as marker for future selection high proliferating goat as well as sheep animals.

As a result, three mutations found in the 5UTR of BMP15 gene in the animals of Beetal, Teddy, Barbari, Kamori and Lehri goat breeds with confirmed twinning or triplet history while no mutation was found in the animals of these goat breeds with confirmed single history. Two important genes having significant role in the fecundity BMP15 and GDF9 genes showed some significant polymorphisms. A very unique insertion of three nucleotides first time in the world an insertion was found in GDP gene in Balochi sheep. BMP15, BMP15 and GDF9 genes can be used as marker for future selection of high proliferating animals at the earlier age.

Three paper have been submitted for approval and publishing. Four sequence of BMP15 gene (Teddy & Beetal goat and Lohi and Balochi sheep breeds) submitted to the NCBI Genebank data base libraries with accessions numbers JN655669, 655670 and 655671 & 655672b respectively. Two students are conducting their Ph. D under the project.

Name of Project: Phenotypic and Genetic Characterization of Indigenous Breeds of Caprine and Ovine Species in Punjab

Name of PI/Institute: Dr. Khalid Javed,
Associate Professor,
Department of Livestock Production, University of Veterinary and Animal Sciences, Lahore

Duration: 28. 07. 2008 to 30. 06. 2011

Financial Status: Total Cost: Rs.5.061 million
Funds Released: Rs.4404200/-
Funds Utilized: Rs.3716964/-

Objectives:

- Phenotypic characterization of the goat and sheep breeds of the Punjab province.
- Genetic characterization of the goat and sheep breeds of the Punjab province.
- Estimate genetic and phenotypic correlation between various productive traits.
- Phylo-genetic relationships among different breeds and development of breed specific molecular genetic markers for identification of different breeds from various populations in different areas in the Punjab province.

Achievements:

Various phenotypic characters and body measurement (body colour, body weight, body measurements characteristics of various body points etc) on flocks of sheep (Kali and Buchi) maintained at Livestock Experiment Station, Khizarabad, district Sargodha and Livestock Experiment Station, Jugaitper, district Bhawalpur have been collected. Measurements of 1200 Kajli sheep and 470 Buchi sheep have been recorded. Also the performance data on sheep and goat flocks maintained at these government livestock farms have been collected for phenotypic characterization. These data has been punched into computer. Analysis of the pool data will be performed for inferring some meaningful results.

For the Genetic Characterization, blood samples of different sheep and goat breeds maintained at different Livestock Farms and private owners were collected. The proper recording of animal ID, breeds, age, sex and location was maintained during blood sampling. 10 ml blood was collected aseptically from Jugular vein in EDTA added falcon tubes and stored in ice before it was brought to Molecular Biology and Genomics Lab in University of Veterinary and Animal Sciences, Lahore. The samples were stored temporarily in -20⁰C freezer before DNA extraction. DNA was extracted using inorganic method. The quantification of all DNA samples was done using gel electrophoresis. All the samples were brought at same concentration of 50 mg/uL by adjusting volumes of working DNA.

Micro satellites are class of marker that has become the preferred technique for population genetic studies. They are useful markers for a variety of purposes as genome mapping, parentage determination, disease research and genetic diversity/variation. So they are highly effective in evaluation differences within a breed and determining population substructure.

For Characterization of breeds the five microsatellite marker (Forward primers were fluorescently labeled at 5' end which enabled to detect and analyze the final PCR product in genotyping) were selected from the International Society for Animal Genetics (ISAG)/FAO recommended lists of microsatellite markers to examine the genetic differentiation and relationship within and between the sheep and goat breeds.

A set of five micro satellites were initially selected and synthesized from Gene Link USA (www.genelink.com). The Forward primers were labeled with recommended Fluorescent Dyes.

All the Micro satellites were optimized for amplification by Polymerase Chain reaction by using Thermal Cycler (BioRad). PCR reactions was carried out in a total volume of 25 µl Touchdown PCR temperature profile used for amplification, including initial denaturation at 94° C for 5 min followed by 10 cycles of denaturation at 94° C for 30 sec, annealing at 65° C-55° C (decrease in temperature was set 1° C/cycle) for 45 sec and extension at 72° C for 45 sec. Following these 10 cycles with annealing temperatures, 25 cycles with constant annealing temperature of 54° C were performed and reaction was ended with a step of final extension at 72° C for 10 min.

The quality of PCR product was checked. The markers will be applied on DNA samples of selected sheep and goat breeds. The dye labeled Microsatellites be amplified and will be genotyped using ABI genetic Analyzer. The data will be processed using the software PopGene 2.1 for construction of their genetic dendogram and identifying values of genetic diversity analysis.

Interpretation of these results will be done after the complete analysis and will be reported in final report.

Name of Project: **Production of Genetically Superior Breeding Bulls of Kundhi Buffalo Breed in Sindh Province**

Name of PI/Institute: **Mr. Mashooq Ali Bhutto,**
President,
Livestock Development Foundation, Shahzad Town, Islamabad.

Duration: 27. 01. 2010 to 26. 01. 2013

Financial Status: Total Cost: Rs.9.414 million
Funds Released: Rs.391200/-
Funds Utilized: Rs.390800/-

Objectives:

- To bring potential farmers in agreement with Livestock Development Foundation (LDF) as Stakeholder of this project.
- To select male calves on proper laid down criteria and Genomic tests.
- To provide animal health coverage to Bull mothers for two lactations and all male calves up to 28-30 months of age.
- To observe periodic culling of calves after first and second Genomic tests.
- Compensate the farmers with feed/fodder in addition to Animal Health coverage.
- To improve the production potential of Kundi Buffalo breed in Sindh Province.

Achievements:

One hundred and eighty six (186) kundi buffalo farmers have been registered after identification in the project area of district Tando Allahyar. Initially 203 male calves were registered by these farmers. The calves were selected after first and second culling in May and December, 2010 on the basis of phenotypic characters. By June 2011, 94 buffalo calves reaching the age of 15-19 months were present with 54 farmers of 12 villages of district Tando Allahyar. Animal health coverage i.e. vaccination with HSv- (NIAB), vaccination with BQV- (VRI-Lahore), deworming with Vermont drench and application of paraciticide/acaricide with ECTOFON provided to the selected. Data on body growth, body length and height at withers regularly collected. Completed two phases of DNA tagging and registered calves blood testing for genomic studies entered in Primer Optimization, synthesis for Mitochondrial D-loop and cytochrom-b gene. The mature healthy and genetically tested superior bulls to be sold through advertisement to other farmers through an agreement for not selling and slaughters, will improve the productive potential of kundi buffalo breeds in Sindh.

One orientation seminars was held in April, 2010 on animal health and production in kundi buffaloes. Two farmers training were held in October, 2010 and May, 2011 attended by 60 farmers. One Ph. D student of UV&AS and one M. Sc (Hons) student of Sindh Agriculture University, Tandojam will complete their degree training program in this project.

Name of Project: Angora Rabbit Farming as High Value Livelihood Source for Pakistani Women

Name of PI/Institute: Dr. Muhammad Afzal
SSO,
LRS, ASI, PARC, Islamabad

Duration: 18. 01. 2010 to 17. 01. 2013

Financial Status: Total Cost: Rs.4.568 million
Funds Released: Rs.1993900/-
Funds Utilized: Rs.1338000/-

Objectives:

- To study the performance of Angora rabbit under Pakistan conditions.
- Develop Angora rabbit farming as high value livelihood source particularly for women in Pakistan

Achievements:

Prepared and fed formulated feed to the rabbits having composition; maize: 25%, soybean meal: 20-25%, wheat bran: 50%, molasses: 3%, DCP: 0.5%, salt: 0.5%, premix: 0.25% and milk powder: 0.5%. Beside the formulated feed various vegetables and leaves were also given to the rabbits. The leaves include maize leaves, water hyacinth leaves, mulberry leaves, barley leaves and grass leaves. Rabbit showed comparatively lesser fondness to eat barley leaves as compare to other leaves.

In intense light and noise doe may killing its own babies. Therefore, special care was given to the doe and the babies. They were kept in dark and noiseless Rabbitry. Food was being served at proper intervals. After 12 days of birth, doe along with the babies were shifted to the normal wired cages.

Following medicines were used to the rabbits to avoid suffering from serious diseases:

- Clotrimazole & Travogen cream for fungal infection
- Flemesyvia Powder for bacterial infection
- Iodine Tuncture for external use for injuries
- Amino Plus liquid for mineral deficiency
- Zenetal for internal parasites
- Dectomex injection for mange

A survey was made in Punjab and Khyber Pakhtunkhwa for the distribution of Angora rabbits in the field. Visit was made to Arukas, Guldana villages of Tehsil Muree, Dist.

Rawalpindi and selected Guldana area for distribution of rabbit in Punjab. Similarly, visit was made to district Haripur and Malakand in Khyber Pakhtunkhwa and selected site for distribution. Total 11 Angora rabbits (8 female and one male) were distributed at Guldana village. The farmers were given advice for proper maintenance of rabbits.

Daily routine for cleaning hutches, feeders and water pots continued. Use of phenyl etc. after cleaning, hutches dried as dampness can result in many diseases.

Rabbits were shampooed after few days. Rabbits were also combed on alternate days to keep the wool neat and protect its silky and soft texture. Wool sheared when it was approximately 5-6 inches long. Angora wool threads were also made.

Three different colored Angora rabbit have been produced; viz Jet Black, Brown and Gray.

Name of Project: Evaluation of Commercial Potential of Sugar Beet Genotypes for their Adaptability in Different Ecologies of Pakistan (Coordinating Unit NARC, Islamabad, Component)

**Name of PI/
Institute:** Dr. Muhammad Zubair,
Coordinator (Sugar Crops),
Sugar Crops Research Program, CSI, NARC, Islamabad.

Duration: 01. 07. 2008 to 30. 06. 2011

Financial Status: Total Cost: Rs.0.924 million
Funds Released: Rs.513300/-
Funds Utilized: Rs.367453/-

Objective:

- Testing of adaptability of different sugar beet genotypes and their agronomic management in NWFP, Punjab and Sindh.
- Studies on pest and disease management practices in sugar beet.
- Increase water-use efficiency through intercropping of sugarcane crop with sugar beet.
- Study salt-tolerance in sugar beet genotypes.

Achievements:

The coordinated research project on sugar beet constitutes three components (sub projects) i.e. NARC, Islamabad; Al-Moiz Sugar Mills, D. I. Khan and NSCRI, Thatta. Meeting of the all PIs arranged and reviewed the progress and plan next year's activities/experiments.. Seed of sugar beet hybrid varieties was arranged from two seed companies (Strube Sat, Germany and KWS, Germany). Sugar beet variety adaptability trials were conducted at Jhang, Leiah, Gujranwala, Muzaffargarh, Sahiwal, Toba Tek Singh areas of Punjab and NARC, Islamabad during the years 2008-09 to 2010-11. The trials comprised of SD-PAK04/06, SD-12970, SD-PAK09/07, SD-PAK03/06, SD-PAK01/07, SD-PAK07/07, Mira Bella, California, Magnolia, Ernestina, Sandrina, SD-PAK110, SD-PAK210 and SD-PAK310 sugar beet varieties.

Eleven (11) varieties (Califloria, Sandrina, Ernestina, Magnolia, Mirbella, SD 03/06, SD 04/06, SD 01/07, SD 07/07, SD 09/07 and SD12/09) were planted for screening at 4 locations in D. I. Khan region. The consolidated yield data for three years (2008-11), confirm the superiority of varieties SD 03/06, SD 09/07, Sandrina and Ernestina in beet root and sugar yield, however, California is known to be the best for stress conditions. Research studies on other aspects like method of planting of sugar beet, ascertaining method of planting and plant population in sugar beet, ascertaining optimum time of planting and harvesting sugar beet, selection of herbicides for control of weeds in sugar beet, intercropping, post harvest stalling

losses and effect of some Micronutrients on yield and recovery of sugar beet were also conducted.

During 2010-11, eleven exotic sugarbeet varieties were tested under different trials i.e. variety, salinity, brackish water and intercropping trials on three locations. The sugarbeet varieties under trials were California, Ernestina, Magnolia, Mirabella, Sadrina, SD-12970, SD PAK 03/06, SD PAK01/07, SD PAK07/07, SD PAK09/07 and SD-PAK04/06 and tested on locations of NSCRI, PARC Experimental Farm, Thatta, Mirpur Sakro, district Thatta and Tando Jam, district Hyderabad. Overall, the performance of all sugar beet varieties was better and satisfactory in all locations. Varieties SD PAK09/07 (62.53 t/ha), California (57.77 t/ha), Sandrina (55.00 t/ha), Magnolia (54.89 t/ha) and SD 12970 (53.99 t/ha) were best with respect to beet yield. For sugar recovery, SD PAK 09/07 (14.83%), SD PAK 04/06 (13.99%), SD PAK 07/07 (13.51%), Mirabella (13.47%) and Magnolia (13.44%) were best while for sugar yield SD PAK 09/07 (8.12 t/ha), Magnolia (7.39 t/ha), Sandrina (7.25 t/ha), California (6.99 t/ha) and SD PAK 04/06 (6.70 t/ha) were best. Further Thatta and Tandojam were observed better locations for sugar beet cultivation. Overall results of three years experiments revealed that sugarbeet could be grown as a supplement sugar crop in normal and saline soils of lower Sindh. The farming community could have additional benefit for their income generation by cultivating this crop if the growers are provided with easy approach for seed availability in compass with better marketing system. This could be done through installing sugar beet processing plant at the Sugar Mills, which could increase the crushing period up to May.

The final completion report of the coordinating unit has not yet been provided.

Name of Project: Evaluation of Sugar Beet Genotypes for their Adaptability in Different Soil and Environmental Conditions of Punjab; A Component of the Coordinated Project “Evaluation of Commercial Potential of Sugar beet Genotypes for their Adaptability in Different Ecologies of Pakistan” (NARC, Islamabad, Component-I)

**Name of PI/
Institute:** Dr. Sagheer Ahmad,
Senior Scientific Officer,
Sugar Crops Research Program, CSI, NARC, Islamabad.

Duration: 01. 07. 2008 to 30. 06. 2011

Financial Status: Total Cost: Rs.2.426 million
Funds Released: Rs.3917600/-
Funds Utilized: Rs.3859166/-

Objective:

- Test adaptability of different sugar beet genotypes and their agronomic management in Punjab.
- Study salt-tolerance in sugar beet genotypes.
- Study pest and disease management in sugar beet.

Achievements:

Sugar beet variety adaptability trials were conducted at Jhang, Leiah, Gujranwala, Muzaffargarh, Sahiwal, Toba Tek Singh areas of Punjab and NARC, Islamabad during the years 2008-09 to 2010-11. The trials comprised of SD-PAK04/06, SD-12970, SD-PAK09/07, SD-PAK03/06, SD-PAK01/07, SD-PAK07/07, Mira Bella, California, Magnolia, Ernestina, Sandrina, SD-PAK110, SD-PAK210 and SD-PAK310 sugar beet varieties.

Over three years of variety adaptability trials conducted at eight locations, four sugar beet varieties were found better for beet yield and four for sugar yield. The best locations for sugar beet and sugar yields were found as Sahiwal, Jhang, Toba Tek Singh and Leiah districts of Punjab Province.

Problems of insect pests and disease infestation were identified in sugar beet varieties planted at different locations of Jhang, Kot Adu, and Kror. Laboratory investigations were conducted on 11 sugar beet varieties for resistance against southern *sclerotium* rot (beet root rot) caused by *Sclerotium (Athelia) rolfsii*.

Intercropping trials of sugar beet in sugarcane were also conducted. However, this aspect needs further investigations as the yield of sugarcane reduced greatly in these experiments.

Evaluated salt tolerance in 12 sugar beet varieties. At higher salinity levels germination reduced significantly. This aspect also needs further long term and elaborative investigations.

The work conducted under the project leads to the conclusions that:

- Sugar beet varieties SD-PAK03/06 (74.7 t ha⁻¹), SD-PAK01/07 (72.4 t ha⁻¹), SD-PAK09/07 (69.6 t ha⁻¹) and SD-12970 (68.8 t ha⁻¹) performed best for beet yield. The varieties SD-PAK03/06 (9.28 t ha⁻¹), SD-PAK01/07 (8.77 t ha⁻¹), SD-PAK09/07 (8.29 t ha⁻¹), SD-PAK07/07 (8.18 t ha⁻¹) and SD-12970 (8.08 t ha⁻¹) performed better for sugar yield and could be suggested for general cultivation.
- Sahiwal, Jhang, Toba Tek Singh and Leiah districts of Punjab province have been found the best locations for sugar beet cultivation.
- Sugar beet varieties SD-PAK04/06, SD-12970, Magnolia and Ernestina were highly resistant while SD-PAK09/07, SD-PAK03/06, SD-PAK01/07, SD-PAK07/07 and California were resistant to *Cercospora* Leaf spot disease. While studying resistance against southern *sclerotium* rot (beet root rot), only the variety SD-PAK09/07 was resistant where as SD-PAK07/07 was moderately resistant against this disease. Other varieties were susceptible to root rot.
- Sugar beet-sugarcane intercropping trials provoked that October planted sugar beet with sugarcane remained the best with respect to total yield (145.2 t ha⁻¹) and net income to the farmers (Rs.244,000 ha⁻¹). However, this aspect needs further investigations as the yield of sugarcane reduced greatly in the studies.
- Different sugar beet varieties have varying degree of salt tolerance. It was found that varieties SD-PAK0310 and SD-PAK-0110 performed better and germinated up to NaCl salinity of 30 dS m⁻¹ in solution culture. These two varieties and SD-PAK09/07 grew best up to salinity level of 12 dS m⁻¹ in soil and/or irrigation water. This aspect also needs further long term and elaborative investigations.

Two papers were presented in the 44th and 45th Annual Convention of Pakistan Society of Sugar Technologists as a result of project work. A brochure on sugar beet “Sugar Beet Manual” has also been prepared.

Name of Project: Testing of Adaptability of Different Sugar Beet Genotypes and their Agronomic Management in KPK; A Component of the Coordinated Project “Evaluation of Commercial Potential of Sugar beet Genotypes for their Adaptability in Different Ecologies of Pakistan” (Al-Moiz Industries, D. I. Khan-Component-II)

Name of PI/Institute: Mr. Karim Bakhsh Malik,
Advisor R & D,
Al-Moiz Industries, Chashma Road, D. I. Khan

Duration: 01. 07. 2008 to 30. 06. 2011

Financial Status: Total Cost: Rs.2.962 million
Funds Released: Rs.2284700/-
Funds Utilized: Rs.1810666/-

Objective:

- To evaluate different sugar beet varieties for their yield and quality performance and studies on various agronomic aspects to solve various beet production problems in the region

Achievements:-

Screening of sugar beet varieties adaptable in D. I. Khan region: Eleven (11) varieties (California, Sandrina, Ernestina, Magnolia, Mirbella, SD 03/06, SD 04/06, SD 01/07, SD 07/07, SD 09/07 and SD12/09) were planted in October, 2011 at 4 locations in D. I. Khan region. The data on economic characters was recorded at harvesting during April/May, 2011 and analyzed. The consolidated yield data for three years (2008-11), confirm the superiority of varieties SD 03/06, SD 09/07, Sandrina and Ernestina in beet root and sugar yield, however, California is known to be the best for stress conditions.

Method of planting: The single row and dual row planting at 45 and 75 cm row spaces were compared for top seeding, side planting and flat planting. Beet root yield data show significant differences in the means of different treatments. Single row top seeding at 45 cm has given the highest beet root yield (94.22 t ha⁻¹), than single row and dual row planting at 75 cm row distance (85.32 and 76.26 t ha⁻¹). Top seeding at 75 cm gave the highest sugar recovery of 12.43%, followed by 45cm row distance. Dual row planting at 75cm gave the lowest sugar recovery of 10.53%. These data confirm the findings of 2008-11 periods.

Ascertaining method of planting and plant population in sugar beet: Comparison of single row and dual row planting at 75 cm row distance, show that single row top seeding gave higher yield and recovery than dual row planting. Plant densities show non significant differences in means which is due to beet root weight reduction in higher plant densities. Plant densities of 75,000 to 100,000 ha⁻¹ show the same yield trends. Similar trends were observed

in the means of 2008-11 data. Single row with 75,000 and 87,000 plants confirm higher sugar yields.

Ascertaining optimum time of planting and harvesting sugar beet: Five planting dates (1 Oct, 15 Oct, 1 Nov, 15 Nov and 1 Dec.) and five harvesting dates (1 April, 15 April, 1 May, 15 May and 1 June), were compared in split plot design. The October planting with harvesting May gave significantly higher yield and recoveries than rest of the treatment periods. Data show drastic reduction in beet root yield (22 to 42%) by planting beet in Nov. and Dec. The April harvest show considerable reduction in sugar recoveries and sugar yields. The average data for 2008-11 show similar trends in yield and recoveries.

Selection of herbicides for control of weeds in sugar beet: Effect of various pre- and post emergence herbicides were studied in comparison with manual weeding to control weeds in sugar beet field. Manual weeding gave most effective control of weeds with significant increase in yield. The pre-emergence weedicides including Dual Gold and Top 330 were equally good to give initial six weeks control of weeds. Later emergence of weeds reduced yield by 32-35%. Check plot gave a yield reduction of 66.5%. At present there is no effective post emergence herbicide for control of dicot weeds; however monocot weeds can be control.

Intercropping: Sugarcane was planted as intercrop in sugar beet along with sugar beet-Mung rotation. Beet planted alone gave significantly higher yield of beet roots. Intercropping had depressing effect on the yield of beet roots and sugar recovery. Beet planted alone gave higher sugar recoveries with significant differences in means. Beet + cane intercropping pose problems in harvesting and is very labor intensive in mechanized harvesting.

Post harvest stalling losses: Sugar beet roots were stored for 5 days after harvest on 1 April, 15 April, 1 May, 15 May and 30 May. Starting from an average beet weight loss of 5.47% after 24 hours of harvesting, it gradually increased to 10.31%, 15.97% and 19.50% after 48 hrs, 72 hrs and 96 hrs of harvesting, respectively, for uncovered beet roots lots. For the beet roots kept under leaves cover, weight loss was reduced by almost 50%. The sugar recovery losses were noticed to the tune of 0.97%, 2.12%, 5.71% and 8.56% for the corresponding period of post harvest days. The losses are low in mild weather and high in late harvest or extreme weather. Such huge losses in yield and recovery call for the necessity to slice beet roots within 24hrs of harvesting. Similar trends in post harvest losses have been observed during 2008-09 to 2009-10 periods.

Effect of some Micronutrients on yield and recovery of sugar beet: Some micronutrients including Zinc, Boron, chellated potash and some humic acid compound like Foundation and Magnet were tried alone and in combination. All the treatments showed some improvement in yield, but means were not significantly different from one another.

Following conclusion has been drawn from the research studies conducted under the project:

- Amongst various field crops, sugar beet proved to be the most remunerative crop during winter season in D. I. Khan region. Consequently, the crop has been commercially adapted by growing in D. I. Khan region.
- The sugar beet varieties tested from KWS and Strube SAAT seed groups, SD 09/07, SD 03/06, Sandrina and Ernestina varieties have appeared to be superior in sugar recoveries and sugar yield per unit area. The results obtained helped the organization to import seed of the varieties giving higher sugar yields.
- Single row planting at the top of the ridge at 45 cm row distance gave significantly higher beet root yield and sugar recovery than dual row planting at 75 cm row space.
- The month of Oct. is the ideal time of planting while the month of May is suitable for harvesting to fetch good yield and recovery of sugar beet.
- To avoid severe post harvest staling losses in beet root weight and sugar recovery, crop must be processed in the factory within 24 hours of harvesting.
- Pre-emergence spray of Dual Gold give effective weed control at initial stage of growth. This must be followed by two manual hoeings to get good yield.
- Harvesting beet crop in dry soil state gave 2 degree higher sugar recovery (12-13%) than harvesting from moist soil (10-10.5%).

Name of Project: Introduction of Sugarbeet as a Sugar Crop in Lower Sindh; A Component of the Coordinated Project “Evaluation of Commercial Potential of Sugarbeet Genotypes for their Adaptability in Different Ecologies of Pakistan” (NSCRI, Thatta, Component-III)

Name of PI/Institute: Mr. Ghulam Moheyuddin Kaloi,
Scientific Officer,
National Sugar Crops Research Institute- PARC, Makli, Thatta

Duration: 01. 07. 2008 to 30. 06. 2011

Financial Status: Total Cost: Rs.2.454 million
Funds Released: Rs.2298800/-
Funds Utilized: Rs.2289664/-

Objective:

- Introduction of sugar beet on farmer’s field as a major sugar crop.
- Testing for adaptability of different sugar beet genotypes and its agronomic management
- Increase per acre sugar yield through intercropping of sugar beet with sugarcane.

Achievements:

During 2010-11, eleven exotic sugarbeet varieties were tested under different trials i.e. variety, salinity, brackish water and intercropping trials on three locations. The sugarbeet varieties under trials were California, Ernestina, Magnolia, Mirabella, Sadrina, SD-12970, SD PAK 03/06, SD PAK01/07, SD PAK07/07, SD PAK09/07 and SD-PAK04/06 and tested on locations of NSCRI, PARC Experimental Farm, Thatta, Mirpur Sakro, district Thatta and Tando Jam, district Hyderabad. Overall, the performance of all sugarbeet varieties was better and satisfactory in all locations.

Varieties SD PAK09/07 (62.53 t/ha), California (57.77 t/ha), Sandrina (55.00 t/ha), Magnolia (54.89 t/ha) and SD 12970 (53.99 t/ha) were best with respect to beet yield. For sugar recovery, SD PAK 09/07 (14.83%), SD PAK 04/06 (13.99%), SD PAK 07/07 (13.51%), Mirabella (13.47%) and Magnolia (13.44%) were best while for sugar yield SD PAK 09/07 (8.12 t/ha), Magnolia (7.39 t/ha), Sandrina (7.25 t/ha), California (6.99 t/ha) and SD PAK 04/06 (6.70 t/ha) were best. Further Thatta and Tandojam were observed better locations for sugarbeet cultivation.

Sugarcane-sugarbeet intercropping in autumn planting season (cane and beet planted in October) on wider row space (1.25 m) was found best with total cane beet yields of 137.70 t/ha. A net income of Rs.222,533/ha could be earned. However, this aspect needs further study; because yield decrease was observed in sugarcane.

Brackish water trials (drain and underground water) were conducted during 2009-11. The outcomes are summarized:

The results obtained under drain water revealed that maximum beet yield (70.60 t/ha) was obtained under 2-4 applications (2 canal and 4 drain water) and minimum (46.72 t/ha) was obtained under 0-6 applications. While, for sugar recovery, maximum (14.75%) obtained under 6-0 applications and minimum recovery (12.12%) obtained under 6-0 applications.

The results obtained for underground water study revealed that among varieties, maximum beet yield (59.33 t/ha) for SD PAK 09/07 was obtained 3-4 applications (3 canal and 4 underground) and minimum (40.66 t/ha) for SD PAK 01/07 obtained under 2-5 applications. While, for sugar recovery, maximum (16.61%) for SD PAK 07/07 was obtained under 4-3 applications and minimum (9.44%) for SD PAK 01/07 obtained under 2-5 applications. Moreover, these studies need further investigations as long term use of brackish water might cause a negative impact on soil properties.

Salinity trials (field and pot) were conducted at NSCRI, Thatta and SAU, Tandojam during 2009-11. The outcomes are summarized:

Field study revealed that among varieties, maximum beet yield (82.00 t/ha) for SD PAK 09/07 was obtained under EC 12 dS/m and minimum (30.08 t/ha) for Sandrina obtained under EC 16 dS/m. While, maximum sugar recovery (14.45%) for SD PAK 09/07 was obtained under EC 8 dS/m and minimum (5.74%) for SD PAK 01/07 was obtained under EC 16 dS/m.

Pot study revealed that among varieties, maximum beet weight (285.66g) for SD PAK 09/07 was obtained under EC 8 dS/m and minimum (76.33g) for Mirabella was obtained under EC 16 dS/m. With respect to sugar recovery, maximum (11.49%) for SD PAK 09/07 was under EC 8 dS/m and minimum (3.55%) for Mirabella was obtained under EC 8 dS/m.

Infestation rate of insect pest on sugarbeet was observed more in areas of Thatta as compared to Badin, Matyari and Hyderabad. This might be due favorable climatic conditions as well the host crop cultivation like vegetables and barseem on large scale in Thatta district. Root rot (*Sclerotium Rolfsii*) disease was observed on some varieties during late periods (May and June).

It has been concluded for the research studies and experiment conducted:

The agro-climatic conditions in Thatta, Badin, Hyderabad and Matyari districts of lower Sindh are conducive for sugarbeet cultivation.

Sugarbeet varieties like SD PAK 09/07, California, Magnolia, SD-12970 and Sandrina were best with respect to beet yield, SD PAK 09/07, SD PAK 07/07, California, Magnolia and Antek were best varieties with regard to recovery and sugar yield. These varieties could be recommended for general cultivation.

Sugarcane-sugarbeet intercropping in autumn planting season (cane and beet planted in October) on wider row spaces (1.25 m) was found best. A net income of Rs.222, 5333/ha could be earned. However, this aspect needs further study to bring out solidified results.

Most of the sugarbeet varieties performed well up to EC level of 8 dS/m, however, the salt resistant varieties can withstand well up to EC level of 12 dS/m. Therefore, soils having EC of 12 dS/m could be bring under beet cultivation by growing salt resistant varieties like SD PAK 09/07.

Overall results of three years experiments revealed that sugarbeet could be grown as a supplement sugar crop in normal and saline soils of lower Sindh. The farming community could have additional benefit for their income generation by cultivating this crop if the growers are provided with easy approach for seed availability in compass with better marketing system. This could be done through installing sugarbeet processing plant at the Sugar Mills, which could increase the crushing period up to May.

Name of Project: Evaluation of Sugarcane Gemrplasm for Frost Tolerance; A Component of the Coordinated Project “Screening of Sugarcane Germplasm and use of Induced Mutation/Callus Culture for Frost Tolerance, High Cane and Sugar Yield” (NARC, Islamabad, Component-I)

**Name of PI/
Institute:** Dr. Muhammad Zubair,
Coordinator, Sugar Crops
Sugar Crops Research Program, CSI, NARC, Islamabad.

Duration: 01. 07. 2008 to 30. 06. 2011

Financial Status: Total Cost: Rs.3.528 million
Funds Released: Rs.3026365/-
Funds Utilized: Rs.2042473/-

Objective:

- Identify the nature, extent and severity of frost damage to commercial cane varieties.
- Screening of sugarcane germplasm for frost tolerance under natural conditions.

Achievements:

After the plan and objectives of the project being converted to planting of elite sugarcane varieties at progressive farmers’ twenty acres of elite sugarcane varieties (HSF-240, NSG-59, CPF-246 and HSF-243 were planted at farmers fields of Jhang, and sargodha districts. Sowing was done on well prepared lands. Row to row distance was kept 3 feet while seed rate was 100 mounds/acre. At the time of sowing fertilizer; SSP @ 4 bags/acre, SOP @ 1 bag/acre and CAN @ 1 bag/acre were applied. Carbofuran @ 8 kg/ac was applied for the control of root borer at sowing time, irrigation was applied immediately. All other practices were kept standard. Amitrine + Etrazine were sprayed for the control of weeds during October 2010 in all plots. Data on all parameter i.e. germination, tillering, growth, insect and pest attack, purity, pol, recovery and CCS recorded with regular intervals. Sugarcane seed of high quality and approved sugarcane varieties will be available to the farmers in their near localities during next season.

The final technical report of the project has not been provided.

Name of Project: Screening of Sugarcane (*Saccharum officinarum*) Germplasm and Use of Induced Mutations/Callus Culture for Frost Tolerance, High Cane and Sugar Yield; A Component of the Coordinated Project “Screening of Sugarcane Germplasm and Use of Induced Mutation/Callus Culture for Frost Tolerance, High Cane and Sugar Yield (NIFA, Peshawar Component-II)

**Name of PI/
Institute:** Mr. Roshan Zamir,
Principal Scientist,
Nuclear Institute for Food & Agriculture, Peshawar

Duration: 01. 07. 2008 to 30. 06. 2011

Financial Status: Total Cost: Rs.2.853 millions
Funds Released: Rs.2661000/-
Funds Utilized: Rs.2647829/-

Objectives:

- Culture media optimization for callus, shoot and root induction
- Creation of genetic variability through induced mutation and tissue culture
- Testing of the developed sugarcane genotypes in the frost prone areas.

Achievements:

Sugarcane variety CP-77/400 was selected for creation of genetic variability for frost tolerance, early maturity with high cane and sugar yield potential. One hundred setts containing 2-3 buds/sett were exposed to 0.05, 0.1, 0.15 and 0.20 kGy gamma rays using Co⁶⁰ gamma cell source and sown in field. The germination in all the M1 population decreased with the increase in radiation dose. There was also a decrease in seedling height and cane diameter with increase in radiation dose.

Buds were collected from mother plants of *Sccharum officinarum* L. (CSSG-668, CP77/400 and Mardan-93) and cultured on to a Murashige and Skoog (MS) (1962) medium containing 30 g l⁻¹ sucrose, and solidified with 8 l⁻¹ agar. Bud explants used in these studies responded to all PGRs.

Somatic embryogenesis were induced from bud explants of cv. Mardan-92, incubated on Murashige and Skoog (MS)-medium supplemented with different plant growth regulators (PGRs) and white sugar. It was observed that lower concentration of 2, 4-D induced somatic embryos in bud explants of *Saccharum officinarum* L. cv. Mardan-92, however, higher concentration induced non embryogenic callus.

One hundred and fifty plantlets produced from explants of Mardan-93 were irradiated with 10, 20, 30, and 40 Gy gamma rays for induction of mutations and somaclonal variation against frost tolerance. The radio sensitivity (LD_{50}) for Mardan-93 was 25 Gy.

Research work for identification and selection of frost tolerant, high cane and sugar yield genotypes were carried out and fifty three (53) promising sugarcane genotypes were evaluated in the field under natural frost conditions. Out of 53 lines, 18 were less affected by frost/freeze damage. Out of 18 survived germplasm, juice quality of 12 lines was affected. While juice quality of six lines; CSSG-668, CSSG-676, CPSG-244, HOSG-1145, HOSG-104 and QSG-69 were not affected. The remaining 35 lines were completely damaged by frost/freeze injuries. This data has been recorded on the basis of one year study (2010-11). During the project year 2008-09 and 2009-10, there was no frost.

The germplasm were also evaluated for their agronomic characters. The data on stool/stock was significantly different in all the germplasm. The highest stool/stock (5.3) were observed in line HOSG-529 followed by lines CPSG-24, CPSG-2476, CPSG-375, CPSG-192 and HOSG-1607 where (5.0) stool/stock were obtained. The data on cane thickness is also significantly different from each other at 0.05 level of significance. The maximum cane thickness (28.3mm) was recorded in line CPSG-1602 followed by line SPSG-1004 with cane thickness of 27.0 mm. The highest number of nodes (19.0) was recorded in line HOSG-1607 followed by line CPSG-468 with 18.3 nodes. The highest plant height (246 cm) was recorded in line HOSG-2476 followed by line HOSG-104 with plant height of 227.6 cm.

According to chemical analysis of all the germplasm, the highest recovery of 12.18 was recorded in line CPSG-1004 followed by line HOSG-1021 with recovery of 11.67. The highest commercial cane sugar (13.61%) was recorded in line CPSG-1004 followed by line HOSG-1021 with 13.02% CCS. The highest purity of 84.89% was recorded in line CPSG-1004 followed by Line HOSG-315 with purity of 83.43%. The lowest purity of 74.90% was recorded in line CPSG-494. The data related to the fiber % shows that the highest fiber content (11.80) was in line HOSG-1257, HOSG-118 and HOSG-439 followed by line CPSG-1275 with fiber (11.50%). The highest Pol of 18.78% was recorded in line HOSG-1021 followed by line CPSG-468 with 18.36% Pol.

Name of Project: Screening of Sugarcane (*Saccharum officinarum L.*) Germplasm for Frost Tolerance, High Cane & Sugar Yield; A Component of the Coordinated Project “Screening of Sugarcane Germplasm and Use of Induced Mutation/Callus Culture for Frost Tolerance, High Cane and Sugar Yield” (SCRI, Mardan Component-III)

Name of PI/ Mr. Sartaj Ali,
Research Officer,
Institute: Sugar Crops Research Institute, Mardan.

Duration: 01 .07. 2008 to 30. 06. 2011

Financial Status: Total Cost: Rs.2.539 million
Funds Released: Rs.1764400/-
Funds Utilized: Rs.1635906/-

Objective:

- Screening of Commercial Sugarcane Varieties and Exotic Germplasm under natural frost conditions of NWFP.
- Creation of genetic variability through hybridization.

Achievements:

Fifty two (52) varieties/germplasm of sugarcane were received from various sources in October, 2008 for sowing at two locations of Peshawar valley viz; Sugar Crops Research Institute, Mardan and Sugarcane Seed Multiplication Farm, Harichand. Commercial varieties of sugarcane i.e. CP 77/400 and SPSG-394 were sown as check varieties in October, 2008.

On the basis of germination percentage, tillering, growth, resistance to insect and pest attack, recovery and resistance to frost etc., 42 varieties/germplasm have been selected during 2nd year of the project. These 42 varieties were sown in autumn, 2009 both at Sugar Crops Research Institute, Mardan and Seed Multiplication Farm, Harichand. Moreover, 10 more varieties/germplasm were received from Sugarcane Research Institute, Faisalabad and Sugar Crops Research Institute, Shakarganj, Jhang and sown at Sugar Crops Research Institute, Mardan. Data on all parameters i.e. germination, tillering, growth, Pol%, Brix%, Rec%, frost damage, yield etc. were recorded with regular intervals at both the locations and reported.

During 3rd year of the project, objectives of the project were changed to Sugarcane Seed Multiplication of approved and commercial high yielding and high sugar varieties on Sugar Mill and progressive grower’s farms. In order to increase sugarcane yield and recovery through these new varieties and also to provide fresh sugarcane seed of these new varieties to sugarcane growers during spring season, 43 acres Seed Multiplication plots of these new sugarcane varieties have been sown at various locations of Peshawar valley.

At both locations none of the variety was proved 100% tolerant to frost. However, some highly frost tolerant varieties i.e. QSG-17, CPSG-3481, HOSG-795, HOSG-449, LPSG-1550, HOSG-315, HOSG-439, HOSG-149, CSSG-2402, HOSG-1325 and high sugar varieties i.e. CSSG-668, CPSG-3481 and HOSG-1325 have been observed and will be sown for further testing and evaluation at different locations of the province. Sugarcane variety CSSG-2402 was highly susceptible to smut attack. Sugarcane seed multiplication plots sown at farmers fields will produce about 30,000 – 35,000 mounds seed of new sugarcane approved and pipeline varieties and will be available to sugarcane growers at their nearest location, which will help in solving seed shortage problem upto some extent.

Name of Project: Enhance the Cane Yield, Sucrose Contents and Frost Tolerance of Genotypes Using Callus Culture; A Component of the Coordinated Project “Screening of Sugarcane Germplasm and Use of Induced Mutation/Callus Culture for Frost Tolerance, High Cane and Sugar Yield” (SSRI, Jhang, Component-IV)

**Name of PI/
Institute:** Dr. Shahid Afghan,
Director,
Shakarganj Sugar Research Institute, Jhang

Duration: 01. 07. 2008 to 30. 06. 2011

Financial Status: Total Cost: Rs.0.785 million
Funds Released: Rs.565200/-
Funds Utilized: Rs.515204/-

Objective:

- Evolution of frost tolerant genotypes using selection-breeding techniques.
- Creation of useful genetic variability through induced mutation using callus culture for frost tolerance, high cane and sugar yield.

Achievements:

To develop the frost tolerance sugarcane clones, selected varieties (CSSG-676, CSSG-668, HOSG-529, HOSG-795 from SSRI Jhang, HSF-240, CPF-237 from Faisalabad, CP72-2086, CP-77-400 from Mardan) were cultured on callus media. After four weeks callus regeneration had been started. In addition to that about 54 promising clones at SSRI developed and included in the screening against frost tolerance were given to the collaborating institute viz: NARC, Islamabad, Nuclear Institute for Food and Agriculture, Peshawar and Sugar Crops Research Institute, Mardan. Regenerated callus was shifted to growth media for plant formation. After 4-5 weeks plant formation had been started then its multiplication was done on growth media. The stuff was shifted to rooting media for root development.

Contamination was a major problem in sugarcane tissue culture. Serious bacterial contamination problem was noticed in varieties HOSG-795, CP-77-400, CPF-237, CP-72-2086. Bacterial contamination and slow multiplication problem was also faced by HOSG-529. About four thousand plants of selected frost tolerant varieties have been developed through callus culture that was shifted in green house during Sep-Oct., 2010. Three sugarcane varieties modified through callus culture have own good promise for tolerance against post freeze deterioration. Therefore maximum plants were multiplied of the three sugarcane varieties viz; CSSG-668, CSSG-676 and HSF-240.

Name of Project: **Development of Salt Tolerance in Sugarcane through Genetic Engineering**

Name of PI/Institute: **Mr. Ikram-ul-Haq,**
Lecturer, Institute of Biotechnology and Genetic Engineering (IBGE), University of Sindh, Jamshoro.

Duration: 01. 07. 2008 to 30. 06. 2011

Financial Status: Total Cost: Rs.2.707 million
Funds Released: Rs.2582600/-
Funds Utilized: Rs.2123287/-

Objective:

- Establishment of an efficient plant regeneration system that may regenerate maximum sugarcane cultivars.
- To establish mutagenesis in the proliferating embryogenic calli through chemicals or UV treatment.

Achievements:

Direct and indirect plant regeneration protocols are established for sugarcane cultivars (Thatta-10, CP-72, CPF-237). Efficient propagation was observed (within 1½ month) when 3-4 mm immature leaf segments were cultured on MS₂ (0.1 mg L⁻¹ Kin, 0.2 mg L⁻¹ BAP) medium and incubated in dark for 6-days, then 5-weeks in light conditions (12.0 plantlets explants⁻¹). Meanwhile, for indirect plant regeneration, similar explants were cultured on MS₁ (3.0 mg L⁻¹ 2,4-D, 2.0 % sucrose) medium under dark conditions. Almost 6-weeks old well multiplying callus was cultured on MS₃ (0.4 mg L⁻¹ kin, 0.5 mg L⁻¹ BAP, 0.3 g L⁻¹ CHS, 3% sucrose) from MS₁ culture under dark condition for somatic embryogenesis. After 3-weeks, it was sub-cultured on *MS_{5b} (0.2 mg L⁻¹ kin, 0.3 mg L⁻¹ BAP, 3% glucose) medium in light conditions. Regenerated plantlets (8.0 plantlets callus⁻¹) were normal and rooted by culturing on MS₇ (0.5 mg L⁻¹ IBA) medium within 1½ weeks. Established protocols were observed to be efficient and economic for this crop.

When efficient and economic direct and indirect plant regeneration systems were established, then effects of NaCl on callus growth and plant regeneration efficiency of sugarcane (*Saccharum officinarum* L.) was assessed. Three weeks old callus of CPF-237 (salt sensitive cultivars) initiated from immature leaf tips (3-4mm) as well as proliferated on MS₂ (MS basal salts, 3.0 mg L⁻¹ 2,4-D) medium for 9 weeks, then sub-cultured on MS₂, MS_{2a} (MS₂, 25 mol m⁻³ NaCl), MS_{2b} (MS₂, 50 mol m⁻³ NaCl) and MS_{2c} (MS₂, 75 mol m⁻³ NaCl) media for 6-weeks. Callus growth was effected severely in salinity stressed cultures. Complete callus growth inhibition was observed on MS_{2c} medium. Somatic embryos were induced on MS₃ (MS, 0.5 mg L⁻¹ BAP, 0.4 mg L⁻¹ kin, 0.3 mg L⁻¹ casein hydrolysate, 3% sucrose) medium under dark condition for 2-week. While plantlets were regenerated among the somatic embryo

induced calluses on MS₄ (MS, 0.3 mg L⁻¹ BAP, 0.2 mg L⁻¹ kin, 3% glucose), not on MS_{4a} (MS₄, 25 mol m⁻³ NaCl) and MS_{4b} (MS₄, 50 mol m⁻³ NaCl) and MS_{4c} (MS₄, 75 mol m⁻³ NaCl). Meanwhile, calluses cultured on 50 mol m⁻³ NaCl stressed medium (MS_{2b}) some cells grew into cell colony. These colonies were maintained for three months on same culture. After somatic embryogenesis, plantlets were regenerated on MS_{4a} medium. These plantlets were considered as salt tolerant in comparison to its parent variety CPF-237.

Plant improvement through aseptic conventional breeding was conducted. In this experiment, mutated callus growth and plant regeneration under NaCl stressed conditions were assessed in Sugarcane (*Saccharum officinarum* L.) cultivars. Immature leaf tips of Thatta-10, CPF-237 and SPHS-19 were cultured on MS_{2n} (MS basal plant nutrient salts, 3.0 mg L⁻¹ 2,4-D, 0.5% NaN₃) for 6 days. The NaN₃ treated explants were sub-cultured on MS₂ (MS basal plant nutrient salts, 3.0 mg L⁻¹ 2,4-D), MS_{2a} (MS₂, 25 mol m⁻³ NaCl), MS_{2b} (MS₂, 50 mol m⁻³ NaCl) and MS_{2c} (MS₂, 75 mol m⁻³ NaCl). After 6-weeks, callus growth was observed significantly higher (72.34±3.70 %) in CPF-237 on control (MS₂), while lowest (57.66±4.34 %) in SPHS-19 in MS_{2d} culture. Somatic embryos were induced in proliferated calluses from MS₂ & MS_{2b} on MS₃ (MS, 0.5 mg L⁻¹ BAP, 0.4 mg L⁻¹ kin, 0.3 mg L⁻¹ casein hydrolysate, 3% sucrose) medium under dark condition for 2-weeks. These calluses were cultured on MS₄ (MS, 0.3 mg L⁻¹ BAP, 0.2 mg L⁻¹ kin, 3% glucose), MS_{4a} (MS₄, 25 mol m⁻³ NaCl), MS_{4b} (MS₄, 50 mol m⁻³ NaCl) and MS_{4c} (MS₄, 75 mol m⁻³ NaCl). Maximum (8.41±0.36) plantlets per callus were regenerated in MS₄ (control) culture of Thatta-10, while 4.93±0.05 plantlets per callus of CPF-237 in 25 mol m⁻³ NaCl stressed plant regeneration (MS_{4a}) medium. Regenerated plantlets were rooted and considered as salt tolerant in comparison to its parent cultivars.

For molecular analysis of various sugarcane plants/cultivars were collected from Punjab and Sindh provinces. The genomic DNA of each cultivar was isolated (51 cultivars of sugarcane) and freeze at 20°C for future use.

Following conclusions can be drawn from the studies/experiment conducted under the project:

- Micro-propagation established in 4 sugarcane varieties.
- The callus induction embryogenesis and than plant regeneration system have been established and optimized time and conditions for different sugarcane varieties especially for Thatta-10.
- The developed plant regeneration protocols (direct and indirect) are very efficient and economic for time, labors and nutrient medium consumptions to cope with the present day demand of the sugarcane.
- The direct plant regeneration protocol may also be useful way for developing transgenic plants by using *Agrobacterium*-mediated genetic transformation. Meanwhile, the calluses that has been developing along the micro-propagating plantlets are not regenerate-able that is not useful or performing inhibitory role for genetic transformation.
- Indirect plant regeneration system is a major way for the development of genetic modification based plant improvement.
- For salt stress tolerance in different sugarcane cultivars, salinity causes sever effects on callus proliferation as well as on plant regeneration from somatic embryogenesis.

Two papers have been accepted for publication, one in Journal of Life Science-USA and other in African Journal of Biotechnology-South Africa, while one paper is submitted to Pakistan Journal of Botany and one to Journal of Biotechnology-South Africa for acceptance. Three students of BS-Genetics (Hons)-IV were engaged in the project for doing their thesis research work.

Name of Project: Phenotypic Plasticity of Safflower (*Carthamus tinctorius* L.) in Response to Environment and Integrated Nutrient Management

**Name of PI/
Institute:** Dr. Fayyaz-ul-Hassan,
Professor,
Department of Agronomy, Pir Mehr Ali Shah Arid Agriculture
University, Rawalpindi

Duration: 01. 07. 2008 to 30. 06. 2011

Financial Status: Total Cost: Rs.1.913 million
Funds Released: Rs.1879400/-
Funds Utilized: Rs.1879400/-

Objective:

- To generate information related to the potential of safflower cultivation in Pothwar
- To document the effect of environment on quantity and quality of safflower
- To sort out the most appropriate integrated nutrient management technique for safflower under rainfed conditions.
- To impart practical training to students relevant to safflower cultivation
- To transfer the generated technology to the end users.

Achievements:

To explore the potential and identify the most promising cultivars of safflower from newly developed local and exotic cultivars under varying environmental conditions, eight cultivars (four local and four exotic) were planted at three locations (Rawalpindi, Chakwal & Talagang) for three years. At the same time a separate study was conducted on integrated nutrient management using six different treatments of NPK, FYM & Poultry Litter for safflower. However, 2010-11 was good year so crop was successful. Results from studies revealed significant differences among cultivars for different parameters. The exotic cultivar TN-79-683 out yielded rest of the cultivars in almost all the parameters, while amongst local cultivars, Thori-78 proved to be better than rest of the cultivars. Pooled data of yield and yield related parameter showed that Talagang and similar area have better potential to have successful safflower crop than other locations.

From the integrated nutrient management experiment, it become clear that neither alone application of NPK nor FYM is a good practice, rather combination of both at appropriate rate is the best option. Both the cultivars used in this study performed equally good which showed that both of them are promising cultivars for general cultivation by the farmers in Pothwar. It became evident from the interaction with farmers and survey of different areas of Pothwar that farmers are looking for some early maturing and less spiny safflower cultivars, those are high yielding in terms of seed as well as fodder. Based on results, exotic cultivar TN-79-683

has the potential to be adapted under Pothwar conditions. However, local check Thori-78 may be an alternate.

From the studies conducted, it is concluded that the farmers are looking forward for some alternate winter oilseed crops to that of Brassica as shattering of its pod causes considerable losses during harvesting. The exotic cultivar TN-79-683 proved to be stable in terms of yield and related traits. Amongst locations, crop performance at Talagang was consistent as compared to other two locations (Fatehjang and Jhelum). The combination of fertilizer along with FYM is most suitable option for long term sustainable crop production. One research publication entitled "Growth rhythms in Safflower cultivars" has been submitted to Journal of Animal and Plant Science. One Ph.D student enrolled during spring semester 2009 has started his research on safflower. One student M.Sc (Hons) has completed his research thesis on "Response of safflower to integrated nutrients management".

Name of Project: **Enhancement of Quality & Storage Stability of Dhakki Dates Using Advanced Technology**

Name of PI/Institute: **Dr. Shahzada Arshad Saleem,**
Post Harvest Technologist,
Agricultural Research Institute, D. I. Khan

Duration: 01. 07. 2007 to 30. 06. 2011

Financial Status: Total Cost: Rs.4.099 million
Funds Released: Rs.4063600/-
Funds Utilized: Rs.4014134/-

Objective:

- Characterization of various developmental stages, maturity indexing.
- Artificial ripening by various ripening stimulators.
- Probing of shelf life extension.
- Storage studies at different temperature and water activity levels.

Achievements:

Specific area was selected at the sites where most of Dhakki dates activities exists namely Dhakki, Paharpur, Rangpur & Paniyala. Survey completed and data regarding the amount of produce, area under date cultivation collected. Causes of quality deterioration were assessed to find out the extent of damage to the produce.

In order to study processing and artificial ripening techniques for Dhakki date, right/optimum maturity stage for picking of Doka and Dong of Dhakki fruit were identified. The procedure for maturity indexing was established. The fruits at different Doka stages were subjected to various stimulatory ripening treatments so as to induce and hasten curing and ripening. For the artificial ripening applied some physical means of abrading, pressing and squeezing to initiate and encourage enzymatic activity associated with curing/ripening. For the same purpose the fruits were also treated with chemicals such as sodium chloride, acetic acid, sodium/potassium hydroxide etc. The fruits were also subjected to various blanching treatments using different blanching methods like water blanching, steam blanching and microwave blanching, and making time/temperatures variation.

Dates were employed for drying so as to enhance shelf life using different drying methods viz. Solar drying, Cabinet drying and Oven drying. The product dried from different drying techniques is found to have different qualities. The dates were graded according to standard ranking (A, B, C) for quality in terms of colour, flavour, size, taste, and general acceptability. A fine quality product of Grade “A” was achieved under solar drying conditions.

Storage trials were conducted in order to extend Shelf life of the product and to identify various water activity levels at 40°C temperatures. The water activity of Dhakki dates was determined by storing the date samples over selected water activity levels in range of 0.12 to 0.97 a_w at 40°C. Sorption isotherm is constructed by relating equilibrium moisture content with water activity. The water activity of the Dhakki dates dried over following Solar drier technique was found to have 0.62 a_w . The stability of the date was measured by keeping samples over selected waster activity levels of 0.44, 0.52, 0.58 and 0.75 a_w at 40°C for 6 months, and quality evaluated by follow-up changes in moisture content, NEB, pH, titratable acidity and soluble solid content. The methodology for the evaluation of moisture, pH, acidity, total soluble solids, water activity and browning determination was standardized. On the basis of results it is recommend that the fruit may be stored at around its own water activity 0.62 a_w indicated the most promising one for the extended storage.

The 25 minutes boiling period appeared more effective producing good quality Chhuhara which possess high amount of pulp and total soluble solids, hold large size and weight, and furnish high yield of very appealing organoleptic qualities. The Dhakki variety appeared to be highly suitable for chhuhara formation, and the chhuhara from the Dhakki fruits shows great promise for commercial exploitation.

Four workshops were arranged for the Dates growers and Agriculture official of the Extension Deptt. about the Processing of Dhakki Dates.

Two days Dates Seminar & Exhibition at Khairpur, Sindh 28-29 July 2009 and Fourth International Date Palm Conference at Abu Dhabi, UAE 15-17 March, 2010 were attended.

Name of Project: **Investigations on Pesticide Residues in Fruits and Vegetables Grown under Agro Climatic Conditions of KPK**

Name of PI/Institute: **Dr. Barkat Ali Khan,**
Research Officer,
Agricultural Research Institute, Tarnab, Peshawar.

Duration: 01. 07. 2008 to 30. 06. 2011

Financial Status: Total Cost: Rs.5.441million
Funds Released: Rs.5408400/-
Funds Utilized: Rs.5408400/-

Objective:

- Determine the residue levels of various insecticides on fruits and vegetables through surveys by collecting samples from farmers' fields in major growing areas of NWFP.
- Determine withholding periods of commonly used insecticides fruits (peach, apple, sweet orange and guava) and vegetables (Okra, tomato, peas and cauliflower) in field supervised trials under agro climatic conditions of NWFP.
- Impart trainings to farmers on the judicious use of pesticides and create awareness among them about the harmful effects of the persistent pesticide residues.

Achievements:

A. Supervised field trials: During the reporting period (July 2010 – June 2011, conducted and supervised eight field trials; four each on vegetables (peas, tomato, cauliflower and okra) and fruits (peaches, guava, sweet oranges and apple) to determine withholding period of frequently used pesticides for local vegetable and fruit growers. Tomato, okra, peas and cauliflower were sprayed with indoxacarb, lambda cyhalothrin, imidacloprid, and cypermethrin at recommended doses of 70, 15, 60, 60 g a.i ha⁻¹ respectively while guava and peaches each was treated with trichlorfon @ 80 and 100 g a.i/100 liter water while sweet oranges and apple were sprayed with chlorpyrifos at the rate of 200 and 100 g a.i/100 liter water.

Based on Codex/EU MRLs and residual dissipation at the recommended doses mentioned above it can be recommended to local fruit/vegetable growers to elapse the following days as the safe waiting periods for harvesting:

- 7 days after cypermethrin application to cauliflower
- 3 days after indoxacarb application to tomato
- 7 days after chlorpyrifos application to apple
- 14 days after trichlorfon application to peaches
- 7 days after trichlorfon application to guava
- 7 days after λ -cyhalothrin application to okra
- 8 days after imidacloprid application to peas

- 10 days after chlorpyrifos application to sweet oranges

B. Monitoring pesticide residues in fruits and vegetables from farmers' fields: In order to assess possible contamination of fruits and vegetables with pesticide residues, marketable samples were collected from farmers in ten districts of Khyber Pakhtunkhwa (Swat, Mardan, Charsadda, Malakand, D. I. Khan, Bannu, Haripur, Peshawar, Bunir and Dir) during 2010-11. In total 470 samples of five vegetables (egg plant, okra, cauliflower, cucumber and tomato) and 150 of two fruits (guava and peach) were collected at harvest (2 kg each) and analyzed for pesticide residues. At the time of sample collection information were obtained regarding the types of pesticides used, dose and number of application and final dates of pesticide application prior to harvest.

- Of the 620 samples analyzed, pesticides were detected in 40% but the residual levels exceeded MRLs in 3.06% samples.
- Investigation on samples of known history showed that most irregularities were due to poor compliance of the pre-harvest interval by the farmers.

C. Training/Brochures: Nine training workshops on “Pesticides residues in crops & their management” were conducted in districts of D. I. Khan, Bannu, Mardan, Charsadda, Peshawar, Swat, Malakand, Chitral and Mansehra for awareness. Farmers, extension workers, researchers, representatives of NGOs, field assistants, field workers and pesticide dealers participated in the workshops.

A booklets in Urdu titled “*Pesticide residues in vegetables and fruits*” was published and distributed to the growers for guidance.

Statistical analysis of the impact of the trainings using t-values indicated significant relationship between training education and low level of contamination level (%) in the aforementioned districts except Peshawar and D. I. Khan.

Name of Project: **To Determine Optimum Maturity Indices of Various Mango Varieties (Langra, Dusehri and Samar Bahist) to Enhance Export and Minimizing Post Harvest Losses**

Name of PI/Institute: **Abdul Rahim Khan**
Assistant Research Officer,
Post Harvest Research Centre, Ayub Agricultural Research Institute, Faisalabad.

Duration: 01. 07. 2008 to 30. 06. 2011

Financial Status: Total Cost: Rs.3.947 millions
Funds Released: Rs.3385800/-
Funds Utilized: Rs.3186557/-

Objectives:

- To determine/identify the maturity indices of promising mango varieties
- To introduce the maturity indices among the mango growers
- To study the interdependence of the different physical and chemical changes which occur during the maturing and ripening of mangoes
- To develop storage parameters for mature green mango on variety bases.

Achievements:

Shelf life extension in mango is the main aim of research activities, to control quality of mangoes by avoiding physiological disorders during ripening. Fungicide spray at the time of fruit setting reduces the chances of Anthracnose and stem end rot during ripening. Sap washing, pre-cooling and control ripening process can better improve freshness of mangoes and extend market span.

Sap washing of harvested mangoes was done with calcium chloride and potassium aluminum sulphate solution to improve fruit outlook. After harvesting total sugar, reducing sugar, non-reducing sugar and ascorbic acid (Vitamin C) were analyzed along with TSS, firmness and pH.

The research study showed that sap washing and pre-cooling expand shelf life and maintain freshness by reducing fungal attack and improving cosmetic value. Uniform ripening of mangoes was achieved with application of ethylene gas. Total sugar reducing and non-reducing sugar of ripe mangoes showed significant data for future study.

The summary of the work done is as follows:

- Maturity indices with reference marketing period has been developed

- Interdependence of different characters is studied and would be representing in the report.
- Save harvest picking bag has been designed
- Pictorial literature in Urdu is developed and disseminated
- Assist the R & D work of one M. Sc (Hons) Horticulture student from Institute of Horticultural Sciences, University of Agriculture, Faisalabad
- One seminar was conducted at Multan.

Name of Project: Use of Spectral Reflectance to Estimate Growth, Biomass and Yield of Different Wheat Cultivars, under Moisture Stress Conditions

**Name of PI/
Institute:** Dr. Ashfaq Ahmed
Associate Professor,
Department of Agronomy, University of Agriculture,
Faisalabad

Duration: 01. 07. 2008 to 30. 06. 2011

Financial Status: Total Cost: Rs.3.713millions
Funds Released: Rs.2223600/-
Funds Utilized: Rs.2230704/-

Objectives:

- To determine vegetative indices such as spectral ratio (NIR/Red) and normalized difference vegetation index (NDVI) of different wheat cultivars at different growth stages during the season.
- To investigate the relationship between canopy structure and plant composition (LAI, biomass, light interception & yield), and vegetative indices.
- To prepare recommendations for suitable cultivars by estimating in-season biomass and grain yield.
- To improve the quality of teaching and research at post-graduate levels by providing new knowledge related to spectro radio-metry.

Achievements:

Recently, crop growth research has been focused on measurements of light interception and its utilization efficiency in field crops for assessing productivity. Total dry matter production (TDM) is measured as the difference between successive harvest and the analysis of radiation use efficiency (RUE), by this technique refers to periods of at least a week. For these reasons measurements of radiation interception are integrated over a day, or several days, to eliminate any diurnal variation. Such measurements make the technique too expensive and labour consuming for its use in large scale agronomic experiments. Over the past decade, an increased use of irrigation and nitrogen application increased environmental degradation and contamination. This sense of concern has brought an awareness of efficiently utilizing our resources and decreasing the negative environmental impacts of fertilizers leaching and runoff. To avoid or at least to reduce this laborious, time consuming techniques, an easy, rapid and inexpensive methods of measurements are needed. Therefore, it would be beneficial to use modern techniques like spectral reflectance or remote sensing to help agronomist, farm managers/farmers determine when and where a water/nutrient stress exists.

To achieve the objectives of the project, a field experiment was conducted at University of Agriculture, Faisalabad. The experiment was laid out in randomized complete block design (RCBD) split arrangement with four replications. Data on growth, development, light interception and yield were taken from the experiment. Measurement of spectral reflectance was made using Green Seeker, above the canopy at different growth stages during the season. Each plot was divided into two 5m long sub plots. One of them was used for destructive biomass and leaf area sampling, whereas the other remained intact for reflectance measurements and grain yield determination. Total dry matter and spectral reflectance measurement was made at tillering, booting, heading, anthesis and grain growth stages. All the data were analyzed using Duncan's Multiple Range Test at 5% probability.

Spectral reflectance indices have shown the potential to differentiate genotypes for grain yield in this study with different types of wheat cultivars under irrigated conditions. The best growth stages to apply the indices to differentiate cultivars for grain yield were heading and grain filling. It has been concluded at the end of the project that fully irrigated crop gave the maximum yield and as regard the wheat varieties Inqlab-91 and Lasani-2008 gave the highest yield. Moreover, data is supported by the spectral reflectance data at growth stages of the wheat crop, two years spectral reflectance data is enough for the assessment of moisture stress and wheat productivity. Moreover,

- This technique allows the evaluation of integrative traits related to yield either over time (i.e. during the plant cycle) or at the organization level (e.g. whole plat canopy)
- The correlation among NDVI at stages with LAI was strong and positive. So stage 5 has been found to be a good depictive stage.
- Result showed that NDVI have the ability to differentiate among cultivars.

Two papers are under process for publication. Two students of Ph. D and one of M. Sc (Hons) worked in the project for their thesis research for degree program.

Name of Project: Establishment of a System Based on HACCP Guidelines for Drying and Storage of Exportable Chilies to Control Aflatoxin Contamination. (SARC, Karachi, Component-I)

**Name of PI/
Institute:** Mr. Mubarik Ahmad,
Director/Principal Scientific Officer,
Grain Storage Research Institute, SARC-PARC, Karachi

Duration: 01. 07. 2008 to 30. 06. 2011

Financial Status: Total Cost: Rs.6.429 million
Funds Released: Rs.3199700/-
Funds Utilized: Rs.2395380/- (up to Dec., 2009)

Objectives:

- To identify the causes of aflatoxins production in chilies grown in Sindh.
- To prevent and control the aflatoxins in chilies.
- To develop the system based on the guidelines of HACCP for the drying and storage of chilies to prevent aflatoxins contamination.

Achievements:

The problem of aflatoxins contamination in chilies (*Capsicum aestivum* L.) is highly emerging. It is known to be mutagenic, teratogenic, carcinogenic and immunosuppressive etc. Aflatoxins are the secondary metabolites mainly produced by *Aspergillus flavus* and *Aspergillus parasiticus*. The key factors in its production are favorable temperature and relative humidity. It was found to be the prime hazard in Pakistani chili.

During study to determine the extent of aflatoxins contamination in chilies as well as to evaluate the critical stage that favors the production of aflatoxins, improper drying was found to be the most critical stage of chili production and need to be optimized for the production of safe chilies.

In order to prevent and control aflatoxins in chilies, various mean for drying including solar, mechanical were evaluated in terms of quality, cost, time etc. The results are in process of compilation and shall be reported in the final progress report. The final/completion report has not been provided so far by the PI.

Name of Project: Development of Small Scale Bone-Fertilizer Plant.

**Name of PI/
Institute:** **Mr. Zulfiqar Ali**
Senior Engineer, Agricultural & Biological Engineering Institute
(ABEI), NARC, Islamabad

Duration: 01. 09. 2010 to 30. 06. 2011

Financial Status: Total Cost: Rs.4.661 million
Funds Released: Rs.1320000/-
Funds Utilized: Rs.780704/-

Objectives:

- To provide an alternative fertilizer which is of bio-origin for improvement of soil fertility at a cheaper rate as compared to chemical fertilizer.
- To improve porosity of the soil through application of bone fertilizer, resultantly enhancing water retaining capacity of the land.
- To convince small farmers especially by providing a relatively less expensive product for easy reach.

Achievements:

A considerable amount of animal bones which is a rich source of Calcium phosphate is wasted in the country. It is the only insoluble fertilizer in the soil, which improves its fertility without any hazardous effect. The bone powder is to be added in the bio-fertilizer. The bone powder may be utilized in poultry feed and also in sugar industry for de-coloring of sugar.

The Bone-fertilizer plant machinery consists of two major parts: (i) Bone Roasting Unit (ii) Bone Crushing Unit. The Designing and fabrication work of the machinery was carried out at the premises of local machinery manufacturer, Faisalabad. The machinery was tested at ABEI after installation and found correct according to design specifications.

The machinery is ready for installation but currently the competent authority of the council has directed to close the project as per policy and directed to hand over the equipments to Fisheries Program for best and efficient utilization. The machinery has been handed over to aqua culture & fisheries program for installation and meeting fish feed.

Name of Project: **Microbial ACC-deaminase Biotechnology for Sustainable Production of Legumes**

**Name of PI/
Institute:** **Dr. Zahir Ahmad Zahir,**
Associate Professor,
Institute of Soil & Environmental Sciences, University of
Agriculture, Faisalabad

Duration: 22. 08. 2008 to 30. 06. 2011

Financial Status: Total Cost: Rs.4.289 million
Funds Released: Rs.3736400/-
Funds Utilized: Rs.3692465/-

Objectives:

- Isolation and screening of rhizobacterial cultures carrying ACC-deaminase enzyme.
- Isolation and screening of effective rhizobial cultures for different legumes.
- Evaluation of the growth promoting and nodulation potential of the rhizobacterial/ rhizobial cultures.
- Evaluation of the co-inoculation of rhizobia and rhizobacteria for improving growth and yield of legumes.

Achievements:

Twenty five isolates, each of rhizobacteria and rhizobia, were isolated, each from lentil, chickpea and mung bean rhizosphere and nodules, respectively. On the basis of results of 1st and 2nd years, three best combinations were selected for each crop to be tested under pot and field conditions during third year. During the third year 2010-2011, the rhizobia and rhizobacteria that were selected during first and second year studies were identified using Biolog[®] identification system.

The identified strains were studied alone and in combinations in pot and field trials to evaluate their effect on growth, nodulation and yield of mung bean, chickpea and lentil. The data showed that co-inoculation with rhizobia and PGPR containing ACC-deaminase significantly increased the productivity of their respective legumes under pot and field conditions. The combinations *Pseudomonas fluorescens* biotype G (F6) x *Rhizobium phaseoli* (MN6), *Vibrios diazotrophicus* (J1) x *Mesorhizobium ciceri* (JH\$), and *Vibrios vulnificus* (LC3) x *Rhizobium leguminosarum* (LCR1) showed best results for improving growth, nodulation, and yield of mung bean, chickpea, and lentil, respectively. It is concluded that these co-inoculated combinations could be used as effective inoculants to improve growth, nodulation, and yield of mung bean, chickpea, and lentil. Rhizogold: A biofertilizers has been developed for mung bean, chickpea, and lentil by using respective rhizobial and PGPR containing ACC-deaminase.

Name of Project: Carbon Sequestration through Tillage, Organic Matter and Mulch: Managing the Soil Quality for Sustainable Crop Production

**Name of PI/
Institution:** Dr. Anwar-ul-Hassan,
Professor,
Institute of Soil & Environmental Sciences, University of
Agriculture, Faisalabad

Duration: 28. 07. 2008 to 30. 06. 2011

Financial Status: Total Cost: Rs.4.881 million
Funds Release: Rs.2463900/-
Funds Utilized: Rs.2209992/-

Objectives:

- To assess the potential of soil carbon sequestration in Pakistan with different farm manure and mulch rates and tillage methods.
- To determine the effects of tillage systems, farm manure and mulch for enhancing soil quality to meet the food demands of the country.
- To determine the effect of deficit irrigation on growth and yield of crops.

Achievements:

Experiments were carried-out under field conditions on an area of two acres at the University of Agriculture, Faisalabad, Two trials on Maize-wheat crop rotation on an area of two acres were conducted. Main conclusions drawn from this study are summarized below:

- The results of maize crop indicated that integrated application of manure with inorganic fertilizer and deep tillage yielded the maximum plant height (245.6 cm), total plant biomass (21.02 Mg ha⁻¹) and grain yield (9.5 Mg ha⁻¹) of maize crop while increased soil organic contents of soil was its additional benefit. Residual effect of manure application showed that the treatment combination MT x DM_{45res} gave maximum plant height, total plant biomass and grain yield of wheat crop i.e. 100 cm, 16.05 Mg ha⁻¹ and 5.78 Mg ha⁻¹, respectively. Integrated application of deep tillage (DT) with manure @45 Mg ha⁻¹ showed the maximum hydraulic conductivity and infiltration rate at maize harvest i.e. 49.05 and 28.56 mm hr⁻¹. Highest concentration of soil organic carbon at 0-10 cm depth was observed with treatment combination “MT x DM₄₅” that was 9.35 g kg⁻¹ while least in case of “CT x DM₀” that was 5.02 g kg⁻¹, however at lower i.e. 10-20 cm depth, the highest value was observed with “CT x DM₄₅” that was 4.59 g kg⁻¹ and at 20-30 cm depth highest value was observed with “DT x DM₄₅” that was 3.47 g kg⁻¹. Minimum value of bulk density at 0-10, 10-20 and 20-30 cm depths was observed with treatment combination “DT x DM₄₅” that was 1.35, 1.48 and 1.50 Mg m⁻³, respectively.

- Deficit irrigation had a significant negative effect on growth and yield of maize and wheat crop. There was a significant decrease in yield of maize and wheat crop with reducing irrigation depth, but with application of mulch this reduction was minimized.
- Frequent irrigation (I_3) along with mulch application @ 15 Mg ha^{-1} proved best treatment combination showing highest grain yield of maize and wheat crop that were 5.75 Mg ha^{-1} and 3.45 Mg ha^{-1} respectively, while minimum grain yield of maize and wheat was observed with treatment combination deficit irrigation along with no mulch " $I_1 + M_0$ " that were 3.40 Mg ha^{-1} and 2.50 Mg ha^{-1} respectively. Application of mulch significantly increased the water use efficiency of maize and succeeding wheat crop. Water use efficiency of maize and succeeding wheat was found maximum with treatment combination " $I_1 \times M_3$ " that was 10.19 and $8.29 \text{ kg ha}^{-1} \text{ mm}^{-1}$ while minimum in case of " $I_3 \times M_0$ " that was 5.20 and $5.70 \text{ kg ha}^{-1} \text{ mm}^{-1}$, respectively. Mulch significantly affects the soil organic content. Highest concentration of soil organic carbon at 0-10, 10-20 and 20-30 cm depth was observed with treatment combination " $I_3 \times M_3$ " that were 6.05 , 2.99 and 2.21 g kg^{-1} , respectively at the harvest of maize crop. Similarly, mulch significantly reduced the bulk density of soil at 0-10 cm depth, while at lower depths (10-20 and 20-30 cm) its effect was non significant. Minimum value of bulk density at 0-10, 10-20 and 20-30 cm depth was observed with treatment combination " $I_3 \times M_3$ " that were 1.32 , 1.38 and 1.42 Mg m^{-3} while highest in case of " $I_1 \times M_0$ ", that were 1.48 , 1.50 and 1.54 Mg m^{-3} at the harvest of maize. Hydraulic conductivity and infiltration rate were significantly increased with the application of mulch, at the harvest of maize crop. Hydraulic conductivity and infiltration rate were found maximum with treatment combination " $I_3 \times M_3$ " that were 70.43 and 26.08 mm hr^{-1} while least in case of " $I_1 \times M_0$ ", that were 28.56 and 18.34 mm hr^{-1} at the harvest of maize.
- Economical analysis of maize crop where tillage and manure applied, proved the treatment combination " $DT \times DM_{45}$ " more economical with maximum net returns, while MRR (marginal rate of return) showed that treatment combination " $CT \times DM_{15}$ " was best due to very low input cost and more returns compared to " $CT \times DM_0$ ". In study-II, regarding economical analysis of irrigation and mulch affect on maize growth and production the treatment combination " $I_3 \times M_5$ " got the highest net return, whereas (MMR) marginal rate of return graded " $I_2 \times M_0$ " as more beneficial due to more returns with less input.
- Data regarding soil physical properties after wheat harvest are being collected and is under analysis.

Name of Project: Assessment of Toxic Metals in Agriculture Products and their Relation with Nutritional Status in NWFP- Pakistan

Name of PI/ Institution: Dr. Ihsanullah
Dy. Chief Scientist,
Food Sciences Division, Nuclear Institute for Food and Agriculture, Tarnab, Peshawar

Duration: 28. 07. 2008 to 30. 06. 2011

Financial Status: Total Cost: Rs.2.926 million
Funds Release: Rs.2626200/-
Funds Utilized: Rs.2592873/-

Objectives:

- To assess the levels of toxic heavy metals in agricultural foods in various locations around Peshawar consumed in the region and to determine circulatory level of toxic elements from selected site in Peshawar.
- To measure the nutritional status of population using anthropometric (BMI) procedures and to collect data for various parameters through food frequency questionnaire.
- To develop relationship between toxic metals and nutritional status of the population and to create awareness in the social sector through training workshops.

Achievements:

In view of the importance of essential/toxic metals for proper maintenance of health, different water, food (samples of vegetable, cereals and other crops, meat, milk etc.) collected from project area (Peshawar: Hayatabad industrial estate, Khyber Pakhtunkhwa Agricultural University, Gulbahar, Nishtarabad, Tarnab, G. T. Road Hazarkhawani, Ring Road, Afridi Ghari and Kabul River) and limited samples for comparison from other areas (Nowshera: Amangarh industrial zone, Pirsabak, Aza khel and Kabul river area; Charsadda: Sardaryab, Nahqi, Naguman, Shah Alam and Chambani and; Mansehra: Marghazar, Dhodial, Khanpur and Bajna) were also collected and analyzed for Pb, Cd, Cr, Ni, Fe, Cu, Mn, Co and Zn using atomic absorption spectrometry (AAS). Additionally blood samples of people from different age group such as children (1-12 years), , adolescent (12-18 years), adults (18-45 years) and old age (above 45 and 55 years for male and female respectively) from project area (Peshawar, Dir and Abbottabad) along with dietary intake (calculated from 24 hours memory recall dietary questionnaire) were collected and analyzed.

The results of the study showed that the consumption of contaminated food crops, meat and milk has significantly increased the concentrations of trace metals in human blood as compared to the control area, indicating that these food chains may be one of the major pathways of exposure and sources of contamination of human blood with metals. This was

further strengthened by correlation and regression study between metal concentrations in the food crops, meat, milk and the blood, where some positive correlation between Cu-Zn, Mn-Zn, Cr-Ni, Ni-Pb, and Cr-Pb metal pairs, while some negative correlations between Cr-Pb with Mn, Cu and Zn were observed in the form regression equations. Moreover, Cu, Zn and Mn concentrations were significantly higher ($p < 0.05$) in the blood samples collected from the polluted area as compared to control area. Similar trends were also observed between the different age groups within the same area.

Overall metal concentrations in males were higher as compared to females which may be due to diet habits and body mass along with other factors. Old age people had accumulated higher concentrations of trace metals as compared to younger ones due to slow accumulation of the metals in their bodies.

Three papers have been published in International Journals from the research work conducted under project. Two Ph. D thesis, 06 thesis of M. Sc (Hons.) and 4 internship report of B. Sc (Hons.) has also been produced as a result of research work conducted by the students.

Two students got their Ph. D degrees after conducting work in the project. Similarly 8 students got M. Sc (Hons.) degrees while 04 students got B.Sc (Hons.) degrees as a result of project work. Two students of 2nd years of Govt. College of Technology, Nowshera worked in project, were awarded diploma.

Name of Project: **Enhancing Stone Fruits (Peach, Plum and Apricot) Orchards Productivity through Integrated Nutrients (NPK) Management; A Component of the Coordinated Project “Stone Fruits Productivity Enhancement through Appropriate Nutrient Management” (NIFA, Peshawar, Component – II)**

Name of PI/ Institution: **Dr. Syed Mahmood Shah,**
Dy. Chief Scientist/Head,
Soil Science Division, Nuclear Institute for Food and Agriculture, Tarnab, Peshawar

Duration: 28. 07. 2008 to 30. 06. 2011

Financial Status: Total Cost: Rs.4.743 million
Funds Release: Rs.2766700/-
Funds Utilized: Rs.2677320/-

Objectives:

- To improve the yield and quality of stone fruits (peach, plum and apricot) through balance nutrition.
- To sustain orchards fertility and fertilizer use efficiency through integrated use of mineral and organic manures.

Achievements:

Six orchards two each of plum, peaches and apricot of different farming communities are under trial at Peshawar and Nowshera district (Khyber Pakhtunkhwa Province). NPK and Farm Yard Manure were applied in different combination along with control. Half nitrogen and all the phosphorus and potassium and zinc fertilizers were applied 0.5 meter away from tree trunk and between the drip lines after fruit picking in mid summer each year while the Farm Yard Manure and half nitrogen was applied in dormant season. There were eight treatments NPK (T₁ 0-0-0, T₂ 0.75-0.5-0, T₃ 1.0-0.5-0, T₄ 0.5-0.5-0.5, T₅ 0.75-0.75-0.5, T₆ 1.0-0.75-0.5, T₇ 0.75-0.5-0.5+FYM, T₈ 1.0-0.5-0.5+FYM) with three replications and two trees per treatment. In this way in each orchard 48 trees of uniform size, age and vigour were selected (Total 288 trees in six orchards).

Yield: During 2009 in peach the highest yield of 85.3 and 84.6 kg/tree was given by treatment received NPK @1.0-0.5-0 and 1.0-0.75-0.5 respectively. In apricot the higher yield 62.0 kg and 63 kg tree⁻¹ were obtained in treatment received NPK @ 0.75-0.75-0.5 and 1.0-0.75-0.5 respectively and in case of plum due to climatic conditions the fruit yield during 2009 was very minimum through out Khyber Pakhtunkhwa. The integrated nutrient management

treatment significantly improved the yield and during 2011 the mean peach yield of Shakerpura and Daman Afghani ranged from 78.5 to 133.5 kg tree⁻¹ while in case of apricot the yield range from 93.42 to 192 kg tree⁻¹. In plum at NIFA orchard, the yield ranged from 50 to 150 kg tree⁻¹. The yield data indicated that in peach, plum and apricot orchards due to integrated nutrient management practices the yield was almost double compared to previous years. All the integrated nutrient management treatments improved the yield significantly in all orchards and the balanced nutrition also reduced the fruit drop, which is a serious problem in deciduous fruit orchards.

1. Soil analysis: Peach orchards: Soil analysis (0-30 cm) indicated that the Soil Organic Matter (SOM) content was significantly improved compared to the previous year. The mean SOM content in the samples collected during mid summer 2010 in the peach orchards ranged from 0.93 to 1.85% with an over all average of 1.83% compared to 0.3 to 0.97% in the first year (2008). The mean NPK of 0.1%, 13.7 mg kg⁻¹ and 135.8 mg kg⁻¹ respectively was found in the treatment received NPK + Farm Yard Manure (FYM) while N contents before application of experimental treatments was ranged from 0.025% to 0.06%, phosphorus ranged from 3.0 to 7.0 ppm and potassium ranged from 150 to 160 ppm. Almost similar trend was observed in other orchards.

2. Leaf analysis: The leaf analysis indicated that nutritional status of fruit trees were improved by application of NPK and FYM and its contents were improved in all NPK treatments compared to control. **i)** The N content in plum leaves with a mean value of 2.33%, P value of 0.28% and K 3.35% was found in treatment received NPK + FYM. **ii)** In peach orchards the N concentration ranged from 1.95 to 2.70%, the P concentration ranged from 0.2 to 0.3% and K was in range from 2.3 to 3.1% while the NPK content in leaf samples collected before the imposition of experimental treatments from peach, plum and apricot orchard showed that nitrogen ranged from 1.8 to 2.3%, P content ranged from 0.1 to 0.13% and potash content ranged from 1.4 to 2.0. In apricot orchards, the NPK contents were also improved.

The studies led to the conclusion that in all the above orchards (peach, plum and apricot) the integrated nutrients management improved the yield and NPK content in the soil. The balance nutrition reduced the fruit drop in all these orchards. FYM manure along with NPK improved the organic matter contents in the soil profile. The FYM manure along with NPK also improved the nutritional status of fruit trees and yield. The balance nutrition improved the fruit quality & increased the productivity of these stone fruits orchards and will also increase the life span of these orchards. High production will improve the socio-economic condition of farming communities and the surplus fruit will be a source of foreign exchange for the country. Soil fertility can be improved and maintained on sustainable basis. Final Conclusion will be drawn after completion of soil/plant analysis collected in mid summer 2011.

Name of Project: **Micronutrients Studies on Stone Fruit Orchards in Peshawar Valley; A Component of Coordinated Project “Stone Fruit Productivity Enhancement through Appropriate Nutrient Management” (ARI, Tarnab, Peshawar, Component-I)**

Name of PI/ Institution: **Mr. Mir Abbas Khattak,**
Agricultural Chemist,
Agricultural Research Institute, Tarnab, Peshawar

Duration: 29. 01. 2009 to 28. 01. 2012

Financial Status: Total Cost: Rs.3.166 million
Funds Release: Rs.2248000/-
Funds Utilized: Rs.2212172/-

Objectives:

- To study the existing level of macro and micronutrients in the soils and leaves of stone fruit orchards.
- To improve the yield and quality of stone fruits (peach, plum and apricot) through balance nutrition.
- To recommend proper doses of macro and micronutrients based on soil test values, leaf analysis and field trials.
- To sustain orchard fertility through integrated use of mineral and organic manures.

Achievements:

Three surveys were conducted during 2009-10 to assess the micronutrients (Zn, Cu, Fe, Mn and B) deficiency and soil fertility status of peach, plum and apricot orchards in Peshawar valley of Khyber Pakhtunkhwa. For each crop about 50 orchards were surveyed. In each survey general observations on orchards were recorded. Each orchard was particularly observed for micronutrient deficiency symptoms. Relevant information from the concerned farmers was also collected.

Soil and leaf samples were collected from each orchard and were analyzed for micro nutrients. Soil samples were also analyzed for fertility and other soil characteristics.

The analysis of peach leaves showed that 60% were low, 30% adequate and 10% high in Zinc. Copper was low in 18%, adequate in 62% and high in 20% samples. None of the 50 orchards was deficient in Fe. Manganese was low in 40%, adequate in 56% and high in 4%. Boron was low in 22% adequate in 72% and high in 6%.

The soil analysis revealed that none of the 50 orchards was deficient in Cu and Mn. Fe was deficient in the surface 0 -15 cm of only 16 orchards. Zinc was deficient in both surface and sub surface soils in large number of orchards. The soils at lower depths (15-45 cm) were more deficient in zinc than the surface 0-15 cm soil. No orchard was low in organic matter in the surface 0-15 cm soil but 44% orchards were low in the 15-45 cm soil. Moreover 4% orchards were low in P in the 0-15 cm and 42% were low in the 15-30 cm soil. Similarly 16% and 44% orchards were low in K in the 0-15 cm and in 15-45 cm respectively. The soil pH of majority of peach orchards was between 7.5 and 8.5 and EC was below 4.0 dS m⁻¹.

Following conclusion could be drawn from the research studies and work:

- Peach orchards in Peshawar valley were found deficient in varying level of micronutrients. Zn was deficient in 60%, Cu in 18%, Mn in 40% and boron in 22% orchards.
- Apricot orchards were also found deficient in micronutrients. Zinc was deficient in 52 %, Cu in 0%, Mn in 14% and Boron in 24% orchards.
- Plum orchards were also found deficient in micronutrients. Zinc was deficient in -52 %, Cu in 0%, Mn in 0% and Boron in 46% orchards.
- No or poor correlation was found between the soil and plant tests for diagnosing micronutrients deficiency in peach, plum and apricot orchards. Based on literature reports plant test was considered more reliable than the soil test for diagnosing micronutrient deficiency in peach, plum and apricot orchards.
- Organic matter contents were generally sufficient in the surface but deficient in the lower soil depths of all peach, plum and apricot orchards. Available P and K were also deficient in most of the stone fruit orchards.
- Soil pH of almost all stone fruit orchards was normal to alkaline (7.5-8.5). Alkaline pH hinders the availability of Zn, Cu, Fe and Mn.
- Low O.M contents in the lower depth together with wide spread deficiency of extractable P and K were likely responsible for unavailability of micronutrients of peach, plum and apricot plants. The alkaline pH in stone fruit orchards further aggravates micronutrients availability to plants

Name of Project: **Micronutrients Studies on Stone Fruit Orchards in Balochistan; A Component of the Coordinated Project “Stone Fruits Productivity Enhancement through Appropriate Nutrient Management” (ARI, Sariab, Quetta, Component-III)**

Name of PI/ Institution: **Mr. Muhammad Nasim,**
Horticulturist,
Agricultural Research Institute, Sariab, Quetta

Duration: 24. 07. 2008 to 30. 06. 2011

Financial Status: Total Cost: Rs.2.126 million
Funds Release: Rs.1305000/-
Funds Utilized: Rs.1304103/-

Objectives:

- To create awareness in farming community about the use of NPK and micronutrients in the stone fruit orchards.
- To find out the best optimal dose of NPK and micronutrients for the benefit of growers to enhance the productivity of apricot.

Achievements:

During initiation of the project, a detailed apricot orchard survey was carried out in the fruit growing areas of the province. Different sites were selected to carry out the experimental trials on foliar and soil application of macro and micronutrients.

Soil, water and leaf samples were collected before and after the application of nutrients from all the experimental sites. The results of soil and water analyses indicated deficient level of micronutrients and optimum level of chemical fertilizers. The data revealed that the application of chemical fertilizers through soil and foliar application of micronutrients i.e. Fe, Cu and B during dormancy and growth period of apricot trees did not indicate increasing trend in per acre yield. However, the efficacy of Mono-hydrate ZnSO₄ spray @ 5% and with the application of chemical fertilizer through soil during dormancy proved to be the most effective, which increases per acre yield as compared to spray carried out @ 2.5% during growth period of apricot. The yield trend was homogenous at all the experimental sites of the project.

The studies concluded that amongst the micronutrients only Mono-hydrate ZnSO₄ foliar spray proved to be the most effective for improvement of physical condition of the trees, vegetative growth, size and quality of fruit, control of die-back of branches and increase in per acre yield.

Name of Project: **Diagnosis and Control of Leaf Reddening in Cotton**

Name of PI/ **Dr. Jawed Akhtar Memon,**
Institution: Soil Fertility Officer,
Agricultural Research Institute, Tandojam, Sindh

Duration: 24. 07. 2008 to 31. 10. 2011

Financial Status: Total Cost: Rs.3.643 million
Funds Released: Rs.2202900/-
Funds Utilized: Rs.2097561/-

Objectives:

- Survey and identify the areas and the possible causes of growth stunting, wilting of the plants and reddening of cotton leaves.
- To develop a package of technology to overcome the problem of reddening in cotton leaves.
- Effective and efficient transfer technologies for controlling cotton leaf reddening disseminated to the cotton growers.

Achievements:

The cotton growers of Sindh are suffering huge losses in yield due to reddening disorders in cotton crops. Thousand acres of area of cotton crop were found to be affected by leaf reddening in major cotton growing belts of Sangar, Mirpur Khas, Umerkot, Matiari, Hyderabad, Tando Allahyar and T. M. Khan districts. The project approach is to diagnose and control leaf reddening in cotton.

During first year of the project, survey of affected areas of district Tando Allahyar, Mirpur Khas and Sanghar was carried out. Leaf samples of affected and un-affected plants were collected for analyzing macro and micronutrients. Soil samples were also collected for physical and chemical properties.

On the basis of deficiency symptoms of nutrients in leaves & soil, some experiments on balance nutrition conducted in 2nd year of the project in Tando Allahyar, Mirpur Khas, Sanghar, Hyderabad, Matiari and Umerkot districts and affected fields of farmers. Field & pot experiments on balance nutrition, soil and foliar application of K and Mg and salinity levels were also conducted at Agriculture Research Institute, Tandojam.

As a result of soil and leaf analysis, the selected fields in Sanghar (65 acres), Mirpur Khas (66 acres), Tando Allahyar (16 acres), Umerkot (20 acres), Matiari (25 acres), Hyderabad (30 acres), Badin (8 acres) and Jamshoro (4 acres) were treated through foliar application of KNO₃, K₂SO₄, MgSO₄, ZnSO₄, & Boric acid against leaf reddening, stunting growth and wilting. After treatments, the problem of reddening, stunting growth & wilting was controlled;

however, severe attack of reddening could not be controlled. For awareness of cotton growers, seminars and field days were arranged in Hala, Matiari and Tandojam. The growers were briefed about the causes of leaf reddening in cotton and its remedial measures.

Following significant findings were observed after survey and as a result of research experiments:

- The problem was higher in plants sown in March than sown in May. For early sown crop, the availability and supply of irrigation water was not regular as per need of the crop. Water stress at early sown crop coupled with high temperatures damaged tenderly root system and development of plant was checked. It further created disturbance in nutrient uptake.
- Old leaves of cotton were more affected by reddening than young leaves, it could be postulated that accelerated ageing was due to impairment metabolism caused by lack of nutrients and hormones in old leaves.
- Climatic changes i.e. hot temperature and wind velocity caused excessive evapotranspiration that resulted reddening.
- Symptoms of potash deficiency were clearly examined in all Bt varieties and caused the problem of reddening. Partially reddening was controlled by 10 mM KNO_3 or K_2SO_4 , applied 3-6 times via foliage at the interval of seven days. However, severe attack of leaf reddening could not be controlled through foliar application of K. Nitrogen deficiency resulted small leaves with less leaf production which improved with foliar application of 2-3% urea applied three times.
- The result of salinity experiment in pot culture revealed that reddening problem appeared when salt concentration in soil profile increased. The selection of the variety is the best means of prevention of reddening problem. Bt lines showed higher trend of reddening than local approved varieties. Severity of reddening was directly proportional to Na concentration in leaf tissues of cotton.
- Zinc deficiency caused growth stunting and wilting problems. $ZnSO_4$ application accelerated cotton growth when applied 4-6 times.
- Addition of Mg via soil and foliage did not increase yield of seed-cotton. 3-4% leaf reddening appeared in Mg treatments. Leaf reddening also appeared, where K was not added with N and P. Additional K increased seed-cotton yield and controlled leaf reddening in cotton.
- A treatment without fertilizer caused 42% leaf reddening and received poor yield. N alone also created 12% reddening problems. Additional Cu, Fe and Mn did not increase cotton yield significantly.

Three students of Sindh Agriculture University were engaged in the project and conducted their research work for M. Sc (Soil Science) thesis writing.

Name of Project: Effect of Different Irrigation Intervals and Mulching Materials on the Growth, Yield and Quality of Onion under Agro Climatic Conditions of Southern Regions (Khyber Pakhtunkhwa)

**Name of PI/
Institution:** Mr. Muhammad Suleman,
Assistant Vegetable Botanist,
Agricultural Research Station, Ahmad Wala, Karak, Khyber
Pakhtunkhwa

Duration: 28. 07. 2008 to 30. 06. 2011

Financial Status: Total Cost: Rs.3.554 million
Funds Release: Rs.2198600/-
Funds Utilized: Rs.2107122/-

Objectives:

- To study the effect of different irrigation intervals and mulching material on the yield of onion.
- To demonstrate the use of mulching materials to the farmers.
- To come up with solid recommendation on various mulching materials, moisture conservation and culture practices for onion crop.

Achievements:

Two experiments one at the farmer's field and other at Agricultural Research Station (ARS), Ahmad Wala, Karak to know the effect of irrigation intervals and mulching materials on growth, yield and quality of onion were conducted using different mulching material i.e. wheat straw, saw dust, rice straw and gram straw against onion crop using irrigation at the interval of 5/6 days. Data regarding plant height, yield ton/ha, irrigation interval, etc. was collected and analyzed. Pot experiment was also conducted using different mulch material. In addition ten adaptive plots were laid out at farmers fields. It was found that, irrigation at interval of 5 days was the most economical and suitable interval for high production of onion in research trials as well as at farmer's field. Gram straw mulching material gave encouraging result at all the locations and prolonged the availability of moisture for onion growth. Combination of gram straw and 5 days irrigation interval supercede all the treatments and gave high production. Gram straw was easily fermented in the soil after application and improved the soil structure. Ten numbers of farmers were trained in the vicinity of each plot on application of mulching materials and irrigation of onion field. Five field days were also arranged at various locations and all the farmers of adaptive plots attended the field days. The farmers were educated about the use of gram straw as mulching material easily available in the area, at the intervals of irrigation after 5 days which gave high yield and improve soil health.

Following conclusion can be drawn from results of the research study:

- Mulching material (Gram Straw) was found the most suitable source of moisture conservation for maximum production of onion bulb.
- Irrigation after 5 days interval is the best interval for high production of onion bulb.
- Mulching material reduces cost of production and substitute for farm yard manure.
- Mulching material (Gram Straw) improves moisture retention capacity of soil and decreases evaporation.
- Gram straw was of no use before the commencement of this project. Its introduction amongst the onion growers as a mulch for vegetables is great innovation of project.

Name of Project: Evaluation of Nitrogen Inhibitors for Reducing Nitrogen Loss under Irrigated Cotton - Wheat System using ¹⁵N-Balance Technique

Name of PI/Institute: Dr. Tariq Mahmood,
Principal Scientist,
Soil Biology & Plant Nutrition Division, NIAB, Faisalabad

Duration: 28. 07. 2008 to 30. 06. 2011

Financial Status: Total Cost: Rs. 5.557 million
Funds Released: Rs.5068400/-
Funds Utilized: Rs.4873017/-

Objectives:

- To identify technically and economically effective nitrification inhibitors for agricultural application under environmental conditions prevailing during the cotton and wheat growing seasons in Pakistan.
- To investigate (using ¹⁵N-tracer Technique) under greenhouse conditions the performance of selected nitrification inhibitors for improving fertilizer-N recovery, crop yields and fertilizer-N use efficiency under cotton and wheat.
- To identify through field experiments appropriate fertilizer-N management practices for cotton and wheat production taking into account the possibility of improving crop yields and reducing fertilizer-N loss, and conserving environment.

Achievements:

At current fertilizer N price and consumption in Pakistan, appropriate fertilizer management practices need to be adopted to reduce N loss under agro-climatic conditions prevailing in Pakistan. Use of nitrification and urease inhibitors is a well documented strategy to reduce N loss from agricultural croplands. Research was embarked upon to evaluate various nitrification and urease inhibitors for reducing N from cotton-wheat system using ¹⁵N tracer technique for studying the fate of fertilizer-N in plant-soil system. Investigations were carried out in three parts viz. a) laboratory experiments, b) green house experiments, and c) field experiments.

Of the various nitrification inhibitors tested under laboratory conditions, 4-amino-1,2,4-triazole (ATC) was found effective in inhibiting nitrification when applied at 2% of urea-N under summer temperature and at 0.25% of N under moderate winter temperatures. Of the commercial urease inhibitors tested, N-(n-butyl) thiophosphoric triamide (NBPT) applied at 1% of urea-N proved to be effective in delaying the urease activity under summer and winter soil temperature.

Two greenhouse experiment were conducted, one each with wheat and cotton, using ^{15}N -labelled urea blended with the nitrification inhibitor 'ATC' or/and the urease inhibitor 'NBPT'. In experiment with wheat, considering effects on grain yield and recovery of fertilizer N in plant+soil, combined application of ATC and NBPT proved to be most effective when urea was applied by conventional method i.e. broadcast/incorporated in bulk soil. When urea granules were applied along wheat rows, incorporating NBPT alone was most effective as it also produced highest grain yield; it further reduced fertilizer-N loss when compared to the conventional broadcast application method. In experiment with cotton, ATC and NBPT applied in combination were most beneficial in reducing the fertilizer N loss and application of N fertilizer at 8 cm depth along plant rows proved better in conserving the fertilizer N as compared to the conventional broadcast method.

Field experiments with cotton were inconclusive due to crop failure caused by CLCV. Two field experiments (using early variety *Bhakkar* and late variety *Seher*) were conducted to elucidate effects of ATC and NBPT on wheat yield. Application of urea granules by conventional method at 90 kg N ha^{-1} along with NBPT (1% of N) was identified as the best management practice for both wheat varieties. With early variety *Seher*, this treatment produced an extra 686 kg ha^{-1} of grain in addition to the fertilizer N saving of 30 kg ha^{-1} ; the net benefit due to NBPT (increased grain yield plus fertilizer saving minus cost of NBPT) was calculated as $\text{Rs.}15595 \text{ ha}^{-1}$. The same treatment also produced the highest grain yield for the late variety *Bhakkar*; the net benefit due NBPT was calculated as $\text{Rs.}24600 \text{ ha}^{-1}$. Third experiment on wheat was conducted to elucidate the effects of urea application methods on biomass yield and N uptake by late wheat variety *Bhakkar*. Urea granules (all applied at sowing) at 120 kg N ha^{-1} along plant rows at about 8 cm depth proved better than urea applied by conventional broadcast method; producing an extra 503 kg ha^{-1} of grain (11% increase over conventional broadcast method; additional benefit, $\text{Rs.}11900 \text{ ha}^{-1}$) without affecting the grain N concentration.

The overall results of the research suggested that it is worth incorporating NBPT in urea granules at 1% of urea-N and that application of urea granules along wheat rows at about 8 cm depth is more effective as compared to the conventional broadcast method.

Name of Project: Centre Pivot Irrigation System for Enhancing Water Productivity of Seed Multiplication System and Crop Production Systems (WRRI, NARC, Islamabad Component-I)

Name of PI/Institute: Mr. Asaf Ali Bhatti,
Principal Scientific Officer,
Water Resources Research Institute, NARC, Islamabad

Duration: 01. 03. 2010 to 28. 02. 2013

Financial Status: Total Cost: Rs.8.386 million
Funds Released: Rs.2094400/-
Funds Utilized: Rs.1391403/-

Objectives:

- To develop Center-pivot sprinkler irrigation facilities for seed multiplication and crop production at NARC and other ecologies of Pakistan.
- To conduct research at various ecologies for crop production under center pivot irrigation systems.
- Devise packages of technology for optimum water productivity for seed and crop production.
- Demonstrate and disseminate state of the art irrigation technologies to farmers, extensionists, researchers and planners.

Achievements:

During the period under report, four sites in provinces and one in Islamabad were selected. Tender was floated and work order awarded to Valley Irrigation Pakistan (Pvt), Ltd for supply and installation of Centre Pivot Irrigation system.

The system was installed on area of 50 acres at NARC with digital pressure and flow measuring devices and fertigation/Chemigation application facility. A 35 KVA diesel Genset with steel fuel tank has been installed for an alternate facility of energy source. A computerized pivot panel is fitted at the pivot point for the system control and operation for different irrigation strategies. The other salient features are as below;

➤ Total system span length (m)	254.31
➤ Total number of spans	4
➤ Sprinkler system flow (liters/second)	14.09
➤ Total number of nozzles	6
➤ Prime mover (HP)	7.5

The application and distribution uniformity was measured after distributing the system in five different segments. The system was operated and only one set of data was collected. To minimize the effect of evaporation from collectors during the test, the volume of water in each collector was measured as soon as water application was completed. The volume of water was measured, depth of water calculated and recorded for the calculation of coefficient of uniformity (Cu) and distribution uniformity (Du). The Cu and Du were calculated 84.5% and 84% by adopting standard procedures. The application efficiency was also calculated and found to be as 85%. The travel speed of the system was measured as 15.68 feet per minute at the outer periphery.

Uniformity Parameters along Span of the System

Description	Segment Number				Overhang	Average
	1	2	3	4		
Cu%	71	88	92	82	72	81
Du%	67	88	89	76	79	79.8

Uniformity Parameters for the whole system

Cu%	Du%
84.5	84

An inception workshop was arranged of all the components of the project to refine the work plan and methodologies.

A training manual has been developed for the system evaluation and practical training was carried for the operation of the system.

Name of Project: Centre Pivot Irrigation System for Enhancing Water Productivity of Seed Multiplication System and Crop Production Systems (FO&S, NARC, Islamabad Component-II)

Name of PI/Institute: Mr. Talat Farid Ahmed
Sr. Engineer,
Farm Operation & Services, NARC, Islamabad

Duration: 01. 03. 2010 to 28. 02. 2013

Financial Status: Total Cost: Rs.21.231 million
Funds Released: Rs.17038900/-
Funds Utilized: Rs.9548757/-

Objectives:

- To develop Center-pivot sprinkler irrigation facilities for seed multiplication and crop production at NARC and other ecologies of Pakistan.
- To conduct research at various ecologies for crop production under center pivot irrigation systems.
- Devise packages of technology for optimum water productivity for seed and crop production.
- Demonstrate and disseminate state of the art irrigation technologies to farmers, extensionists, researchers and planners.

Achievements:

Development of Center Pivot Irrigation system Facility at NARC: In the first phase Center Pivot Irrigation System along with its accessories was procured, assembled and installed. The system is linked directly with the existing tubewell at selected site. Now the system is functional.

Development of Seed Multiplication System: In the second phase land use plan and design of experiments was done jointly by FO&S, WRI and Commodity Program Coordinators. Seed production plan for Kharif-2011 was prepared by different programs like Sugarcane, Pulses, Oilseeds, Fodder and Maize-Sorghum-Millet. Kharif crops sowing process is being in progress under this system as per respective programs plan.

Name of Project: Centre Pivot Irrigation System for Enhancing Water Productivity of Seed Multiplication System and Crop Production Systems (AZRI, Bahawalpur Component-III)

Name of PI/Institute: Dr. Rukhsana Anjum,
Director/Principal Scientific Officer,
Arid Zone Research Institute - PARC, Bahawalpur

Duration: 01. 03. 2010 to 28. 02. 2013

Financial Status: Total Cost: Rs.8.639 million
Funds Released: Rs.5615000/-
Funds Utilized: Rs.5226996/-

Objectives:

- To develop Center-pivot sprinkler irrigation facilities for seed multiplication and crop production at NARC and other ecologies of Pakistan.
- To conduct research at various ecologies for crop production under center pivot irrigation systems.
- Devise packages of technology for optimum water productivity for seed and crop production.
- Demonstrate and disseminate state of the art irrigation technologies to farmers, extensions, researchers and planners.

Achievements:

Selected an appropriate site for installation of Centre Pivot Irrigation System (CPIS) at AZRI farm, Bahawalpur. Installation of State of the Art CPIS has been completed by the Valley Irrigation (Pvt) Ltd. The system has been commissioned/made functional during the month of May, 2011.

Kharif plan for seed multiplication and seed production of valuable cash crops has already been prepared for 20 acres of land covered by Centre Pivot Irrigation System at AZRI farm, Bahawalpur.

Name of Project: Centre Pivot Irrigation System for Enhancing Water Productivity of Seed Multiplication System and Crop Production Systems (WRI Field Station, Thana Boula Khan, Hyderabad, Sindh Component-IV)

Name of PI/Institute: Mr. Abdul Ghani Soomro
Scientific Officer,
Water Resources Research Institute, Field Station, PARC
Thana Boula Khan, Hyderabad

Duration: 01. 03. 2010 to 28. 02. 2013

Financial Status: Total Cost: Rs.18.884 million
Funds Released: Rs.13789000/-
Funds Utilized: Rs.12833096/-

Objectives:

- To develop Center-pivot sprinkler irrigation facilities for seed multiplication and crop production at NARC and other ecologies of Pakistan.
- To conduct research at various ecologies for crop production under center pivot irrigation systems.
- Devise packages of technology for optimum water productivity for seed and crop production.

Achievements:

Twenty three farms were visited in districts of Tando Allah Yar, Jamshoro, Tando Muhammad Khan, Hyderabad, Matiari, Mirpurkhas, Sanghar, Naushero Feroz and Shahdadpur, Sindh due to big land holding prominent for agricultural production. Out of these, three sites were selected for installation of Centre Pivot Irrigation system. After visiting all the three sites by a team from PARC, a site near to Dada Bhaee Cement Factory at Saree Road, Tehsil Thana Boula Khan, district Jamshoro was selected on the basis of location, feasibility and accessibility of the farm.

The centre pivot irrigation system has been installed at the sites by Valley Irrigation (Pvt) Ltd. in February, 2011. Operation of the system was carried out on trial basis to check out the system performance.

Name of Project: Centre Pivot Irrigation System for Enhancing Water Productivity of Seed Multiplication System and Crop Production Systems (AZRC, Quetta Component-V)

Name of PI/Institute: Mr. Saifullah Khan,
Senior Scientific Officer,
Arid Zone Research Centre - PARC, Quetta

Duration: 01. 03. 2010 to 28. 02. 2013

Financial Status: Total Cost: Rs.8.432 million
Funds Released: Rs.5877800/-
Funds Utilized: Rs.5593215/-

Objectives:

- To develop center-pivot sprinkler irrigation facilities for crop production in Balochistan province ecologies of Pakistan.
- To conduct research for crop production under center pivot irrigation systems.
- Devise packages of technology for optimum water productivity for seed and crop production.
- Demonstrate and disseminate state of the art irrigation technologies to farmers, extension workers, researchers and planners.

Achievements:

Site for installation of Centre Pivot Irrigation system was selected at the foot hills of Chilton mountain filled with medium to large size boulders. Area was cleaned from stones and system was successfully installed through M/S Valley Irrigation Pakistan (Pvt) Ltd. in February, 2011. The system is not yet functional/operative as the current discharge capacity of the tube well at AZRI, Quetta is 50 gallons per minute whereas the required capacity for making the system functional is 250-350 gallons per minute. Efforts are underway to construct water reservoir with the coordination of Provincial Agriculture (Extension) Department, Government of Balochistan to make the system functional. In addition, installation of a second tube well with the funding of development project “Strengthening of National Agriculture Research System in Balochistan (NARS-B) is in progress. Functioning of the system will be linked either with the construction of reservoir or with the installation of new tube well. After the system is functional, breeder nucleus seed of wheat, barley & lentil varieties/lines will be multiplied. In addition, seed of improved mung and mash varieties will also be multiplied.

Name of Project: Centre Pivot Irrigation System for Enhancing Water Productivity of Seed Multiplication System and Crop Production Systems (AZRI, D. I. Khan, Component-VI)

Name of PI/Institute: Mr. Noman Latif,
Senior Scientific Officer,
Arid Zone Research Institute- PARC, Ratta Kulachi, D. I. Khan

Duration: 01. 03. 2010 to 28. 02. 2013

Financial Status: Total Cost: Rs.8.689 million
Funds Released: Rs.6401300/-
Funds Utilized: Rs.6391742/-

Objectives:

- To develop center-pivot sprinkler irrigation facilities for seed multiplication and crop production at NARC and other ecologies of Pakistan.
- To conduct research at various ecologies for crop production under center pivot irrigation systems.
- Devise packages of technology for optimum water productivity for seed and crop production.
- Demonstrate and disseminate state of the art irrigation technologies to farmers, extension workers, researchers and planners.

Achievements:

During the reporting period soil and water analysis of the proposed location were carried out. Topographic survey was also accomplished to find the area and dimensions of the proposed field, which came as 33.35 acres. However the circumference of Central Pivot system covers 20 acres.

A 150 ft deep bore was drilled for installation of turbine pump at the location. The Central Pivot Irrigation system has been installed by M/S Valley Irrigation (Pvt.) Ltd. with components including Genset, turbine pump with motor, controlling panel, sprinklers, pressure gauge, flow meter, fertilizer injection tank and pump with motor and commissioned successfully. The operational performance like emitter discharge, pressure, operating speed and genset produced voltage is satisfactory; however, further details can be given after carrying out different experiments. Kharif crop of mung-bean is sown at 01 acre with different study treatments to be conducted under irrigation from Central Pivot system.

A safety shed/room was also constructed for keeping the pump, genset and main electrical panel under the roof safe and also eliminate the danger of any damage by outsiders.

An inception workshop arranged by WRRI, NARC about the operational performance of the system was attended by the PI and another collaborating scientist at AZRI, D. I. Khan.

Name of Project: Use of Alternate Energy Sources for Pumping Water in Agriculture (NARC, Islamabad Component-I)

Name of PI/Institute: Mr. Abdul Wahab Siyal,
Asstt. Agri. Engineer,
Water Resources Research Institute, NARC, Islamabad

Duration: 01. 03. 2010 to 28. 02. 2013

Financial Status: Total Cost: Rs.10.414 million
Funds Released: Rs.6732000/-
Funds Utilized: Rs.3181764/-

Objectives:

- Develop and adapt pumping systems for irrigation water using alternative energy sources (solar, wind and biogas)
- Evaluate and improve efficiency of pumping systems run by alternative energy sources,
- Evaluate economics of pumping systems run through alternative energy sources.

Achievements:

Tender were floated for supply and installation of solar-powered pumping systems coupled with drip irrigation systems at five locations of Pakistan and Wind Generator at AZRI, Umkerkot.

Carried out renovation of existing infrastructure of Alternative Energy Laboratory at WRRRI field station, NARC. (Re-fixing and adjustment of Jack pump on solar and diesel power, repairing of wind generator, wiring and repairing of PV modules for both lighting and pumping purpose, construction of two concrete beds for engines and pumps, construction of one water tank, extending fencing around the laboratory and development of dugwell for desired depth).

Biogas systems at four components are completed at each site. Two biogas systems are developed at WRRRI field station. One is fixed dome Chinese type with 35 m³ capacity and other is Indian floating type with polyethylene (PE) gas holder and has 10 m³ capacity. Total capacity of the biogas system is 45 m³ which can be used for running/testing different engines for pumping water. Breakthrough has been achieved in developing large size PE gas holder with the collaboration of a local company. As a substitute to iron drum which requires regular maintenance costs due to painting, this biogas chamber is UV stabilized with a life of 20 years. Other purpose of the system is to the linking with fermentation of slurry for liquid and solid bio-fertilizer.

Survey was carried out for potential of livestock and dung in NARC. Around 77 animals are available, from which around 770 kg dung will be available per day. Around 500 kg dung will be available after collection and cleaning process. The 45 cubic meter capacity of biogas systems installed at WRRI, field station and available dung per day at LRS fulfills requirement of system capacity sufficiently. It is assumed that installed biogas systems will produce around 36 m³ raw biogas per day. That can run 16 hp diesel engine and 7.5 KW generator for 5 hours per day.

A 16 hp diesel engine converted on dual fuel and run successfully for pumping ground water and generating electricity at a same time in first year of the project.

Name of Project: Use of Alternate Energy Sources for Pumping Water in Agriculture (AZRI, Bahawalpur Component-II)

Name of PI/Institute: Dr. Rukhsana Anjum,
Director,
Arid Zone Research Institute - PARC, Bahawalpur

Duration: 01. 02. 2010 to 28. 02. 2013

Financial Status: Total Cost: Rs.6.912 million
Funds Released: Rs.1257000/-
Funds Utilized: Rs.519000/-

Objectives:

- Develop and adapt pumping systems for irrigation water using alternative energy sources (solar, wind, and biogas),
- Evaluate and improve efficiency of pumping systems run by alternative energy sources,
- Evaluate economics of pumping systems run through alternative energy sources.

Achievements:

Appropriate site was selected at AZRI farm of Bahawalpur. Construction of Biogas Unit has been completed. Production of methane gas has already started and is being tested in the field. Technical team from NARC has completed the survey and designed a system for pumping water. The purchasing of the relevant machinery will be made soon.

Name of Project: Use of Alternate Energy Sources for Pumping Water in Agriculture (AZRI, D. I. Khan, Component-III)

Name of PI/Institute: Mr. Noman Latif,
Senior Scientific Officer,
Aird Zone Research Institute - PARC, D. I. Khan

Duration: 01. 02. 2010 to 28. 02. 2013

Financial Status: Total Cost: Rs.7.176 million
Funds Released: Rs.5381000/-
Funds Utilized: Rs.1230255/-

Objectives:

- Develop and adapt pumping systems for irrigation water using alternative energy sources (solar and biogas)
- Evaluate and improve efficiency of pumping systems run by alternative energy sources.
- Evaluate economics of pumping systems run through alternative energy sources.

Achievements:

Ten agricultural farms with fruit orchards and livestock were visited during the reconnaissance survey. Economic profiling was also made to develop the base line. A farm (Abdul Rehman) farm was selected with more than 25 acres agricultural land with mango/ date and citrus orchard and over 50 livestock heads for fulfilling the bio-gas requirement.

Bio-gas digester was constructed/installed by the M/S Beta-Pak in June 2010. After filling the digester by animal dung with water, the July-August 2010, worst ever floods in Pakistan hit the area and people had abandon the place. After two months the digester was reactivated. However the dung inside had lost its efficacy and whole digester was emptied in September 2010. Again it was filled to the desired level with 3 trolleys of cow dung in October 2010, however this time the leakage problem occurred and gas went off without storage. On recommendation of the Company visit in December, 2010, the digester was emptied again. The company sealed the leaks and twice plastered the inside of fix dome and also an electric motor and mixing mechanism to keep the consistency of liquefied dung into the digester.

This time it worked and gas generation started at small scale i.e. for cooking purpose only. A tam of technical experts from WRRI visited the location in April 2011 and installed pressure gauges, thermo-couple and gas meter to monitor the flow volume. Regular gas generation started in April 2011 and a 12 hp diesel engine was coupled with gas. Initially it

operated for 01-02 hrs and eventually it reached to 04 hrs. In end May 2011, the gas pressure exceeded and dome was displaced from the walls with a bang. Project Coordinator and Company both were immediately contacted for the issue. The installation company had visited the location and developing some methodology for its repair. The digester is emptied again and system is un-operational for the time being.

Solar panels with pumping unit and drip irrigation system are under procurement. The site for solar operated pump of drip system was finalized at AZRI, D. I. Khan farm. A 120 ft deep bore is drilled for installation of submersible pump there.

Name of Project: Use of Alternate Energy Sources for Pumping Water in Agriculture (AZRI, Umerkot, Component-IV)

Name of PI/Institute: Mr. Hamaz Ali Samoon,
Asstt. Engineer,
Arid Zone Research Institute - PARC, Umerkot

Duration: 01. 02. 2010 to 28. 02. 2013

Financial Status: Total Cost: Rs.4.980 million
Funds Released: Rs.3723000/-
Funds Utilized: Rs.1260519/-

Objectives:

- Develop and adapt pumping systems for irrigation water using alternative energy sources (solar, wind, and biogas)
- Evaluate and improve efficiency of pumping systems run by alternative energy sources.
- Evaluate economics of pumping systems run through alternative energy sources.

Achievements:

Survey was carried out to estimate the potential of animal dung for biogas plants in the desert. As a result a large number of animals are available in the Thar desert and surrounding irrigated belt to meet the requirement of biogas plants. Meteorological data from Chore Meteorological Station and livestock from Government Department and NGOs has been gathered. Winds Mills installed for pumping water and biogas plants are also available for domestic use in the area. Biogas plants installed at Dhoronaro, Ghulam Nabi Shah and Raja Rasti were visited and examined to see their capacity of gas storage and daily use.

Solar system operating pumps have been installed with 2" delivery at Tebhri Bhambhro village near Chore and Nangar Parker. The farmers are growing lemons and vegetables on land irrigated through solar system operating pump and are satisfied from the system.

Submersible pump has been installed with 16 hp diesel engine. The biogas and diesel are being used in conjunction in the engine. The average discharge is 12 liters per second.

Name of Project: Solubility Enhancement of Phosphorus from Rock Phosphate (NARC, Islamabad Component-I)

Name of PI/Institute: Mr. Matiullah Khan,
Senior Scientific Officer,
Water Resources Research Institute, NARC, Islamabad

Duration: 08. 01. 2010 to 07. 01. 2013

Financial Status: Total Cost: Rs.5.749 million
Funds Released: Rs.2591600/-
Funds Utilized: Rs. 2000678/-

Objectives:

- Enhance the solubility of rock phosphate by biological means and formulate Biological Phosphate Rich Organic Matter (Bio-PROM) for better crop production.
- Explore other options for effective use of rock phosphate for better crop production.
- Collect information and categorize the indigenous resources of rock phosphate on the basis of phosphorus content.

Achievements:

During the reporting period (Jan 2010 to June 2011) collected samples of rock phosphate from Hazara area and analyzed for total P_2O_5 content. The results showed a range of P_2O_5 from 9 to 37%. It can be concluded that most of the indigenous reserves are fit for single super phosphate (SSP) fertilizer preparation.

Prepared manually 50 bags SSP from Hazara rock phosphate in field and concluded that '100 kg rock phosphate (mesh size 160) having total P_2O_5 of 26%, treated with 60 liter commercial sulphuric acid diluted as 1:1 (acid : water) by volume/volume basis, yielded SSP fertilizer of 19% available P_2O_5 . The cost incurred upon was half as compared with commercial SSP. The self prepared SSP gave at par response on crop as compared with commercial SSP.

Prepared Phosphorus enriched organic manure from Hazara rock phosphate and poultry litter. The compost contained 1.60% available and 6% total P_2O_5 . Application of this compost to rice crop at the rate of 60% of the recommended dose of phosphorus requirement, yielded better than the phosphorus applied at the rate of 100 kg ha⁻¹.

The P-enriched compost and self prepared SSP was tested on the groundnut crop at farmer's field under rain-fed condition of Pothwar. The self SSP gave good results by producing 3218 kg ha⁻¹ yield followed by P-Compost 2613 kg ha⁻¹, showing 38 and 71% increased

yield over control. The contrast results as compared to the rice effect might be due to the rainfed conditions and non application of nitrogen (N) in groundnut field.

Name of Project: Solubility Enhancement of Phosphorus from Rock Phosphate (KPK Agricultural University, Peshawar Component-II)

Name of PI/Institute: Dr. Muhammad Sharif
Professor,
Department of Soil and Environmental Sciences, KPK
Agricultural University, Peshawar

Duration: 08. 01. 2010 to 07. 01. 2013

Financial Status: Total Cost: Rs.3.867 million
Funds Released: Rs.2055500/-
Funds Utilized: Rs.1729198/-

Objectives:

- Enhance the solubility of rock phosphate by biological means and formulate Biological Phosphate Rich Organic Matter (Bio-PROM).
- Determine the effect of Bio-PROM technology on increasing crops production.
- Explore other options for effective utilization of rock phosphate for better crop production.

Achievements:

Different organic materials were composted with rock phosphate (RP) and the compost products were analyzed frequently. By composting with RP, extractable P concentration increased by 54%, 78%, 91% and 96% in city garbage, organic wastes, simple farm yard manure (FYM) and RP feeded FYM, respectively. Composting sugarcane pulp, press mud and humic acid with RP showed an increase in extractable concentration as 23%, 85% and 38%, respectively when compared with materials composted without RP. Materials in heaps were analyzed throughout composting process with interval of fifteen days for moisture content, N, P, organic carbon and pH values with established standard procedures.

Application of FYM, poultry manure (PM) and humic acids (HA) in different combination with RP significantly increased wheat yield and plant P uptake. The highest grain yield of 6000 kg ha⁻¹ was observed in treatment where RP was applied in combination with HA and PM. Total dry matter yield also showed similar response. The experiment on maize showed that full dose of the prepared compost with half recommended dose of SSP significantly increased yield and yield components of maize crop. Maximum maize grain yield of 3264 kg ha⁻¹, dry matter yield of 9634 kg ha⁻¹, stover yield of 7293 kg ha⁻¹ and 230.5 g ha⁻¹ thousand grains weight of maize were recorded in the treatment where full

dose of compost was applied with half dose of recommended SSP followed by the yield in treatment of full recommended dose of SSP.

The capability of bacterial species to solubilize P from RP was studied by incubation of these bacteria qualitatively in solid pikoskaya medium to form a clear light zone surrounding colonies and quantitatively in liquid pikoskaya medium, which showed that 756 mg Kg⁻¹ (0.08%), 465 mg Kg⁻¹ (0.05%) and 202 mg Kg⁻¹ (0.02%) P was solubilized by *Pseudomonas fluorescence*, *P. putida* and *Bacillus megaterium* var. *phosphaticum*, respectively. Shoot dry weight of pearl millet (*Penisetum glaucum*. L) improved by 13.4%, 8.3% and 14.4% over the treatment of RP alone with the inoculation of AMF (*Glomus intraradices*) and PSB (*Bacillus megaterium* var. *phosphaticum*) alone and in combination, respectively with RP. The uptake of P by millet plants increased as 22%, 8% and 25% with the inoculation of AMF and PSB alone and in combination, respectively with RP.

Incubation experiment is in progress in laboratory to determine the effects of different organic acids on P solubility from RP with time. Laboratory and statistical analyses of the various parameters recorded during plants growth period are in progress.

Name of Project: To Improve the Palatability and Nutritive Value of Comparatively Low Palatable Forage Species

Name of PI/Institute: Dr. Imtiaz Ahmad Qamar,
Senior Scientific Officer,
Rangeland Research Institute, NARC, Islamabad

Duration: 18. 01. 2010 to 17. 01. 2013

Financial Status: Total Cost: Rs.7.140 million
Funds Released: Rs.3146800/-
Funds Utilized: Rs.2264849/-

Objectives:

- To evaluate nutritive value of low palatable grasses at different stages of their phenological development
- To add value to less palatable grasses by mixing with waste materials left over from fruits, vegetables, green fodders, and leaves of multipurpose tree species etc.
- To conduct feeding and digestion trials of value added less palatable grasses with the livestock.
- To survey Pothwar, Balochistan and Northern Areas rangeland to assess biomass production of relatively low palatable grass species.
- To conduct economic analysis through calculation of cost/benefit ratio of the new intervention.

Achievements:

Development of bag silage technology at household level: Pothwar region has sufficient supply of forage for grazing livestock during spring and monsoon seasons while other parts of the year like May-June and October-November are the acute feed deficit periods. Silage is the preservation of fresh fodder under anaerobic conditions, Silage formation of many fodder cereals and legumes are being practiced. Mixing of low palatable grasses with maize and ensiling them and adding value can conserve high quality silage for feed deficit period.

Silage was prepared from maize and unpalatable grass of Dabb. (*Desmostachya bipinnata*), Johnson grass (*Sorghum halepense*), Bari grass (*Chrysopogon aucheri*) and Sariala (*Heteropogon contortus*). Chopped maize and low palatable grasses were mixed in the ratio of 3:1. The silage was further value added with molasses (3%), and Effective Micro-organisms (EM). Molasses treated hay quality was superior. However E.M. had no effect on quality.

This successful intervention will help incorporate low palatable grasses into the existing

feed resources. The most important aspect of this study is that once the silage is ready in January-February, can be preserved for a longer duration and will be available to the livestock during the months of fodder scarcity period of May and June and October – November, when little green fodder/forage is available to the livestock.

Improving the Nutritive Value of Less Palatable Grasses by Mixing Iple Iple Leaves: Unpalatable grasses of *Sorghum halepense*, *Chrysopogon aucheri*, *Heteropogon contours* and *Desmostachya bipinnata* were mixed with tree leaves of ipile ipile in the ratio of 75% grass + 25% tree leaves, 50% grass + 50% tree leaves, 25% grass + 75% tree leaves along with sole treatments of grass and tree leaves. Samples were dried in an oven at 80°C to a constant weight for at least 24 hours, will be ground and analyzed for the moisture, crude protein, ether extract and crude fiber. The addition of the leguminous ipil ipil leaves improved palatability, digestibility and crude protein content of the feed.

Development of Value Added Hay of Low Palatable Grasses: Hay formation of many fodder cereals, legumes and grasses is being practiced throughout the world. Value addition of forages grasses is also done by adding urea, molasses and EM. Hay was prepared from unpalatable grass of *Desmostachya bipinnata*, *Sorghum halepense*, *Chrysopogon aucheri*, and *Heteropogon contortus*. These low palatable grasses were harvested from the pasture area of NARC and were chopped. The low palatable hay quality was improved with urea molasses Effective Micro-organisms (EM). Addition of urea increased crude protein content while molasses increased available carbohydrates. This successful intervention will help incorporating low palatable grasses into the existing feedlot while enhancing their quality in term of carbohydrate and crude protein content. The most important aspect of this study is that the hay conserved during spring season will be available to the livestock during the months of fodder scarcity period of May and June and hay from monsoon grasses will be utilized during lean period of October and November when almost no green fodder/forage is available.

Name of Project: Seed Production of Multi-purpose Trees and Forage Species (RRI - NARC, Islamabad Component-I)

Name of PI/Institute: Dr. Javed Afzal,
Senior Scientific Officer,
Rangeland Research Institute, NARC, Islamabad

Duration: 02. 02. 2010 to 01. 02. 2013

Financial Status: Total Cost: Rs.3.242 million
Funds Released: Rs.1578500/-
Funds Utilized: Rs.1193014/-

Objectives:

- To ensure supply of quality seed of multipurpose trees and forage species of foothills and moist temperate zone of Murree for research and development activities.
- To generate baseline data regarding tree phenology, seed viability, and germination percentage of different plant species.

Achievements:

Established six Seed Collection Units at different PARC establishments along altitudinal gradient from sea level to mountain areas covering wide range of tree, shrub, and grass biodiversity.

Developed a check list of 207 plant species for seed collection. Collected more than 1.7 ton good quality seed of 46 tree, shrub, and grass species. Developed grass progeny of promising grass species over one ha at RRI field, NARC.

Recorded flowering and seed harvest time of 46 plant species. Counted number of seed kg⁻¹ of 46 plant species and tested germination percentage of 34 plant species.

Distributed 115 kg seed of improved castor bean variety DS-30-1 among 49 farmers of Cholistan desert. Provided and/or sold 157 kg seed of about 30 species to the end users including NGOs, GOs, delegates, farmers and collaborators for research and development purposes.

The above activities will ensure not only supply of good quality seed for research and restoration activities but will also help develop guidelines for utilization of seed of multipurpose tree and forage species for better seedling production.

Name of Project: Seed Production of Multi-purpose Trees and Forage Species (MARC, PARC, Gilgit Component-II)

Name of PI/Institute: Mr. Munir Hussain,
Senior Scientific Officer
Mountain Agricultural Research Centre (MARC), PARC, Gilgit

Duration: 02. 02. 2010 to 01. 02. 2013

Financial Status: Total Cost: Rs.1.320 million
Funds Released: Rs.533800/-
Funds Utilized: Rs.422688/-

Objectives:

- To ensure supply of quality seed of multi-purposes trees and forage species of dry temperate zone of Gilgit-Biltistan for research and development activities.
- To generate base line data recording trees phonology, seed viability and germination percentage of different plant species.

Achievements:

Different potential valleys/locations in Gilgit Baltistan were visited for selection of suitable sites for seed collection of multi-purpose trees and forage species. The sites visited were; Buner Dass and Gunerfarm, Gais Bala and Paun, Khiner valley, Batogah valley, Thore valley, Ghachi valley, Darel valley, Tangir valley and Babusar valley. The seeds of multi-purpose trees and forages species; Mulberry (*Morus alba*): 135 kg, Berr (*Zizyphus mauritiana*): 174 kg, Sheshum (*Delbergia sisso*): 16 kg, Parking (*Parkinsonai rhamnoids*): 386 kg, Kikar (*Acacia nilotica*): 18 kg and Juniper (*Juniperus excelsa*): 60 kg were collected. During seed collection, information on pheonology including time of flowereing, seed setting and seed maturity was recorded.

Germination test of different multipurpose trees were conducted in trays. After sowing of seed from one week to six week observation on germinated seeds were recorded for calculating the germination percentage of collected seeds.

Name of Project: Seed Production of Multi-purpose Trees and Forage Species (AZRC - Quetta Component-III)

Name of PI/Institute: Mr. Muhammad Afzal,
Senior Scientific Officer,
Arid Zone Research Centre - PARC, Quetta

Duration: 02. 02. 2010 to 01. 02. 2013

Financial Status: Total Cost: Rs.1.320 million
Funds Released: Rs.684700/-
Funds Utilized: Rs.622535/-

Objectives:

- To collect quality seed of important multipurpose trees, shrubs and grasses from different ecological zones of Balochistan.
- To generate baseline data regarding tree phenology, seed viability, and germination percentage of different plant species.

Achievements:

Collected 3326 kg of quality seed of 63 species from all over Balochistan against the target of 2050 kg. Recorded flowering and seed harvest time of these species. Data on number of seeds/cone, number of seeds/kg of 22 plants species collected.

Seed cleaning of 43 plants species after cleaning the seed treated with insecticide and fungicide to save the seed from insect attack was completed.

Germination and viability test of 37 trees/shrubs/grasses species has been carried out in laboratory and nursery conditions. Germination percentage was bit lower due to off-season. Eleven grass species has been planted in nursery and germination percentage was 20 to 70%. Two samples of each species comprising 25 seeds in each have randomly taken under lab testing. Trees and shrubs were included in this testing. Germination was highly successful and more than 70% germination reported.

Distributed 30 kg seed to AZRC and RRI, NARC, Islamabad for research and development activities. A small scale nursery has been developed at AZRC, farm.

Name of Project: Seed Production of Multi-purpose Trees and Forage Species (AZRI, Bahawalpur Component-IV)

Name of PI/Institute: Mr. Bashir Ahmad
Senior Scientific Officer,
Arid Zone Research Institute - PARC, Bahawalpur

Duration: 02. 02. 2010 to 01. 02. 2013

Financial Status: Total Cost: Rs.9.8418 million
Funds Released: Rs.213000/-
Funds Utilized: Rs.101000/-

Objectives:

- To ensure supply of quality seed multipurpose trees and forage species of Cholistan desert of Bahawalpur for research and development activities.
- To generate baseline data regarding tree phenology, seed viability, and germination percentage of different plant species.

Achievements:

A list comprising of 08 desert trees and 10 grass species of Cholistan desert of Bahawalpur have been developed. Data on flowering and seed harvest time of more than 19 species has been collected and compiled.

A sufficient quantity of the seeds of multipurpose trees and forage species have been collected from the Cholistan desert for research and collaboration activities as well as to provide the farmers of this region on payment basis.

After harvesting, germination time of *Acacia nilotica*, *Acacia ampliceps*, *Prosopis cineraria*, *Ziziphus mauritiana*, *Parkensonea aculeate*, *Azadirachta indica*, *Moringa oleifera*, *Millettia pinnata*, *Dalbergia sisso*, *Melia azedarch* and *Lasiurus indicus* was tested under agro-climatic conditions of Bahawalpur.

Name of Project: Seed Production of Multi-purpose Trees and Forage Species (AZRI, D. I. Khan Component-V)

Name of PI/Institute: Mr. Aman Ullah Khan
Senior Scientific Officer,
Arid Zone Research Institute - PARC, D. I. Khan

Duration: 02. 02. 2010 to 01. 02. 2013

Financial Status: Total Cost: Rs.1.320 million
Funds Released: Rs.649600/-
Funds Utilized: Rs.498109/-

Objectives:

- To ensure supply of quality seed of multipurpose trees and forage species of arid zone of D. I. Khan for research and development activities.
- To generate base line data regarding tree phonology, seed viability, and germination percentage of different plant species.

Achievements:

During the period under report efforts were made and collected quality seed of important multipurpose trees and forage species from arid zone of D. I. Khan:

S.#	Name of Species	Botanical Name	Seed collected
1	Mizri	<i>Nannorrhops ritchiana</i>	50 kg seed against target of 50 kg
2	Bakain	<i>Melia azadrach</i>	200 kg against target of 200 kg
3	Shisham	<i>Dalbergia sissoo</i>	80 kg against target of 100 kg
4	Ber	<i>Zizyphus mauritiana</i>	300 kg against target of 300 kg
5	Siris	<i>Albizia lebbek</i>	70 kg against target of 100 kg
6	Iple-Iple	<i>Leucaena leucocephala</i>	10 kg against target of 100 kg
7	Jandi	<i>Prosopis cineraria</i>	Seed collection under process against target of 150 kg
8	-	<i>Acacia faidherbia</i>	40 kg against target of 50 kg
9	Babul, Kikar	<i>Acacia nilotica</i>	Seed collection under process against target of 400 kg
10	Kikar	<i>Acacia ampliceps</i>	07 kg seed collected
11	Kikar	<i>Acacia coracia</i>	01 kg seed collected

Name of Project: Seed Production of Multi-purpose Trees and Forage Species (AZRI, Umerkot, Sindh Component-VI)

Name of PI/Institute: Mr. Ghulam Shabbir Bohio,
Principal Scientific Officer,
Arid Zone Research Centre - PARC, Umerkot.

Duration: 02. 02. 2010 to 01. 02. 2013

Financial Status: Total Cost: Rs.1.320 million
Funds Released: Rs.509100/-
Funds Utilized: Rs.357682/-

Objectives:

- To collect quality seed important multi purpose trees shrubs and grasses from different ecological zones of Pakistan.
- To generate base line data regarding tree phonology, seed viability, and germination percentage of different plant species.
- Progress achievements July 2010 to June 2011.

Achievements:

Seed Collection: 1207 kg seed of desert species of shrubs, grasses and trees have been collected from selected sites at Mithi, Kantio, Islamkot, Chelhar, Naukot and live herbarium of AZRI Umerkot. Seed of different species viz; *Acacia senegal*, *Acacia ampliceps*, *Acacia stenophylla*, *Acacia nilotica*, *Acacia parkansonia*, *Lasiurus scindicus*, *Panicum antidotale*, *Cenchrus biflorus* and *Zizuphus numularia* etc. were collected

Seed Cleaning: All the collected seed of trees, grasses and shrubs were cleaned on manual methods i.e. sieving fanning, winnowing, beating and hammering.

Seed Storage: The cleaned seeds sun dried were treated with insecticide and fungicides and was packed in the plastic and cloths bags of 10 kg.

Collection of Phonological Information: During the processing of seed collection, information on phonology was recorded such as name of species, local name, flowering time and maturity of seed.

Seed Counting, Viability and Germination: Maximum seed was obtained from *Acacia senegal* followed by *Acacia amplicep*. The tree species of *Acacia senegal*, *Acacia jaqamotti* and *Prosopis cineraria* showed highest seed viability as compared to grasses and shrub species. Germination test was carried out for *Acacia ampliceps*, *Acacia stenophylly*, *Acacia*

parkansonia *Acacia jaqamotti*, *Tecoma undulate*, *Albizia lebbek*, *Commiphoroa mukul*, *Lasiurus sindicus*, *Panicum turgidum* and *Panicum antidotale*. Due to low and high temperature in desert area, trees and grasses germinated 50% while shrubs germinated 10% at AZRI nursery, Umerkot.

Name of Project: Management of Rawal Watershed under Changing Landuse

Name of PI/Institute: Mr. Muhammad Saleem Pomee,
Scientific Officer,
Water Resources Research Institute, NARC, Islamabad

Duration: 28. 09. 2010 to 27. 09. 2013

Financial Status: Total Cost: Rs. 21.722 million
Funds Released: Rs. 4448600/-
Funds Utilized: Rs. 3633297/-

Objectives:

- Organization of Rawal Watershed users through a process of social organization and social engineering at selected sub-watersheds.
- Participatory assessment of current state of Rawal watershed at selected sub-watershed in terms of changing landuse and infrastructural development.
- Develop integrated strategy for cost effective management of Rawal Watershed based on experimental interventions in selected sub-watershed for sustainable yield and livelihood.

Achievements:

Reconnaissance survey of Rawal Watershed area was carried out. Initially three sub-watersheds selected to represent different ecological conditions. Process of social organization initiated for establishment of watershed user association at selected sub-watersheds. Participatory rapid appraisal (PRA) has been completed at ArroKus, Pail and Ghoragali field area through structured individual and group discussions. The prevailing demography, real issues and entry points have been identified after processing results through SPSS software and prepared detail report. Community organization at ArroKus upper watershed area was successfully established.

The detailed delineation of Salgiran sub-watershed indicating landuse, drainage pattern, elevation ranges and other important infrastructure have been completed through GIS/RS image processing. The water resources (surface and ground waters), and land resources have been analyzed for database development in terms of quality. To address the issues of sewage effluent discharges into freshwater creeks (leading toward Rawal Dam), a comprehensive wastewater sampling strategy has been developed to investigate temporal and spatial water quality variations in Bharakaho subcatchment. The results are being analyzed to devise average organic and hydraulic loading rates so that appropriate wastewater management technology can be suggested.

Monitoring systems have been established at selected locations within Rawal Watershed area to estimate meteorological, hydrological (runoff and sediment transport) and soil moisture information on long term basis. The data so far gathered is being organized for database development and meaningful analysis.

Sustainable irrigation systems have been planned, designed and constructed in close consultation with local community to convert about 100 kanals of culturable wasteland into productive agricultural farms at ArroKus field area. The irrigation system comprised of two contour channel having total discharge capacities of 1.4 to 1.6 cfs. The water productivity improvement trials under both irrigated and rainfed environments of Rawal watershed have been initiated. Irrigation scheduling is being made by using multiple criterions (tensiometers, farmers' judgment and Cropwat-W model based scheduling). Tensiometers have been installed at various locations and calibrated with soil moisture content across crop root zone to develop characteristics curve for ArroKus field area. While Cropwat-W model has been run by using historical meteorological data and other localized information to assess water needs of maize crop and farmer's behavior is being monitored for irrigation. Similarly, trials on water productivity under rainfed conditions of Ghoragali and Satrameel have also been started by using improved farming practices including variable tillage. The data is being collected for water use efficiency estimations under both irrigated and rainfed systems.

Efforts to establish fruit/forest nurseries have been initiated in Satrameel. The existing nursery has been supplemented with more fruit and forest plants. Land preparation, fencing and irrigation facility has been developed at ArroKus field area to establish another nursery. Automated irrigation facility over 4 kanals of Satrameel nursery area was designed and constructed for demonstration purpose.

To build the capacity of local community, short-term training workshop on Kitchen gardening was organized for females of ArroKus field area.

Name of Project: Commercialization of Biofertilizer (inoculant) for Important Crops

Name of PI/Institute: Dr. Muhammad Aslam,
Principal Scientific Officer,
Soil Biology, LRRI, NARC, Islamabad

Duration: 25. 10. 2010 to 24. 10. 2013

Financial Status: Total Cost: Rs.10.818 million
Funds Released: Rs.4465500/-
Funds Utilized: Rs.92467/-

Objectives:

- Commercialization of multipurpose synthesized biofertilizer through private sector.
- Technical backstop support to private sector: Build capacity of private sector for mass propagation of microbial inoculants, field testing, impact monitoring.
- Provide feedback to production team for improvement of the quality of Biofertilizer.
- Up-scaling of the existing pilot production facility.

Achievements:

The Soil Biology & Biochemistry group of LRRI had worked on legume & cereal crops and established a microbial gene bank and a Bio-inoculant (Biofertilizer) Production Unit at Innovative Technology Yard, National Agricultural Research Centre, Islamabad. The following achievements were made under this project:

- For commercialization of Biozote different private sector companies were visit like Four Brothers Pvt. (Ltd.), Auriga Chemicals Pvt. (Ltd.), Techserve Pvt. (Ltd) and Technology International. The field demonstrations were conducted at two sites; one at Research Farm of Four Brothers, new Waga Border, Lahore and other on comparative study of Biozote vs Humiphos (Biofertilizer of Auriga Chemicals) at Kala Shah Kaku, Research Farm. The Biozote performed better than Humiphos and Dr. Irfan-ul-Haq, Manager Technical, Auriga Chemical was convinced by the performance of Biozote.
- M/S Techserve Pvt. (Ltd.), marketed Biozote for 1000 acres during recent wheat season (2011-12) and they are interested to sign an agreement for Biozote marketing with PARC.
- Negotiations are in progress with Technology International Pvt. (Ltd), Faisalabad for private production of Biozote.
- Farmer field demonstrations of Biozote for wheat crop were conducted at different locations under Rice-wheat area during 2010-2011. The crop yields were increased by 10-20% with 25% less chemical fertilizers than the recommended rate of application.

- During Kharif 2011, about 125 acres of direct seeded rice were treated with Biozote and 25 acres of transplanted rice were sown after treating with biozote solution. The yield of direct seeded rice was 5-10 monds higher than transplanted rice at different locations. Even then Biozote increased 7-15% higher paddy yield than untreated plots.
- A farmer field day for “**direct seeding of rice with biozote inoculation**” was conducted at Vashuki Kallan, Hafizabad. At that occasion more than 70 farmers and a number of PARC scientists participated.
- Up-scaling of Biofertilizers (Bio-inoculants) Production Unit at Innovative Technology Yard, NARC in progress.

Name of Project: **Formulation and Quality Improvement of Biofertilizers (inoculants) for Crop Production**

Name of PI/Institute: **Dr. Tariq Sultan,**
Senior Scientific Officer,
Soil Biology, LRRI, Islamabad

Duration: 27.10.2010 to 26.10.2013

Financial Status: Total Cost: Rs.9.988 million
Funds Released: Rs.4756500/-
Funds Utilized: Rs.177992/-

Objectives:

- Isolation and identification of beneficial bacteria from roots and rhizosphere soil of sugarcane and cotton.
- Selection of isolates showing high nitrogen fixing, phosphorous solubilizing activity and/or producing higher amounts of phytohormones.
- Evaluation and selection of the promising strains and their combinations showing beneficial effects on their respective host crop under lab. greenhouse as well as field conditions.

Achievements:

Cotton rhizosphere soil and root samples were collected from Southern Punjab; Multan, Khanewal, Sahiwal and Vehari and for sugarcane from central Punjab; Faisalabad, Sargodha and Sheikhpura districts were collected. Isolation and plant growth promoting bacteria (PGPR) and phosphate solubilizing (PSB) from these samples was done by dilution plate method. The plates were incubated at 26-28⁰C for 3-4 days and then studied for various morphological characteristics of microbes. Different types of colonies were counted and studied under microscope and their morphology was noted. Selected colonies were picked and the microbial strains were purified by 4-way streaking. Twenty strains from cotton and 45 from sugarcane rhizosphere were purified and preserved on Luria-Bertani (LB) media. The strains were characterized for gram staining, growth hormone production and phosphate solubilizing capabilities. The purified strains were then preserved on slants and stored for further testing/evaluation. The PGPR isolates of cotton and sugarcane were screened by method adopted by standard procedure of spectrophotometer using tryptophan as precursor in the culture media. Development of pink color was an indication. The hormones produced were estimated by standard IAA graph. The promising strains having high efficiency of IAA & PSB were tested for cotton under green house conditions.

The project salient achievements are as under:

- Twenty (20) strains from cotton & forty five (45) strains from sugarcane rhizosphere were purified for microbial gene bank.
- Four promising strains were tested under greenhouse conditions out of which two strains performed better and these strains will be used for field experiments.
- The sugarcane strains are being under characterized for beneficial functions, fourteen (14) were found as good candidates for phosphate solubilization.
- The carrier used for biofertilizers is very important for its formulation development. For this purpose, initiated research on the development of new carrier material.
- New maize isolates were evaluated under green house as well as field conditions (study in progress).
- The rhizobium strain of mungbean were evaluated for co-inoculation with PSB under green house and field conditions (crop harvested and data analysis in progress)

Name of Project: **Model Women Network of Livestock Farmers for Poverty Reduction**

Name of PI/Institute: **Mr. Manzoor Ali Memon**
Principal Scientific Officer,
Technology Transfer Institute (TTI) - PARC, Tandojam

Duration: 18. 01. 2010 to 17. 01. 2013

Financial Status: Total Cost: Rs.7.933 million
Funds Released: Rs.4701000/-
Funds Utilized: Rs.450424/- (up to 30. 06. 2010)

Objectives:

- Capacity Development of Livestock Farmers (men & women)
- Strengthening Public Private partnership
- Facilitating Livestock
- Research and Development
- Formation of Women Livestock Farmers Groups

Achievements:

The activities under the project are being conducted in Nawabshah and Sanghar districts of Sindh to form a livestock farmers network at local level to obtain maximum benefits from their resources and brought change in the existing livestock system to enhance technical capacity of livestock farmers to reduce losses and control over best management practices.

The baseline survey of selected talukas (tehsils) of Sanghar (Sanghar and Sanjhor) and Nawabshah (Nawabshah and Sakrand) district carried out and data was analyzed. Farmer's registration and livestock facilitator completed. Two 04 days trainings, one each at Sanghar and Nawabshah of livestock facilitator of both the district and students of Shaheed Banazir Public School, Nawabshah conducted on yoghurt preparation, livestock diseases, prevention and cure, social mobilization and gender development during 2010. More than 12 community meetings of livestock farmer group (LFG) of different villages in each district have also been organized. Similarly training of LFG at village levels has also been conducted.

Name of Project: Establishment of Milk Cooperative Marketing Systems in Tehsil Fateh Jang

Name of PI/Institute: Mr. Noor-ul-Hassan Tehseen,
General Manager,
IDARA-E-KISAN, Lahore Milk Plant, Lahore

Duration: 09. 09. 2010 to 08. 09. 2013

Financial Status: Total Cost: Rs.27.100 million
Funds Released: Rs.10060000/-
Funds Utilized: Rs./-

Objectives:

- To provide alternate improved cooperative milk marketing facilities and infrastructure for better returns to producers of milk in the project area
- To provide sustainable livestock services such as veterinary health, artificial insemination and fodder production to the member farmers of the cooperatives
- To provide meat marketing initiatives by calves fattening
- To provide development and social facilities to member farmer's women for their empowerment.

Achievements:

Visited 57 sites in 50 villages of Tehsil Fateh Jang and selected 36 villages for milk marketing. Meetings were held with the farmers. Purchased breeding bulls (5) and procured chillers (6) & other equipment (oven, AI kit, fridge & veterinary kit). Semen centre and veterinary centre developed for providing breeding and veterinary coverage for animals of farmers. Small livestock keepers were socially mobilized and village cooperatives formulated. AI facilities were provided to 270 member farmers.