FOREWORD

Agriculture is the backbone of Pakistan's economy. It accounts for 20.9 percent of the GDP and 43.4% of the total work force and is the main sources of livelihood for 66% of the country's population living in rural areas. Growth in agriculture sector registered a sharp recovery in 2006-07 and grew by 5%. Agriculture contributes to the country's exports and also provides raw material to major industries such as textile, sugar, dairy, leather and other agro-based industries as well as market for industrial products.

Pakistan Agricultural Research Council (PARC) being the apex research organization at national level is responsible to undertake, aid, promote, and coordinate research at federal and provincial levels plays an important role in advancing agricultural research. PARC maintain its linkages at national and provincial levels by funding research projects from various sources. PARC has also strengthened research collaboration with international and regional research organizations and centres such as CIMMYT, FAO, ICARDA, ICIMOD, IFPRI, IRRI and USDA and bilateral cooperation with several countries such as Bangladesh, China, Egypt, India, Iran, and Nepal etc.

The Agricultural Research Endowment Fund (AREF) established by the Government of Pakistan in 1999 for Rs.1.3 billion for Agricultural Linkages Program (ALP) with the assistance from USA. The objectives of ALP is to promote and support agricultural research and development activities in accordance with the Pakistan's long term development goals and to promote long term scientific cooperation between Pakistan and the United States in agriculture sector. The Planning Directorate of PARC performing the functions of ALP Secretariat is handling the operation of ALP. The Secretariat has so far launched three batches of projects all over the country in research centres, institutes, stations and universities.

The completed projects have contributed in updating the research and development of agriculture. The contributions and achievements of 75 completed projects has already been published during 2006 and were presented in the ALP 3rd International Workshop. The achievements made by other projects has been reported in final technical progress reports, provided to the technical divisions and PARC/NARC libraries, will be useful for reference and further use by the scientists. The efforts of the scientists in implementation and completion of ALP projects is highly appreciated.

This 5th annual progress report highlights the activities and performance of ALP Secretariat. It covers status of ALP projects, technical and financial progress of ongoing projects and monitoring and evaluation of projects and key findings. The efforts of Ms. Shahida Jamil, Executive Director, ALP, PARC and other ALP team who prepared and compiled the 5th Annual Progress Report 2007 deserve special thanks and appreciation for compiling the document highlighting the summary of ALP completed and ongoing projects.

Chairman, PARC/BOD, ALP

ACKNOWLEDGEMENT

The Government of Pakistan established an Agricultural Research Endowment Fund (AREF) in 1999 for Rs.1.3 billion under Agricultural Linkages Program (ALP) with the assistance of USA. The ALP fund was to be utilized by Pakistan Agricultural Research Council (PARC) for operating agricultural research and innovation through competitive grant mechanism. PARC being the apex research organization at national level has been implementing the program. The Planning Directorate is performing the functions of ALP Secretariat and is launching the program from processing & approval to the completion stage of projects. Since the initiation, the ALP Secretariat has implemented projects in three batches in priority areas on competitive basis in various research centres/institutes, organizations and universities.

The officers of the Planning Directorate, PARC working as Desk Officers of ALP projects play an important role in successful implementation of the projects. They are involved in all the steps of projects i.e. invitation of preliminary proposals, short listing, appraisal, approval, implementation, monitoring and evaluation and completion of projects. The Technical Divisions and Finance Division also play an equal role in implementation of projects i.e. timely releases and technical advice etc. Their timely support is appreciated and acknowledged.

All the time, kind support and guidance of Dr. M. E. Tusneem, the Chairman, PARC and BOD of ALP has been a constant source of encouragement and motivation.

I proudly mention the names of my colleagues, Dr. Muhammad Mushtaq, PSO, Mr. Noor M. Khan, PSO, Mr. Zia-ul-Haq, Dy. Director, Mr. Muhammad Asif, Dy. Director, Mr. Shujaat Yaqoob, Dy. Director and Mr. Tahir Zahoor Chohan, Assistant Director for their contribution in compilation of the report and smooth implementation of the ALP. Due to their hard work and devotion this program is a success.

Contribution of other staff members including Mr. Muhammad Ali, Superintendent, Mr. Muhammad Aslam, Mr. Jahangir Khan, Mr. Muhammad Javid Bhatti, Office Assistants, Ms. Nighat, Stenographer, Mr. Mushahid Raza, DEO, and Mr. Safeer A, Sabri, Steno typist being part of ALP team also merits acknowledgement and appreciation.

Executive Director (ALP)

INTRODUCTION

Pakistan's economy is still predominantly agrarian in nature. Agriculture accounts for 20.9 percent of the GDP and 43.4% of the total work force and is the main sources of livelihood for 66% of the country's population living in rural areas. Growth in agriculture sector registered a sharp recovery in 2006-07 and grew by 5%. Agriculture is playing a key role in stability and growth of country's economy.

PARC being the apex national agricultural research organization plays an important role and support agricultural research in the country. PARC is operating the Agricultural Research Endowment Fund (AREF), established by the Government of Pakistan in 1999 for Rs.1.3 billion for Agricultural Linkages Program (ALP). The objectives of ALP is to promote and support agricultural research and development activities in accordance with the Pakistan's long term development goals and to promote long term scientific cooperation between Pakistan and the United States in agriculture sector.

PARC is responsible for operation of ALP funds. It includes selection, processing, approval, monitoring, evaluation and coordination of projects, supported in whole or in part by the fund. The primary source of such funding shall be from the income of the fund. The fund shall minimize its annual operational costs to permit the maximum utilization of its resources to support agricultural research and development grants from all public or private entities that demonstrate needed research and development (R&D) capabilities and financial responsibilities. The fund shall encourage project proposals to be developed and submitted jointly by the Pakistani and US scientists.

The Planning Directorate of PARC is the Secretariat of ALP and Director (Planning) is the Executive Director of the fund. The ALP has its own management system and the Board of Directors (BOD) is the governing body of ALP fund responsible for the fund's program and its financial and managerial policies. The Chairman, PARC is the Chairman of the 15 members Board of Directors posses all the powers necessary to carryout its objectives.

This program is fully functional since 2000 and successfully launched three batches of projects. The progress report is compiled every year by ALP Secretariat. The 5th annual progress report for the year 2007 includes progress of ongoing projects and implementation status of 3rd batch announced in March 2006.

EXECUTIVE SUMMARY

Since inception of the ALP, three batches of projects has been launched; 1st in December 2000, 2nd in July 2002 and 3rd in March 2006 for funding. In total 1835 preliminary proposals were received from scientists and BOD of ALP finally approved 276 projects worth Rs.755.868 million approximately. So far 156 projects have been completed, while 94 continued and remained in operation for achieving the objectives.

The completed projects besides research and development have i) strengthened the institutes in form of research and lab. equipments, machinery and computers etc., ii) host institutes were provided operational funds and made functional to some extent, iii) new knowledge and information has been generated in forms of progress reports, research papers, brochures etc. and shared with scientists through circulation, field days and seminars, workshops etc., iv) supported students especially in agricultural universities in conducting research for their degree program, v) provided job and better training facilities to the graduate students on recruitment in projects as Research Assistants/Fellows/Associates, vi) being the 1st competitive grant in field of agricultural research, enhanced the capabilities and skills of scientists to develop and win research proposals for funding and vii) established national and international linkages and coordination among various research scientists and institutes. The achievement of 86 completed projects has already been published in December 2006 on the occasion of ALP 3rd International Workshop.

Research is being conducted under ongoing ALP research projects on improvement and standardization of vaccine for important diseases of animals, epidemiology of major animal diseases, alternate feed resources, micronutrient feed resources, cryopreservation of buffaloes semen, mastitis control, feed for intensive fish and shellfish culture, epidemiology and control of fish diseases, maintenance of genetic diversity, crop improvement, post harvest management, integrated pest management, improved technology, development of new varieties, weed management, micro-nutrient management of fruit plants, soil fertility and crop productivity, management of salt affected soil and brackish water, recycling of organic wastes and impact of sewage wastes on soil properties, water harvesting and quality management, plant growth through use of nitrogen, rhizobial inoculation & biofertilizer, economic efficiency, competitiveness and sustainability of farming systems, agricultural productivity and technology transfer etc. Useful research information has been generated through research studies conducted under these projects. The projects contributed in form of new knowledge and training of research students in universities for their thesis research work for award of master and Ph. D degrees. The progress and achievements of the ongoing projects is reported in the coming section. The progress of ongoing projects was monitored through mid year/annual progress reports with the help of technical divisions.

A major contribution of the projects is human resource development, where a number of students got their degrees in higher education. As per PIs reports, 30 students (17 in animal sciences, 5 in crop sciences and 8 in natural resources) have completed their Ph. D study program. M. Phil degrees were awarded to 18 students (12 in animal sciences, I in crop sciences and 5 in natural resources. Maximum number of students got their M. Sc degrees where total 106 students (23 in animal sciences, 25 in crop sciences and 58 in natural resources) were benefited. In addition 9

students got their degrees in B. Sc after doing their research for writing special paper. A number of students are currently doing their work in the projects as Research Associates/Fellows/Assistants for their degrees program.

A number of research papers have also been published in national and international journals from research and scientific work of the projects. The PIs of the projects have reported that 142 papers evolved from their projects while many are either submitted for approval or are under preparation. More than 30 brochures, manuscripts, booklet or pamphlets have been prepared under the projects. Many papers have also been presented in seminars and workshop for sharing knowledge with each others. A numbers of scientists, farmers, students and other beneficiaries have been trained in various skills, technologies etc. as a result of training arranged under these projects.

On completion of projects the capital assets (computers, lab and office equipments) purchased under the projects has been transferred to the host institutions. In this way the institutions have been strengthened and made functional.

Progress of ALP

ALP 3rd BATCH 2005-06

The 3rd batch of ALP was announced in March 2006. In response to PARC call for the 3rd batch, 599 concept papers were received, against which 160 were short-listed by the Technical Division. Detail proposal were received in respect 121 projects. These projects including recommendations of national referees and USDA rating considered in three meetings of TAC of BOD and finally recommended 50 revised projects for approval of BOD.

S. No.	Discipline	Pre-Proposal	Short Listed	Recommended for Approval
1	Animal Sciences	129	31	11
2	Crop Sciences	354	79	29
3	Natural resources	88	39	09
4	Social Sciences	28	11	01
Total		**599**	**160**	**50**

The BOD in its 8th meeting held on 9th April. 2007 approved 19 projects. These projects are under implementation since July 2007. The remaining projects will be considered in 9th BOD meeting after necessary revision/improvement.

2. Implementation of Projects

After the approval of projects, project implementation agreements were signed with the host institutes and projects were implemented. ALP projects falls in plant sciences, natural resources, animal sciences and social sciences sectors. In plant sciences, out of 136 projects approved in the three batches, 120 projects were implemented and 76 completed. In natural resources, 43 projects implemented out of 50 approved projects and 32 projects have been completed, whereas 12 were

in operation. Three other projects two each at NARC and one at AZRC, Quetta started in July 2007. In the sector of animal sciences 61 projects were approved and implemented. Of these, 28 projects completed and 30 continued. Similarly in social sciences sector out of 29 projects approved, 26 were implemented and 19 completed. The duration of some of the projects physically completed on June 30, 2007 was, however, extended beyond the completion date for payment of outstanding liabilities especially honorarium of PIs. The numbers of projects completed in various research institutes and universities are as follows:

Number of Completed Projects:

S.#	Regions	Discipline wise Number of Projects				Total
		Animal Sciences	***Plant Sciences***	***Natural Resources***	***Social Sciences***	
1	*Federal	02	11	03	-	**16**
2	Punjab	10	16	10	05	**41**
3	Sindh	03	05	01	02	**11**
4	NWFP	03	11	06	02	**22**
5	Balochistan	-	04	02	01	**07**
6	AJ&K	-	-	01	-	**01**
7	PARC/NARC	09	27	09	10	**55**
8	Other /NGO	01	02	-	-	**03**
Total		**28**	**76**	**32**	**20**	**156**

**include federal institutions located in provinces*

The list of completed projects is given in appendix-I. The region/province wise detail of the ongoing projects is as follows:

Number of Ongoing Projects

S.#	Regions	Discipline wise Number of Projects				Total
		Animal Sciences	***Plant Sciences***	***Natural Resources***	***Social Sciences***	
1	*Federal	-	08	01	-	**09**
2	Punjab	15	14	02	04	**35**
3	Sindh	03	04	-	-	**07**
4	NWFP	02	06	04	-	**12**
5	Balochistan	02	-	-	-	**02**
6	AJ&K	-	-	-	-	**-**
7	PARC/NARC	08	11	07	01	**27**
8	Other/NGO	-	01	-	01	**02**
Total		**30**	**44**	**14**	**06**	**94**

**include federal institutions located in provinces*

The list of ongoing projects is given at appendix-II.

3. Monitoring and Evaluation of Projects

Beside project appraisal and approval, the Secretariat is actively involved in monitoring, review and evaluation of ongoing projects. The progress of projects are monitored at various levels using different means i.e. evaluation of mid year and annual technical progress reports, in-house review on completion of one year and onsite evaluation through experts by visiting field and lab. activities. The Secretariat through a panel of experts comprising a representative each from the concerned Technical Division and ALP Secretariat, leading by a Subject Matter Specialist evaluated progress of 63 projects. Of these 20 projects were from Animals Sciences, 23 from Crop Sciences, 15 from Natural Resources and 5 from Social Sciences.

The recommendations/observations have been conveyed to the concerned PI's for improvement and future guidance. The evaluation reports comprising the salient findings, deficiencies and summary statement of recommendations of the experts are summarized in a separate chapter of this report.

4. Progress/Achievements of Projects

The financial and technical progress of the individual project which remains in operation during 2006-07 in various research institutes in the four disciplines is given separately in the forthcoming chapters.

5. Investment of Funds

The BOD of ALP constituted an investment committee to look into and develop appropriate strategies for investment of fund. The investment committee started work and has made recommendations for taking further necessary actions. Major recommendations of the committee are investment of Rs.90 million in Treasury bills and hiring of a consultant and appointment of two qualified Accountants.

Animal Sciences

Name of Project: **Enhancing Milk Yield of Kundhi Buffaloes Through Production of Performance Tested Bulls (Component-II)**

Name of PI/ Institute: **Dr. Mushtaque Hussain Jokhio,**
Veterinary Officer,
Breed Improvement and Development Centre (SPU), Kundi Buffalo Farm, Rohri

Duration: 14. 08. 2005 to 13. 08. 2008

Financial Status:

Total Cost:	Rs.3.556 million
Funds Released	Rs.1976700/-
Funds Utilized:	Rs.1349704/-

Objectives:

- To exploit the production of Kundhi buffalo through genetic improvement.
- To initiate a strategic buffalo breeding program on Kundhi buffaloes in Sindh province.
- To produce performance tested Kundhi buffalo bulls for AI.
- Community involvement in the genetic improvement of Kundhi buffaloes.

Achievements:

More than 6000 doses of semen have been collected and utilized in registered buffaloes. Surplus doses of semen have been supplied to all the Livestock Production Officers of Sindh to use in the field.

Information about the semen doses used in the registered buffaloes and results obtained are recorded. Nine young candidate bulls having excellent pedigree record purchased and included in the project. Three mature bulls are being trained for future production of semen.

Name of Project: **Evaluation of Indigenous Medicinal Plants for the Steroid Hormonal Activities for Veterinary and Medical Usage**

Name of PI/ Institute: **Dr. Nazir Ahmad,**
Associate Professor,
Department of Animal Reproduction, University of Agriculture, Faisalabad

Duration: 08. 09. 2005 to 07. 09. 2008

Financial Status: Total Cost: Rs.5.046 million
Funds Released: Rs.2556600/-
Funds Utilized: Rs.2002286/-

Objectives:

- To study the steroid sex hormonal or like activities (oestrogen, progesterone and testosterone) of several common indigenous medicinal and fodder plants.
- To isolate and purify the active hormonal or like substances in the indigenous medicinal plants.
- To investigate feasibility of production of hormonal preparations from the indigenous medicinal plants for therapeutic purposes in animals.

Achievements:

Three experiments were conducted during the period under report. In the first experiment, estrogen or like activity of ethanolic extracts of *Calotropis procera* were studies. For this purpose, 40 immature female rats were divided into 4 equal groups; A, B, C and D. Rates of group A served as control, while those of groups B,C and D were given ethanolic extracts of roots, branches and leaves of the plant, respectively for 14 days at the dose rate of 250mg/kg body weight. Body weight and weights of ovaries, uterus and vagina were recorded. Serum samples were analyzed for estradiol and progesterone concentrations, using commercially available ELISA kits. The body weight and weights of the ovaries and uterus did not differ between treated and control groups. However, the weight of the vagina was higher ($P<0.05$) in rats of control group and other three groups. Serum estradiol values did not differ between rats of the four groups. However, serum progesterone concentration were higher in rats given extracts of branches and leaves than those of other two groups ($P<0.05$).

In the second experiment, estrogen or like activity of aqueous extracts of three parts of *Calotropis procera* was studied. For this purpose, 40 immature female rats were treated in the same way as described for the first experiment, except that aqueous extracts of three parts of the plant were used instead of ethanolic extracts. There were no differences in body weight, weights of left ovary and uterus between treated and control groups. Weight of the right ovary was higher in rats treated with extract of leaves, while the weight of vagina in treated rats of all groups was lower than the controls. Control rats also showed higher serum estrogen concentrations than treated groups.

In the third experiment, testosterone or like activity of ethanolic and aqueous extracts of *Tribulus terrestris* was studied. For this purpose, 30 immature male rats were divided into 3 equal groups A, B and C. Rats of group A served as control, while those of groups B and C were given ethanol and aqueous extracts, respectively orally for 14 days at the dose rate of 250 mg/kg body weight. Body weight and weights of testis, liver and kidneys were recorded. Blood samples were analyzed for various haematological, biochemical and testosterone concentrations. Similarly, epididymal sperm counts were also made. Body weight, weights of liver, kidneys and testis, blood hemoglobin, RBCs, WBCs, MCHC, total proteins and globulin, and epididymal sperm counts were higher in ethanolic extract treated rats compared to controls ($P<0.05$). Similarly, testis weight, blood hemoglobin, RBCs, WBCs and epididymal sperm counts were higher in aqueous extract treated rats than controls and lower than ethanolic extract treated rats. However, blood testosterone concentrations were higher in aqueous extract treated rats compared to controls or ethanolic extract treated rats, the difference between the latter two groups was non significant.

Name of Project: **Mott Grass as a Potential Source of Dietary Forage for Lactating Sahiwal Cows**

Name of PI/ Institute: **Dr. Muhammad Qamar Bilal,**
Assistant Professor,
Department of Livestock Management, University of Agriculture, Faisalabad

Duration: 14. 09. 2005 to 13. 09. 2008

Financial Status:
Total Cost: Rs.1.66 million
Funds Released: Rs.1101900/-
Funds Utilized: Rs.803978/-

Objectives:

- To determine the proper stage of cut for Mott grass feeding and silage making.
- To establish the best additive, level of additive and fermentation period for Mott grass silage making.
- To determine the effect of Mott grass and its silage on the performance of lactating Sahiwal cows

Achievements:

Study was conducted to determine the effect of feeding Mott grass, Mott silage and their combinations on the production performance of lactating Sahiwal cows. The results of the study indicated that dry matter intake ranged from 9.46 to 10.08 kg/day. Maximum intake was in cows fed Mott grass in green form supplemented with molasses and minimum in those fed silage ensiled with molasses. Dry matter intake (DMI) as a percent body weight ranged from 2.69 to 2.80. However, statistically difference in DMI was non significant. Daily CP intake varied from 1.21 to 1.30 and NDF intake ranged from 7.08 to 7.60 kg. In the study, the concentration of CP in all experimental diets was almost similar and variation in CP intake was attributed to variation in DMI. Milk yield (4% FCM) ranged from 7.84 to 9.06 lit/day. Maximum FCM yield was in cows fed Mott grass/silage in combination and minimum in those cows fed Mott silage in which no additive was used. Statistically, differences in milk yield was non significant in cows fed Mott grass and Mott silage alone. Milk composition of cows fed experimental diets remained unaltered. Fat % ranged from 4.20 to 4.80, protein from 3.20 to 3.62, total solids from 13.20 to 13.90 and solids not fat from 9.07 to 9.20 %. Maximum DMD (62.20-62.84%) was found in cows fed Mott grass/silage in combination and minimum (58%) in cows fed silage in which no additive was used. NDF and CP digestibility ranged from 46.90 to 48 and 70.60 to 71.35%, respectively. Statistical analysis indicated that there was non significant difference among digestibility of Mott grass/silage based diets in which molasses was used but these differ significantly from Mott grass/silage where no molasses was used (control). However, a non significant difference in NDF and CP digestibility was found across all treatments means.

Name of Project: **Studies on the Reproductive Physiology of one-humped Camel (*Camelus dromedarius)* in the Natural Ecology of Pakistan**

Name of PI/ Institute: **Dr. Anas Sarwar,**
Chairman/Associate Professor,
Department of Veterinary & Anatomy, University of Agriculture, Faisalabad

Duration: 21. 10. 2005 to 20. 10. 2008

Financial Status:

Total Cost:	Rs.5.00 million
Funds Released:	Rs.2378500/-
Funds Utilized:	Rs.1998726/-

Objectives:

- The main purpose of this study is to promote an efficient, ecologically sound, economically viable camel production system in Pakistan.
- To describe the reproductive physiology of camels kept in traditional management system.
- To study the reproductive events of camel in traditional management system and delineate those are amenable to intervention.
- To make recommendations on improved methods of production based on manipulations of reproductive physiology.

Achievements:

Survey was carried out to study the production system and breeding history variables in selected breeds of camels. The observations recorded showed that lactation yield and lactation length of Marecha was statistically ($P < 0.01$) higher than that of the other breeds included in the study.

Females of different camel breeds have showed significant variation for their reproductive parameters, for instance Dhatti females took relatively longer time to reach their puberty, whereas Kohi females were found younger at their first breeding. A significantly ($P < 0.05$) longer gestation period has been observed in Marecha females. Dhatti females showed longer calving interval than those of Kohi, Sakrai and Campbelpuri camels. Kohi males have showed statistically ($P < 0.05$) shorter age at puberty than that of other males.

Seasonal influence on macro- and microscopical reproductive parameters of both male and female camels were investigated and recorded

The third part of study ultrasonoraphy is being performed to study the reproductive activities and an observational study is done on the manifestation of oestrus signs during all four seasons of the year. Serum samples are being collected for determination of progesterone, estrogen, and testosteron to confirm physiological status around the year. Data on climatic factors, seasonal nutrition status and the body condition of animals is also recorded.

Name of Project: **Clinical and Biochemical Studies on Genital Prolapse in the Buffalo**

Name of PI/ Institute: **Dr. Laeeq Akbar Lodhi,**
Professor/Chairman,
Dept. of Clinical Medicine and Surgery, University of Agriculture, Faisalabad

Duration: 25. 10. 2005 to 24. 10. 2008

Financial Status:
Total Cost: Rs.6.641 million
Funds Released: Rs.2025000/-
Funds Utilized: Rs.1797704/-

Objectives:

- To conduct survey of the genital prolapse under different agro-ecological zones and production systems in the country.
- To study haematological, biochemical and hormonal profile in buffaloes suffering with the problem and in clinically healthy buffaloes as a control.
- To investigate level of macro and micro minerals in soil, fodder and blood of the buffaloes suffering with genital prolapse for the adoption of therapeutic measures.
- Development of suitable packages for treatment, prevention and control of the problem according to various zone

Achievements:

Review of literature in terms of research papers and abstracts to seek guidance and to establish methodology for the determination of risk factors contributing to the development of genital prolapse under prevailing agro-ecological and production system in buffaloes conducted. Epidemiological survey for genital prolapse is in progress and about 500 survey proformae have been completed by the end of June, 2007. About 400 (200 prolapsed and 200 healthy) blood samples for biochemical, macro and micro mineral analysis have been digested and preserved. Also 120 fodder samples for macro and micro mineral analysis have been digested and preserved. While 400 (200 prolapsed and 200 healthy) blood and 30 fodder samples have been analyzed for different minerals. District wise detail of these minerals has also been released.

Two Ph. D students are involved and conducting their research studies on factors influencing genital prolapse in the buffalo.

Name of Project: **Effect of Long Term use of Bovine Somatotropic (BST) Hormone on Milk Production, Reproduction, Health and Various Physiological Parameters in Nili-ravi Buffaloes**

Name of PI/ Institute: **Dr. Makhdoom Abdul Jabbar,**
Chairman/Associate Professor,
Department of Animal Nutrition, University of Veterinary and Animal Sciences, Lahore

Duration: 17. 07. 2004 to 16. 07. 2007

Financial Status:
Total Cost: Rs.3.464 million
Funds Released: Rs.3113200/-
Funds Utilized: Rs.3033994/-

Objectives:

- To study the long term effect of Bst hormone on milk production in Nili-Ravi buffaloes.
- To study the effect of use of Bst on reproductive behavior and other physiological parameters in buffaloes.
- To compare the efficiency and economics of milk production of treated animals versus control.
- To determine the quality of milk under influence of Bst hormone through chemical composition.

Achievements:

The study was conducted to determine the effect of long term use of bovine somatotropic hormone (BST) on milk production, milk composition, reproduction, health and physiological parameters. Thirty Nili-Ravi lactating buffaloes with similar milk production and stage of lactation were selected and randomly divided in to two groups A and B with 15 animals in each group. The group A severed as control while animals in group B were given injection of bovine somatotropic hormone (250 mg / animal) with trade name of Boostin-250 at an interval of 14 days. Nutritional requirements of experimental animals were met through available green fodder (45-50 kg/day) supplemented with concentrate ration @ half of milk production. The composition of concentrate ration was 17.0% CP and 2.20 ME / kg. The over all daily milk production per animal was 6.86 vs. 7.92 liters for groups A and B, respectively. The milk production was increased by 15.5% in treated group compared with control. Statistical analysis revealed that difference was significant ($P< 0.05$). Numerical variations in the values of Fat, SNF, and TS percent were observed but these variations were non significant. The calving interval, dry period and lactation length were shorter by 14.0, 26.0 and 2.7 percent in treated group compared with the control. The postpartum estrous period, service period and services per conception were 98.2 + 76.40 vs.160 + 56.9 days, 115.10 + 107.0 vs. 207.04 + 85.0 days and 1.31 + 0.51 vs. 1.47 + 1.11 in the group B and A respectively. Statistically differences were significant for postpartum estrous and services period but for services per conception, the difference was non-significant which reflected positive effect of BST on

reproductive parameters. Prevalence of mastitis was 57.14% higher in treated animals. There were variations in body weights for animals in group A and B but these changes over the time were non-significant. The differences among hematological and biochemical parameters were also non-significant.

Name of Project: **Development of Supplementary Feed Based on Apparent Nutrient Digestibility of Different Feed Ingredients for Labeo Rohita Fingerlings**

Name of PI/ Institute: **Dr. Muhammad Salim,**
Assistant Professor,
Department of Zoology & Fisheries, University of Agriculture, Faisalabad

Duration: 14. 09. 2005 to 13. 09. 2008

Financial Status:

Total Cost:	Rs.2.137 million
Funds Released:	Rs.1373500/-
Funds Utilized:	Rs.1106725/-

Objectives:

- To determine apparent nutrient digestibility of twenty feed ingredients.
- Development of compatible and suitable supplementary diet.
- To increase the integrated period of the test and reference diets.

Achievements:

There is increasing demand for development of nutritionally balanced diet for carp using inexpensive, locally available agro based by products. To meet the demand of fish farmers, twenty feed ingredients of plant and animal origin were evaluated for nutrient digestibility. The proximate analysis of feed, feces and estimation of chromic oxide ($Cr_2 O_3$) were conducted during 1st year of study and reported.

During the reporting year, previous results have been verified by determing the nutrient digestibility of the twenty feed ingredients used last year. The apparent digestibility of nine ingredients (dry bread, fish meal, soybean meal, rice broke, corn glutting, 60% wheat, wheat bran and sunflower meal) were higher and recommended for inclusion for formulation of diet for *Labeo rohita.* The feed ingredients with significant digestibility will be used for the formulation of fish diet. The digestibility of formulated diets will be estimated for *Labeo rohita* and the diet with better digestibility will be recommended for field trials.

Name of Project: **Pharmacokinetics and Dosage of Flouroquinolones in Animals**

Name of PI/ Institute: **Dr. Faqir Hussain Khan,**
Associate Professor,
Dept. of Physiology and Pharmacology, University of Agriculture, Faisalabad

Duration: 11. 02. 2006 to 10. 02. 2008

Financial Status:

Total Cost:	Rs.3.100 million
Funds Released:	Rs.2623300/-
Funds Utilized:	Rs.2333322/-

Objectives:

- Establish therapeutic norms/ dosage regimen in the indigenous domestic animals and environments.
- Pharmacokinetics of quinolones would provide a basis for determination of an optimal dosage regimen of these antibacterial agents in indigenous animals under indigenous conditions.
- The rational dosage regimen of fluoroquinolones on the basis of the original kinetic data under our own specific indigenous conditions would be helpful for successful treatment of infectious diseases in animals.
- Describe the preslaughter withdrawal period to provide wholesome food to human beings.

Achievements:

The analytical method for determination of concentration of ciprofloxacine in biological fluids (plasma and urine) is being standardized and validated. The experimental work regarding the pharmacokinetic of ciprofloxacine in goats, sheep, cows and buffalos remain in progress. The pharmacokinetic of ciprofloxacin is being valuated in 8 animals in each species i. e.; sheep, goats cows and buffalos. After restraining each animal, the jugular vein was cannulated by plastic cannula (branula) for collection of blood samples. For collection of urine samples, Balloon catheter was inserted into the urinary bladder. One control sample of blood and urine was collected in each animal prior to the drug administration. The recommended dose of ciprofloxacine was injected VM in each animal. The blood samples were collected in heparinized centrifuge tubes at different predetermined time intervals (i.e: 15 min, 30 min and then at an hourly interval unto 10-12 hours continuously post medication). For renal clearance study the urine samples were collected at specified time period and were frozen at -20° C. The blood samples collected at various time intervals post medication were centrifuged and plasma was collected and kept at -20° C temperature for further analysis. The analysis of drug in plasma and urine samples is in progress. After completing the analysis, the concentration versus time data will be subjected to pharmacokinetic analysis

Name of Project: **Inter-relationship of Mycotoxins Levels in Feed, Organs/Tissues and Health of Poultry and Livestock**

Name of PI/ Institute: **Mr. Muhammad Zargham Khan,**
Chairman/Associate Professor,
Deptt. of Vet. Pathology, University of Agriculture, Faisalabad

Duration: 25. 07. 2006 to 30. 02. 2009

Financial Status:

Total Cost:	Rs.9.356 million
Funds Released:	Rs.6552500/-
Funds Utilized:	Rs.5564018/-

Objectives:

- Determination of aflatoxin and ochratoxin levels in poultry livestock feed/ feed ingredients, organs/ tissues of poultry and livestock as well as in milk produced for human consumption.
- Establishment of relationship between:
  - Dietary mycotoxins levels and its tissues/ organ contents.
  - Dietary/ tissue mycotoxins levels and pathological alterations.

Achievements:

The experimental study focused upon establishing a relationship of feed aflatoxins (AFBl) levels with pathology and tissue levels of AFBI. In three trials. Aflatoxicosis was induced in broiler chicks of 7, 14 and 21 days of age by incorporating 0, 1600, 3200 and 6400 µg/kg AFB1 for 7 days. In fourth trial broiler chicks of 14 days of age were given feed carrying 0, 50, 100, 200, 400 and 800µg/ kg AFBI for 28 days. The severity of clinical picture, gross and microscopic changes in these trials increased with increased in dietary AFBI levels. However, the severity of disease in all the groups decreased gradually returned to normal when AFBI was removed from the diet.

AFBI residues were detected in the livers on day 3 in birds given 1600 and 3200 µg/ kg AFBI in feed while it appeared on day 2 in livers of birds given 6400 µg/ kg AFBI in feed. Upon withdrawal of AFBI contaminated feed AFBI disappeared from the tissues before the end of the experiment (42 days of age). In muscles AFBI was detected on day 5 in birds given 1600 and 3200 µg/ kg AFBI in feed while it appeared on day 3 in livers of birds given 6400 µg/ kg AFBI in feed. Upon withdrawal of AFBI contaminated feed AFBI disappeared from the muscles before the termination of the experiment.

Birds given 50 µg/ kg AFBI levels had no detectable residues in livers throughout the experiment. Those given 100, 200, 400 and 800 µg/ kg AFBI for 28 days had this toxin present in liver tissues on days 28, 20, 15 and 10 of the experiment, respectively. On day 42 of experiment none of the birds had AFBI residues in liver tissues. AFBI was not present in muscle tissue of the birds fed 50 and 100 µg/ kg AFBI for 28 days. It appeared after 20 days in muscles of birds fed 200-800 µg/ kg AFBI and disappeared before the termination of the experiment.

Name of Project: **Application of PCR Technology for the Detection of Avian Mycoplasma in Poultry Birds and Farm Environment**

Name of PI/ Institute: **Dr. Sajjad-ur-Rahman,**
Associate Professor,
Deptt. of Vet. Microbiology, University of Agriculture, Faisalabad

Duration: 22. 05. 2004 to 21. 05. 2007

Financial Status:

Total Cost:	Rs.2.939 million
Funds Released:	Rs.2057200/-
Funds Utilized:	Rs.1419096/-

Objectives:

- Screening test antigens of MS, MG and MM from local isolates separately and standardize techniques for conventional screening tests like RSA and HI using hyper immune serum.
- Adopt latest technique of PCR based diagnosis of avian mycoplasma
- To compare the efficacy of conventional screening methods (RSA, HI) and latest diagnostic technique of PCR for the detection of mycoplasma species in birds and farm house environment.
- To introduce the latest technology for raising mycoplasma free flock to the farmers in public and private sector and field veterinarian, particularly to meet the requirements of World Trade Organization (WTO) programs in the country through seminar and workshop.

Achievements:

Avian Mycoplasmosis caused by *Mycoplasma gallisepticum* (MG) & *Mycoplasma synoviae* (MS) are the most pathogenic and economically significant egg transmitted mycoplasma of chicken. MG causes chronic respiratory disease (CRD) of chickens.

A total 481 field specimens (trachea, lungs, oral, cloacal, nasal & air sac swabs etc.) were collected for isolation of avian mycoplasmas from total 150 birds including breeder, layer and broiler flocks, showing respiratory distress signs. Flocks were preliminary examined for screening test using RSA (Rapid Serum Agglutination Test) and those farms showed more than 50% positive results were selected for further studies. Specimens were inoculated directly into modified Frey's broth medium (PPLO broth medium) satisfying complex nutrition requirement of avian mycoplasmas including yeast extract, horse serum, cysteine, thallium acetate and (NAD) nicotinamide adenine transferred to solid Frey's agar medium and observed for specific culture characteristic under light microscope at low magnification.

Out of 17 flock 52.9% were found positive by RSA with more than 50% positivity. A total of 79 specimens were found positive by culture examination including 16.4 percent occurrence of Mycoplasma spp. Highest percentage of positive cases were recorded from palatine swabs (25 %), followed by trachea (24.7%), nasal secretions (18.9%), oral swabs (18.8%), air sac swabs (12.7%), lungs (11.5%), esophagus (10%), cloacal swabs (9.5%), kidneys (8.3%) and dropping swabs (7.6%). Mycoplasma spp. were mostly isolated at 1^{st} and 2^{nd} passage (5.6% each) followed by 3^{rd} (3.3%), and 4^{th} (1.9%) passage.

Name of Project: **Taxonomical Studies of the Prevalent Ticks Species on Different Livestock Hosts Throughout NWFP**

Name of PI/ Institute: **Dr. Rahim Ullah Shah,**
Research Officer,
Veterinary Research Institute, NWFP, Peshawar

Duration: 25. 01. 2005 to 24. 01. 2007

Financial Status:

Total Cost:	Rs.2.629 million
Funds Released:	Rs.1768200/-
Funds Utilized:	Rs.1413408/-

Objectives:

- Survey for collection / preservation and processing of the prevalent ticks.
- Collection, preservation and mounting of collected tick specimens.
- Taxonomical identification of prevailing ticks throughout NWFP using proper keys.

Achievements:

Field visit has been made to conduct the survey for ticks prevalence in different ecological zones of NWFP and samples collected & preserved for laboratory processing. The specimens collected were preserved and mounted for taxonomical studies in the laboratory.

Name of Project: **Microbiological Studies on Caprine Mycoplasma in Balochistan**

Name of PI/ Institute: **Dr. Mohammad Arif Awan,**
Veterinary Officer,
Center for Advanced Studies in Vaccinology and Biotechnology (CASVAB), University of Balochistan, Quetta.

Duration: 26. 10. 2004 to 25. 10. 2007

Financial Status:

Total Cost:	Rs.4.8 million
Funds Released:	Rs.2130000/-
Funds Utilized:	Rs.387652/-

Objectives:

- To study the clinical manifestations and pathology in the mycoplasma suspected affected animals.
- To carry out the isolation and identification of caprine mycoplasmas particularly Mycoplasma capricolum subs capripneumoniae (Mccp).
- To reproduce an experimental disease in the susceptible goats using the local field isolates of mycoplasma. Spp.
- To prepare an effective vaccine from the suitable local field isolates of mycoplasma species.
- To attempt the development and use of Latex agglutinin test using the Mycoplasma field isolation.

Achievements:

Strengthen the existing mycoplasma laboratory at the center under the project. The clinico-pathological studies have shown chronic form of pleuropneumonia in goats suspected for contagious caprine pleuropneumonia (CCPP). The bacteriological investigations based on biochemical tests, have revealed the presence of Mycoplasma species other than *Mycoplasma capricolum* subspecies *capripneumoniae*, the cause of CCPP. The confirmation of the field mycoplasma isolates through the Molecular biological based tools is under way.

Name of Project: **Studies on Mineral Imbalances in the Livestock of Canal Irrigated Districts of the Punjab**

Name of PI/ Institute: **Dr. Talat Naseer Pasha,**
Professor,
Department of Animal Nutrition, University of Veterinary and Animal Sciences, Lahore

Duration: 21. 09. 2005 to 20. 09. 2008

Financial Status:
Total Cost: Rs.8.596 million
Funds Released: Rs.5609800/-
Funds Utilized: Rs.4585870/-

Objectives:

- The long-term project objective is the efficient and balanced feeding resulting in better health of the livestock at lower cost of production leading to increased productivity of milk and meat of livestock resulting in higher income, better nutrition and improved food security for small holder farms.
- Mineral (macro and micro) mapping of the ten canal irrigated districts of the Punjab based on water, forages, feedstuffs, soil and serum analyses.
- Development of mineral mixers, feed supplements for livestock as per needs of the different districts of the Punjab.

Achievements:

To achieve the objectives of the project, sampling for the soil, water, feedstuff, fodder, blood of small and large ruminants was carried out. The sampling for the entire project area i.e. 10 canal irrigated districts (Lahore, Okara, Sheikhupura, Kasur, Gujranwala, Hafizabad, Pakpattan, Sahiwal, Muzafarghar and Khushab) was carried out during the report period. These samples were collected at five sites of each district both in summer and winter season. Whereas, forage samples were collected four times a year' to cover all seasonal forages. The analytical analysis of macro mineral was carried out for the Hafizabad and Okara districts and GIS maps for these districts were also developed with the help of GIS Center of University of the Punjab. Analytical work of districts Lahore, Kasur and Gujranwala has also done. The data analysis remain in progress during report period.

Name of Project: **Development of Database on Minerals Profile of Feedstuffs, their Availability and Strategic Supplementation of Minerals Block to Dairy Animals**

Name of PI/ Institute: **Dr. Atiya Azim**
Principal Scientific Officer,
ASI, NARC, Islamabad

Duration: 17. 09. 2005 to 16. 09. 2008

Financial Status:

Total Cost:	Rs.2.513 million
Funds Released:	Rs.2199800/-
Funds Utilized:	Rs.1511400/-

Objectives:

- To generate database on minerals profile of feedstuffs i.e. crop residues, green fodder and concentrate feed ingredients
- To quantify availability of minerals to dairy animals.
- Execution of minerals supplementation strategy through minerals powder mixture and particularly minerals block development.

Achievements:

Samples of feedstuffs, i.e., green & dry roughage, concentrate feed ingredients and feeds were collected from LRS, NARC, Islamabad, Cattle Breeding and Dairy Farm, Harichand, BLPRI, Kherimurat and peripheral private farms.

Samples were analyzed for their macro and micro minerals composition. Sodium and potassium were analyzed by flame photometer, phosphorus by spectrophotometer and calcium, magnesium, copper, manganese, cobalt, iron and zinc were analyzed by atomic absorption spectrophotometer. Results of mineral analysis of feed stuff have been reported in annual reports of the project.

Among the mixed cropped fodders of rabi season, highest calcium, phosphorus, magnesium and potassium (macro minerals) was found in berseem mixed with oats fodder. In micro mineral profile of rabi green fodder, copper ranging from 18.0 to 63.3 ppm was highest in berseem and lowest in mustard. Manganese ranged between 47.0 to 81.6 ppm was in lucerne and lowest in mustard. Zinc was maximum in mustard while cobalt and iron were maximum in berseem.

Macro and micro mineral profile of kharif fodder reveal that calcium ranged from 0.22 to 0.47%. Calcium was highest in millet and lowest in sorghum. Phosphorous was 0.29, 0.16 and 0.27% in maize, sorghum and millet, respectively. Millet contained highest Magnesium, Sodium and Potassium among all the kharif fodders and the values were 0.44, 0.08 and 2.07%, respectively. Micro mineral in kharif fodders were as copper in the range of 9.0 to 38 ppm and it was highest in millet and lowest in maize. Manganese ranged from 21.0 to 44.9 ppm and found highest in maize

and lowest in millet. Zn concentration was found to be the highest (68.2 ppm) in sorghum and lowest in maize (29.14 ppm). Cobalt was highest in maize followed by millet and sorghum. Iron was highest in millet (0.07%) and lowest in maize (0.014%).

Macro and micro mineral profile of dry roughages revealed that Ca was higher in sorghum stover while P, Mg, Na and K were found to be higher in wheat straw. In dry roughage, manganese, cobalt and zinc contents of sorghum stover were found to be higher than wheat straw. Copper and iron were found to be higher in wheat straw as compared to sorghum stover.

Macro and micro minerals profile of concentrate feed ingredients and blended feeds have been analyzed and reported in annual progress report.

A survey was conducted at different farms in public sector and private sector and collected information on daily allowance of different type of feedstuffs to animals, i.e., green fodder, dry roughage and concentrate feed ingredients. Daily intake of each mineral from different type of feedstuffs to animals was calculated from intake of different type of feedstuffs and their minerals composition

Name of Project: **Studies on Epidemiology of Peste des Petites Ruminant (PPR) in Pakistan**

Name of PI/ Institute: **Dr. Aamer Bin Zahur,**
Senior Scientific Officer,
ASI, NARC, Islamabad

Duration: 17. 09. 2005 to 15. 09. 2005

Financial Status:

Total Cost:	Rs.5.969 million
Funds Released:	Rs.3845000/-
Funds Utilized:	Rs.3368960/-

Objectives:

- To study the epidemiological factors responsible for persistence/ transmission of PPR virus in small ruminants.
- Development of laboratory assay for the diagnosis of PPR.
- Isolation and characterization of PPR virus from field cases.

Achievements:

Developed a data base for PPR outbreaks in Pakistan. Information available in the participatory disease search (PDS) reports and other published reports were used in the database.

High and low risk areas were identified and selected for field-investigation and sero sampling. Twenty one districts were randomly selected and visited in all the four provinces, AJK & NA. Flocks with a history of PPR outbreaks were identified, where (30) outbreaks were investigated and serum samples collected. Reported outbreaks were attended throughout the country. Clinical and postmortem examination carried out, epidemiological observations recorded and appropriate samples were collected.

Fifteen training workshops organized jointly by Regional Project, FAD and PARC at Sindh (5), Punjab (6), NWFP (2) provinces & AJK (2). Economic impact of PPR estimated. Ascertained epidemiological factors responsible for persistence/ transmission of PPR virus in small ruminants. Established cell culture facility and isolated PPR virus from field cases. The development of HA test is in process

Name of Project: **Role of Steroid Hormone in Regulation of Ovarian Follicular Development in Tor Putitora**

Name of PI/ Institute: **Mr. Zafarullah Bhatti,**
Dy. Director (Fisheries),
Fish Hatchery & Research Center, Rawal Town, Islamabad

Duration: 27. 09. 2005 to 26. 09. 2008

Financial Status:

Total Cost:	Rs. 8.5 million
Funds Released:	Rs.5253500/-
Funds Utilized:	Rs.5244953/

Objectives:

- To generate information which would enable us to better understanding of hyperphysical and steroidal regulation of the ovarian follicle in Tor putitora
- Determination of maturation of inducing steroids T. putitora
- Development of techniques for artificial manipulation of fish in aquaculture and fish farming in the country.

Achievements:

To check the availability of live *Tor putitora*, visited Wah Garden, Simly Dam, Mangla Dam, Rawal Dam and also different sites in district Attock i.e Jand & Ziarat (Indus River), Hattian Nursery unit Attock, Fatehjang area and Shakar Dara Dam.

Preliminary work on ovarian cycle and gonad somatic index of female *Tor putitora* was carried out and is resumed with regular sampling since February 2007 up till now.

Extraction of steroid hormones from ovarian tissues of fish and blood has been started while analytical work will be done on installation of HPLC and availability of other required chemicals. Other scientific work like histology, photography and invitro incubation of ovarian follicle was carried out.

Name of Project: **Aquaculture of Fin Fishes (Snappers and Groupers) in Ponds along Hub River Estuary/ Gharo Creek**

Name of PI/ Institute: **Syed Makhdoom Hussain,**
Professor,
Center of Excellence in Marine Biology, Karachi University, Karachi

Duration: 17. 04. 2004 to 16. 04. 2007

Financial Status:

Total Cost:	Rs.4.679 million
Funds Released:	Rs.3731000/-
Funds Utilized:	Rs.3390491/-

Objectives:

- Growth potential and survival rate of one species each from Snapper and Grouper out of the two species mentioned below will be studied;
  - Snappers: *Lutjanus lutjanus* Bloch, 1790 and *L. johni* (Bloch, 1792)
  - Groupers*: Epinephelus fuscoguttatus* (Forsskal, 1775) and *E. tauvina* (Forsskal, 1775). The selection of the species will be based on the easy availability of seed from wild.
- Step wise development of grow-out techniques on different protein level diets based on locally available ingredients.
- Determine economic feasibility of marine fin fish culture.

Achievements:

Hydrographical data of five ponds was regularly taken from March 2006 to January 2007. Every month two - three observations were recorded. Water temperature in all ponds was found to be almost the same during whole months i.e. 29 ^{0}C - 31 ^{0}C in summer and 21^{0}C - 26 ^{0}C during winter. Salinity some times lowers to 8 % even low salinity of 5% was also observed in July during low tides when fresh water flows from river Indus in the channel. Most of the marine fish species entering the Gharo creek survive in low salinity. The cultured fishes *Lutjanus* and *Epinephelus* don't show any sign of stress. The analysis of growth of harvested fish showed that two species attained significant growth both in mono and bi- culture set up. Initial finding suggests that these species are suitable for culture in the brackish water areas and can tolerate low salinity such as 5% and high salinity as that observed in the creeks (40 %). Sometimes low oxygen observed in the pond due to growth of brown algae may affect the fishes and mortality has been observed in the month of January and February. Gonads of two species collected from fish market; *Lutjanus lutjanus* and *E. fuscoguttatus* were studied. Large size specimens of *L. lutjanus* were observed common in the market, however, these specimens were costly as it was sold about 100 - 200 rupees per kg. The mature *E. fuscoguttatus* were not observed at the fish market. The usual size is about 1 - 2 Kg in weigh and gonads showed no sign of development. The study of large sized specimen was found to be mature males.

Name of Project: **Epidemiology of Helminthiasis in Sheep**

Name of PI/ Institute: **Dr. Haji Ahmad Hashmi,**
Associate Professor/Chairman,
Dept. of Parasitology, University of Veterinary & Animal Sciences, Lahore

Duration: 21. 09. 2005 to 20. 09. 2007

Financial Status:

Total Cost:	Rs.0.547 million
Funds Released:	Rs.432100/-
Funds Utilized:	Rs.275429/-

Objectives:

- To determine epidemiology of helminthiasis in sheep by studying various epidemiological determinants.
- To devise forecasting methods for helminthiosis
- To generate epidemiological information which may lead to the development of integrated methods of control of important helminth parasites of small ruminants with a view to increase their productivity

Achievements:

Epidemiology has been recognized as a major tool for the control of diseases in developed countries. Presently, epidemiological studies were carried out in two districts namely Kasur & Sheikupura. During study the following parameters were noted to see the monthly prevalence of gastro intestinal parasites:

Mean fecal egg count: The districts of Kasur and Sheikhupura were visited twice in months for samples collection. The maximum no. of eggs per gm (EPG) of faeces were observed in June, 2006 where 1400 & 1560 found in the district of Sheikupura & Kasur respectively. *H. contortus, Trichostrongylus colubriformis, Ostertagia circumcincta* eggs were found most commonly & the numbers of ova of these parasites was greater compared to other parasites eggs like Fasciola sp, Cooperia, Oespohagostomum & Chabertia which were observed in negligible number. Similarly month wise prevalence of live snails has been studied during the period from December 2005 & June 2006. A total of 8000 snails were collected from five places in & around Sheikupura & Kasur, which included different genera namely; Lymnaea, Gyrayulus, Physa, Bulinus & Oncomelania. During December, 2005 & January 2006 the minimum temperature ranged between 8.5^0 C & 6.2^0 C respectively which is detrimental for survival of snails. So lymnaca were minimum during the month of January & maximum in June. *H.contortus, Trichostrongylus colubriform*i s & *Ostertagia circumcincta* were more prevalent on pastures.

Name of Project: **Development of Local Starter Culture Technology for Preparation of Fermented Milk Products**

Name of PI/ Institute: **Mr. Tariq Aziz,**
Senior Scientific Officer,
ASI, NARC, Islamabad

Duration: 14. 04. 2004 to 13. 04. 2007

Financial Status:

Total Cost:	Rs.3.75 million
Funds Released:	Rs.3329100/-
Funds Utilized:	Rs.3311884/-

Objectives:

- Identification and characterization of local strains of starter cultures.
- Maintenance and preservation of defined local starter culture in lyophilized form.
- To develop and expand the modern cheese and yoghurt production technology.

Achievements:

Out of 120 samples, 95 isolates were obtained by preliminary screening. Out of these 29 strains of Lactic Acid Bacteria (LAB) were identified down to species level belonging to various genera such as S*treptococcus, Lactococcus, Enterococcus* and *Lactobacillus.*

Isolates of Lactic Acid Bacteria (LAB) obtained from raw milk, traditional dahi, yoghurt, cream etc. and stored in the Microbank were reprocessed for revitalization. Thirteen samples were evaluated. After inoculation and incubation, the selected colonies were observed for their morphological characters. The identification to species level was then done with the help of API identification system. The isolates identified were further confirmed by observing their growth at different temperatures and salt concentrations according to standard procedures.

The protein profile of selected strains was determined by SDS-PAGE. A typical profile of some strains revealed that isolates 45, 43 and 42 have similar protein pattern and are same. The isolates 55 and 57 are different as well as from rest of the strain. Thus three strains of Lactococcus lactis spp. Cremoris can be identified from the profile.

Three trials were conducted to increase the biomass of selected strains of cocci. The biomass of the growth calculated gravimetrically comes out to be 13.54 mg/ml. Freeze drying of some isolates was carried out and found that 16-18 hours are typical time required for practical drying.

Name of Project: **Development of Health, Nutrition and Breeding Management Package for Increased Output from Range-Sheep/Goats Production Operations in Balochistan**

Name of PI/ Institute: **Dr. Abdul Razzaq,**
Scientific Officer,
Arid Zone Research Center, (PARC) Quetta

Duration: 01. 04. 2006 to 30. 04. 2009

Financial Status:

Total Cost:	Rs.3.867 million
Funds Released	Rs.1896500/-
Funds Utilized:	Rs.1316000/-

Objectives:

- To study feeding, breeding and health management impacts on the AZRC research flock and the farmers' flocks for improving small ruminant's productivity, controlling year to year fluctuations and making the sheep/goats production operations profitable on sustained basis in Loralai and Kalat areas.
- To ascertain the fattening potential of native lambs/kids for increased mutton production under intensive feedlot research studies for economic modulation of these activities.
- To assess the contribution of farm-wastes, crop/fruit residues and range-forage in the diets of small ruminants in the target areas.

Achievements:

A lamb fattening (15 lambs of 56 month age) experiments conducted at AZRC, Quetta. Previously a lamb fattening experiment (24 lambs of 3-4 months age) conducted at AZRC, Quetta and four farmer lambs flocks i.e. two from each site, Tomagh and Pishin. Initially mix starter ration (Barley grain 47%, Cotton seed cake 30%, Lucerne hay 20%, Di-calcium Phosphate 1 %, Common Salt 1% and Vitamins 1%) offered to these lambs to familiarize with this ration for 15-60 days according to the adoptability of the ration. Subsequently mix ration (Maize oil cake, Rapeseed cake, Maize gluten feed, Barley grain, Wheat bran, Lucerne hay, wheat straw, Di-calcium phosphate, Common salt, Lime and Urea) with 13%, 14.5% and 16% crude protein was offered to three groups for 110-120 days. Data recording feed consumed and weekly weight gain was recorded for all the lambs. The results of live-weight gain showed that Harnai breed lambs (between 3-4 months age) gained upto 18 kg than grazing lambs (2.5 kg) in 140 days, while Harnai breed lambs between 5-6 months old gained more live-weight i.e. 23 kg compared with grazing (5 kg) in 120 days. Farmer's flocks (Harnai breed male lambs) on grazing and supplemental ration @ 500 g daily showed increase live-weight gain up to 10 kg in 128 days. From the experiment it was observed that five months age lambs easily digest and familiar with fattening ration. Economics analysis showed that lamb fattening is profitable business and a farmer can earn up to Rs.2000/- compared with sample grazing Rs.850/- and grazing with supplemental Rs.1500/- in four months. In this way early marketable lamb's production is possible and reduces the pressure on native rangelands.

At AZRC, Tomagh Station, sheep (100 Nos.) and goat (20 Nos.) and farmer's flocks at Tomagh were involved to assess internal parasitic infestation incidences and its control with broad-spectrum anthelmintics (Nilzan and Zodec). Microscopically eight types of internal parasites i.e., *Eimeria, Moniezia benedeni, Moniezia expensa, Fasciola hepatica, Protostrongylus rufescens, Tricuris ovis, Strongyloides* and *Dictyocaulus* were identified. Incidence of these parasites were found up to 40% but due to regular de-worming reached to 8% with eradication of some parasites. These results indicated that range sheep and goats must be drenched against internal parasites after each three months interval for higher production. A training workshop was arranged at Tomagh Station during May 29-30, 2007 for farmers on "Animal health and lamb/kid management".

Name of Project: **Trout Farming in the Mountains of Northern Areas. A Research Project at TRMC Juglote**

Name of PI/ Institute: **Mr. Faridullah Khan,**
Scientific Officer,
Karakuram Agricultural Research Institute for Northern Areas, (PARC), Juglote, Gilgit

Duration: 16. 09. 2005 to 15. 09. 2008

Financial Status:

Total Cost:	Rs.5.713 million
Funds Released:	Rs.3619700/-
Funds Utilized:	Rs.3357857/-

Objectives:

- To conduct research on fattening, reduction in mortality rates in early stages, disease diagnoses and their proper control.
- To enhance per year growth rate of trout fish.
- Introduce trout farming in Northern Areas through trainings of fish farmers' about pond culture to enhance income of the rural communities.
- Develop packages of technology on trout production in ponds, striking in streams and commercial farming through the communities.
- To motivate communities like water waste, land for income generation.
- Capacity building through training etc.

Achievements:

At Trout Research and Multiplication Centre (TRMC), KARINA, Juglot, exclusive intensive rainbow trout (*Onchyrinchus mykiss*) was farmed in five treatments (T1 - T5) with same density under the same ecological conditions fed with five selected feeds (F1 - F5) respectively @ body weight based on water temperature. According to collected data (FCR, weight gain, percent diseases reduction and survival rates, cost per kg feed), by using the same data, two feeds have been selected for further multiplication and utilization. The same will be carried out in coming months to finalize the same data to select most suitable feed for fattening of trout fish for commercial use.

Few common diseases (fungal, bacterial, protozoan, nutritional and environmental) were observed during the research study. Treatments of fishes were done and results were encouraging and diseases were reduced. Turbidity was also recorded where highest recorded was 80 NTUs.

Name of Project: **Studies on Biology & Mapping of Warble Fly Infested Areas**

Name of PI/ Institute: **Dr. M. Qasim Khan,**
Senior Scientific Officer,
ASI, NARC, Islamabad

Duration: 21. 05. 2004 to 20. 05. 2007

Financial Status:

Total Cost:	Rs.6.072 million
Funds Released:	Rs.3230500/-
Funds Utilized:	Rs.2717312/-

Objectives:

- To study the biology of warble fly in different ecological zones of Pakistan.
- Mapping of warble fly areas and identification of high and low intensity habitats.
- Development and demonstration of controlled strategies in different disease frequency zones.

Achievements:

Information on disease prevalence and biology of the warble fly were collected all over the country. The disease has been reported from all the provinces, particularly from hilly, semi hilly and desert areas (Bahawalnagar and Sangar) of Pakistan. The incidence of disease varies from 5 - 75%. It is higher in interior of hilly areas and its intensity gradually decreases toward plain areas. The disease was physically verified in the reported areas of Pishin, Mastung, Ziarat, Loralai, Sanjawi, Qilla Abdullah, Zhob, Muslim Bagh, Qilla Saifullah, Barkhan, Rakni, Barkhan, Musa Khel, Noushki, Kharan, Baseema, Kallat, Sibbi, Bolan, Dhadhar, Nasirabad and Jafarabad. The data were computerized for developing a map indicating diseased areas of Balochistan.

To demonstrate the control strategies and study the efficacy of different drugs indicated for control of warble fly, a field trial was conducted at two places i.e. Darapur in district Jhelum and Khairabad in district Nowshera. At Darapur a total of 581 cattle were included in the experiment. These animals were divided into six groups. Group I to V were treated groups whereas group No. VI served as non- treated control. Group No. 1 was given Ivomec (59) II; Endectine (53) III; Dectomax (29) IV; Promectin (59) and group V was given Euvectin (252) during the 1st week of September, 2006. Group No. VI (129) served as non treated control and was given normal saline as placebo. Similarly in goats six groups were made each comprising 200 animals. At Khairabad a total of 331 cattle were included in the trial and 3 groups were made. Group I (157) was given Endectin, II; (145) Dectomax and group III (29) which served as untreated control was given normal saline as placebo during the 3rd week of September 2006. All these animals were thereafter, monitored on fortnightly basis for the appearance of warbles (nodules).

All the five medicines were found 100 % effective for controlling cattle and goat warbles as none of the treated animals developed warbles (nodules). Of control group, 40 (31.0%) cattle developed nodules at Darapur while at Khairabad nodules were seen on 8 (27.58 %) of the control animals. Administration of drug even at the third week of September was safe as no side effect of the drug was seen in any of the treated animal.

Name of Project: **Production of Thermo-stable Newcastle Disease (ND) Vaccine for Rural Poultry**

Name of PI/ Institute: **Dr. Shakeel Babar,**
Associate Professor,
Centre for Advanced Studies in Vaccinology and Biotechnology (CASVAB), University of Balochistan, Quetta

Duration: 11. 09. 2006 to 10. 09. 2009

Financial Status:

Total Cost:	Rs.3.459 million
Funds Released:	Rs.1691000/-
Funds Utilized:	Rs.255185/-

Objectives:

- Availability of thermo-stable vaccine for rural poultry/ backyard chicken rearing villagers.
- Trials to adopt the thermo-stable strains of ND on permanent cell line like vero and others.
- To develop an easy, more convenient way of administration of vaccine.
- Development of ND control booklet in national and local languages.

Achievements:

Performed HA activity and inoculating positive samples into SPF eggs for preservation of isolated virus for further studies. Vaccination with locally available vaccines and collection of serum from vaccinated birds for preservation of hyperimune sera for further use like HA and virus neutralization performed. Inoculation of thermos table and isolated virus in the cell lines for checking of growth pattern of virus on cell lines completed.

Name of Project: **Development of Milk Replacer and Early Weaning Diets for Sustainable Calf Rearing**

Name of PI/ Institute: **Dr. Atiya Azim,**
Principal Scientific Officer,
Animal Nutrition, ASI, NARC, Islamabad

Duration: 24. 08. 2004 to 23. 08. 2007

Financial Status:
Total Cost: Rs.6.076 million
Funds Released: Rs.4592500/-
Funds Utilized: Rs.4563500/-

Objectives:

- Development of milk repalcer and early weaning diets for calf feeding.
- Evolving suitable feeding system based on milk replacer and early weaning diets for sustainable and bio-economical calve rearing.

Achievements:

Milk replacer for calves prepared as a substitute of whole milk for rearing infant calves. Like other products developed, the milk replacer for calves will provide the opportunity to the dairy farming community to rear their future progeny on cost effective and sustainable basis for feeding the newly developed milk repalcer.

Early weaning diet for calves prepared as a substitute of whole milk for rearing calves from 20 days to three months of age. There are lot of ongoing evidences that under the current dairy production system the early weaning diet will have potential role in rearing the calves on cost effective, easy to adopt and sustainable basis.

Name of Project: **Epidemiological Survey of Mastitis and Evaluation of Economic Losses due to Clinical & Sub clinical Mastitis in NWFP**

Name of PI/ Institute: **Dr. Mirza Ali Khan,**
Senior Researcher,
Veterinary Research Institute, NWFP, Peshawar

Duration: 08-09-2005 to 07-09-2008

Financial Status:

Total Cost:	Rs.3.248 million
Funds Released:	Rs.2270600/-
Funds Utilized:	Rs.1923178/-

Objectives:

- Survey for prevalence of mastitis and determination of various epidemiological factors in different zones of NWFP.
- Study of somatic cell count and bacteriology of mastitis milk.
- Evaluation of economic losses due to different forms of mastitis.

Achievements:

Survey regarding the study of prevalence of mastitis and demonstration of various managemental, epidemiological and other risk factors in different regions/zones of NWFP conducted.

Osmatic cell count and evaluation of economic losses due to different forms of mastitis was studied. The studies concluded that proper milk recording system in majority of the farms was not available. Similarly the knowledge of the farmers regarding the observations of clinical cases in different categories of animals, mastitis occurring season, mastitis detection, performance of tests for the diagnosis and control of under problems, utilization of veterinary services, mastitis treatment/ control, cleaning procedures of teats before treatment, calving season, animal health condition, shed/floor structure, control of flies, milk discarding procedure, drying of animal, hygienic milking/ milking techniques/ milking procedure/ general hygienic measures at the sheds/ farms, cleaning/ disinfection of udder before and after milking, udder/ teat structure, fore milk testing practices, milk let down/ stimulating procedure before milking, adverse effect of oxytocin practices, immediate treatment losses due to clinical/ sub-clinical mastitis was very low and poor. Moreover, according to major farmers the mastitis infection was observed more in hind quarter, in older animals, in first lactation stages and in both cows and buffaloes. In addition, in majority of the farms suckling practice by calves and traditional feeding program according to the local environment was observed. Prevalence of clinical and sub-clinical mastitis was recorded more in buffaloes than cow and the economic losses were recorded more in Buner, Upper Dir, Lower Dir, Lakki districts and Malakand Agency. While in districts Bannu, Swabi, Mardan, Batagram, Hangu, Karak and North Waziristan, Mohmand and Kyber Agenciies such losses wer comparatively low.

Name of Project: **Genetic Improvement of Buffaloes in Pakistan (GIBP) (Component-I)**

Name of PI/ Institute: **Dr. Abdul Ghaffar,**
Senior Scientific Officer,
ASI, NARC, Islamabad

Duration: 12. 11. 2004 to 11. 11. 2007

Financial Status:

Total Cost:	Rs.2.287 million
Funds Released:	Rs.1447200/-
Funds Utilized:	Rs.1112900/-

Objectives:

- To initiate a strategic buffalo breeding program on Kundhi buffaloes in Sindh province.
- To supplement the on-going improvement program in the Punjab province.
- To produce performance tested buffalo bulls and superior frozen semen for domestic use and export.

Achievements:

Data on 961 lactation records of 237 Kundhi buffaloes maintained at Research and Development Kundhi Buffaloes Farm, Rohri, collected over a period of 29 years were used in the study. An effort was made to estimate the magnitude of various environmental and genetic sources of variation in milk yield. The average milk yield in the herd under study was 1356.48 kg per lactation. The length of lactation and dry period averaged 218.72 days and 347.64 days respectively. The average at first calving and calving interval were 1123.18 days and 556.15 days respectively. The average lactation milk yield was lower in the study as compare to Sanjani etal 1999 who reported 1953 liters for selected buffaloes. Average lactation was also higher in their study (330 days).

The influence of various environmental factors (YOB, YOC, SOC and L No.) on MY, CI, LL and DP was studied. Analysis of variance showed that YOB had significant on CI and DP and had no effect on MY and LL. YOC had significant effect on milk yield while the year of birth, season of calving and lactation number had no significant effect on milk yield. SOC had significant effect on LL while LL has no effect on any production trait in this set of data. The genetic variance is higher for MY followed by DP and CI.. The heritability for MY, CI, LL and DP was 0.209, 0.018, 0.009 and 0.024 respectively which is in accordance with other reports. The genetic analysis using the animal model (DFREML) for computing the breeding values was completed. The breeding values for calving interval, lactation length, and dry period were computed and being analyzed how these could be coupled with milk, yield EBVs.

Name of Project: **Effect of Civic Pollution on Fish and Fisheries in the Riverine System**

Name of PI/ Institute: **Mr. Muhammad Afzal,**
Senior Scientific Officer,
ASI, NARC, Islamabad

Duration: 21. 05. 2004 to 20. 05. 2007

Financial Status:

Total Cost:	Rs.1.996 million
Funds Released:	Rs.1993100/-
Funds Utilized:	Rs.1913538/-

Objectives:

- To determine water quality of rivers/streams including estimation of the pollutants such as heavy metals and pesticide/ insecticides
- To study the effect of civic/industrial pollution on planktons, fish and fisheries of our riverine system.
- To devise managemental- plan for sustaining fish population in our riverine system and to suggest measures to protect and sustain/increase present fish production level.

Achievements:

Survey of River Kabul, Soan, Korang and Nala Lai was conducted for site selection of water, fish and plankton sampling. Eleven sites from Nala Lai, 11 from Soan River, 11 from Korang River and 18 from Kabul River were selected for sampling.

The study reveals that some sites in all the rivers and Nala Lai were highly polluted. Seven sampling sites of Nala Lai, Rawalpindi/Islamabad (F-7/2, Christian Colony, 1-9/1 Kachi Abadi, New Katarian Bridge, Gawalmandi, Jhanda Chichi, Fauji Foundation hospital and Soan Bus Stand), four sites of River Soan (near Soan Bus Stand, Kahuta Bridge, Sihala Bridge and Hummak Industrial Area), six sampling sites of Korang River (Samli Sanitorium, Shakrial, Malpur, Poonah Faqeeran and Khanna Dak) and six sampling sites of Kabul River at Peshawar, Nowshera, Jahagira and Kund were found highly polluted and showed poor water quality.

Concentration of heavy metals in waters, fish and plankton were found higher and crossed the safe limit for conservation of freshwater fisheries in some sites of these rivers; in River Kabul sites at Khazana Sugar Mill (Source), Khazana Sugar Mill (Down), Marble Factory Kund (Source), Dalda Oil Mill (Upstream) and Fauji Corn Complex (Source and Down) were higher in Nickel, Arsenic, Zinc and Cadmium respectively. Copper and Zinc was higher in F-7/1 Christian Colony, 1-9/1 Kachi Abadi, New Katarian Bridge and Soan Bus Stand sites of Nala Lai. Zinc, Copper, Nickel and Cadmium were higher in Shifa Hospital and New Katarian sites. In River Soan, Nickel and Lead was higher in Hummak Industrial Area, Sihala Bridge, Kahuta Bridge and Soan Bus Stand sites. Cadmium was higher in Sihala and Kahuta bridges. Zinc was on higher side at Hummak Industrial Area site.

Fish liver, scales, heart and muscles appeared the organs which accumulates significantly higher quantities of heavy metals. In fifteen fish species obtained from rivers Kabul, Korang and Soan, concentrations of Zinc, Copper, Lead, Cadmium, Arsenic and Nickel in different organs (muscles, kidney, scales, heart, gills and liver) of fishes, viz. *Clpisoma naziri* (Shermahi), *Labeo dyocheilus* (Forki)), *Cirrhina reba* (Bhangan), *Cyprinus carpio* (Gulfam), *Ompok bimaculatus*, *Shizopyge labiatus*, *Puntius sarana*, *Wallagu attu* (Mulli), *Punctius ticto* (Chidoo), *Oereochrimus niloticus* (Tilapia), *Tor putitora* (Mahsheer), *Cyprinion watsoni*, *Channa punctatus* (Dola), *Mastacembelus armatus* and Blue catfish were studied. The organs like gills, heart, muscles, scales and liver were found to be higher in heavy metals estimated.

Eleven genera of zooplankton and sixteen genera of phytoplankton identified from sampling sites, accumulate heavy metals in their body and act as bio-indicator of pollution. Zinc is the metal which was found to be present in higher forms in all the rivers.

The bioassay experiments were conducted for LC50 estimation of Nickel chloride and Copper sulphate on three fish species viz., LC50 of Nickel chloride and Copper sulphate for Bighead Carp (*Aristichthys nobili*s) were 57mg/l and 1.5mg/l respectively, LC50 of Nickel chloride for Gulfam (Cyprinus carpio) was 140 mg/l and LC50 of Nickel chloride for Rohu (*Labeo rohita*) was 13.97mg/l. POPS (Persistent Organophosphate Pollutants) like Aldrin. Dieldrin, DDT, Endrin, Mirex, DDT, Heptachloroepoxide, Hexachlorohexane, Hexachlorbenzene and Lindane were determined with the help of HPLC and found absent in all samples collected from highly polluted sites of river Kabul and Nala Lai.

Four M. Sc students of University of Arid Agriculture, Rawalpindi and one student of M. Sc from University of Azad Jammu and Kashmir completed their research for thesis and report writing. Two M. Phil students, one each from University of Arid Agriculture, Rawalpindi and Quaid-e Azam University, Islamabad conducted research for their thesis writing.

Name of Project: **Genetic Characterization of Native Cattle Breeds of Pakistan**

Name of PI/ Institute: **Dr. Safdar Ali,**
Professor,
Department of Animal Breeding & Genetics, University of Agriculture, Faisalabad

Duration: 06. 04. 2004 to 05. 04. 2007

Financial Status:

Total Cost:	Rs. 4.628 million
Funds Released:	Rs.3651800/-
Funds Utilized:	Rs.3265307/-

Objectives:

- To develop phylogenetic relationship among indigenous cattle and buffalo breeds of Pakistan.
- To identify breed specific DNA markers for genetic characterization of different breeds of cattle and buffaloes.

Achievements:

The genetic characterization of indigenous cattle and buffalo breeds have been completed and local population present both at farms and in field with private breeders have been screened for this reason. DNA fingerprinting technologies were used for the estimation of genetic differentiation among different breeds of these two species (fourteen cattle and five buffalo).

Name of Project: **Development of Milk Recording and Genetic Evaluation Models in Sahiwal Cattle**

Name of PI/ Institute: **Dr. Muhammad Sajjad Khan,**
Associate Professor,
Dept. of Animal Breeding & Genetics, University of Agriculture, Faisalabad

Duration: 22. 05. 2004 to 21. 05. 2007

Financial Status:

Total Cost:	Rs.3.695 million
Funds Released:	Rs.2811800/-
Funds Utilized:	Rs.2336642/-

Objectives:

- To develop an information system for Sahiwal cattle for data recording in public and private sector to be used for dairy cattle recording in future.
- Computerization of the available data on the breed from various public institutions maintaining Sahiwal breed for use in genetic evaluation.
- Development of recording schemes for milk recording at institutional as well as tenant herds to introduce recording culture at farmer level.
- Development of genetic models for different recording plans and identification of genetically best animals for use as dam/sire lines for up-gradation and propagation of Sahiwal population.

Achievements:

Longitudinal performance data on Sahiwal cattle breeds was computerized for the main five herds of Sahiwal with Livestock and Dairy Development Department of Punjab to develop a database for the development of statistical models to genetically evaluate cows and bulls for traits like milk yield. Recording continued with the tenant Sahiwal farmers both around Livestock Experiment Station Bahadurnagar, Okara (LESB) and Livestock Experiment Station, Jahangirabad, District, Khanewal (LESJ). These farmers were facilitated for deworming of their animals and fodder seed. Using complete lactations of about 5000 Sahiwal cows, three studies were completed. A fourth study is being prepared regarding the effect of inbreeding on performance traits. Test day records of LESJ since 1980s have also been computerized while similar effort is underway for LESB.

Name of Project: **Influence of Altering Dietary Cation Anion Difference on Productive and Reproductive Efficiency of Buffaloes**

Name of PI/ Institute: **Dr. Muhammad Sarwar,**
Professor/ Director,
Department of Animal Nutrition, University of Agriculture, Faisalabad

Duration: 28. 05. 2004 to 27. 05. 2007

Financial Status:

Total Cost:	Rs.5.058 million
Funds Released	Rs.4837200/-
Funds Utilized	Rs.4794360/-

Objectives:

- To examine the influence of altering dietary Cation and Anion (DCAD) on reproductive efficiency, milk fever incidences.
- Milk yield and its composition in buffaloes under different physiological and environmental conditions.
- Extension of DCAD technology to dairy farmers

Achievements:

The results of summer and winter experiments indicated a linear increase in dry matter intake (DMI), milk yield and milk fat content with increasing the DCAD in lactating buffaloes. The DM, neutral detergent fiber (NDF) and acid detergent fiber (ADF) digestibility increased in buffaloes fed negative (-110 and -220) DCAD diet. Nitrogen balance also increased in buffaloes fed high DCAD diets. A significant increase in blood pH was noticed by elevating the DCAD of lactating and pregnant buffaloes both during summer and winter. Serum (Na + K) - (CI + S) increased linearly with increasing the DCAD levels while serum chloride was higher in buffaloes fed -110 and -220. Serum calcium increased significantly with decreasing the DCAD of diets. Serum magnesium and phosphorus remained unaffected. Urine pH increased significantly with raising the DCAD of diets. Urinary excretion of calcium and chloride increased in -110 and -220 DCAD diets. A gradual increase in cortisol level was observed with decreasing the DCAD of diets. An improved ovarian cyclicity was noticed in buffaloes fed +220 and +330 compared to those fed -110 and -220 diets. This may be due to better energy status of buffaloes fed high DCAD diets. Rectal palpation findings were in line with serum estradiol and progesterone levels. Increased DCAD not only significantly increased the DMI and milk yield but also improved reproductive performance of early lactating buffalo's during summer and winter. Not a single case of hypocalcaemia was observed in buffaloes fed + 11 0, -110 and -220 DCAD diets during summer and winter. However, one buffalo from each group fed +220 and +330 DCAD diets experienced hypocalcaemia during summer and winter. The experiments on pregnant buffaloes indicated that feeding + 110, -110 and -220 DCAD diets before parturition not only increased calcium balance but also prevent hypocalcaemia in Ravi Buffaloes.

Name of Project: **Molecular Characterization and Pathogenicity of Avian Adeno-viruses Causing HPS**

Name of PI/ Institute: **Dr. Mansur ud Din Ahmad,**
Associate Professor,
Dept. of Microbiology, University of Veterinary & Animal Sciences, Lahore.

Duration: 02. 04. 2003 to 30. 06. 2007

Financial Status:
Total Cost: Rs.2.746 million
Funds Released: Rs.2474600/-
Funds Utilized: Rs.2046377/-

Objectives:

- Determining the role of immunosuppressive viruses in the causation of hydropericardium syndrome (HPS).
- Development and characterization of monoclonal antibodies for Avian adenovirus causing hydropericardium syndrome (HPS)
- Development of various diagnostic tools with particular emphasis on differentiation of virulent and non-virulent AAdVs.
- Evaluation of egg passaged local isolate for vaccine production.

Achievements:

The pathogenicity of the fowl adenovirus causing hydropericardium was studied in susceptible broiler birds. The experimental birds were infected with infectious material directly prepared from the morbid material (liver homogenate) and virus propagated in chicken embryo liver cells. The birds were infected with varying doses of HPS virus through parental and oral route at the age of 25 days. Data for post-infection mortality was recorded. Evaluating the role of Immunosuppressive Viruses; the changes in blood values of infected birds were studied. The infected birds had decreased hemoglobin and packed cell volume as compared with the uninfected control birds. The drop in hemoglobin value was more in birds infected with infectious material prepared directly from liver tissue as compared with cell culture propagated virus. The decrease in hemoglobin value could be the indication of an infectious agent which could lead to anemia such as chicken anemia virus. Studies on Antigenic Homogeneity of FAdV causing HPS (Hydropericardium); the homogeneity of different strains of virus collected from field and various biological production units was studied by Agar gel Immunodiffusion (AGID) assay and by studying biological cross neutralization in host (challenge protection studies).

Name of Project: **Studies on the Effect of Bovine Somatotropins on Productive and Reproductive Parameters of Kundi Buffaloes in Sindh.**

Name of PI/ Institute: **Dr. Saghir Ahmed Sheikh**
Professor (Meritorious),
Department of Vet. Physiology & Biochemistry, Sindh Agriculture University, Tandojam

Duration: 26. 07. 2004 to 30. 06. 2007

Financial Status:

Total Cost:	Rs.2.975 million
Funds Released:	Rs.2898500/-
Funds Utilized:	Rs.1043777/-

Objectives:

- Evaluate the raise in meat and milk production of rbST treated buffaloes
- Evaluate productive and reproductive performance of rbST treated buffaloes.
- Determine the biochemical and hematological changes in rbST treated animals coupled with hormonal imbalances if any.
- Determine quality of meat and milk from rbST treated animals.
- Appraise feasibility of rbST use.
- Produce manpower with Ph. D degree as part of Human Resource Development

Achievements:

Sixteen primaparous Kundhi buffaloes were purchased from the markets. These buffaloes were randomly divided into four groups i.e. Group-A, Group-B, Group-C and Group-D placing four buffaloes in each group. Feed intake of all groups was recorded and computed. Nutritive value of feed stuffs analyzed. High energy protein and low energy protein rations were computed. Blood samples were collected for biochemical and haemotological analysis. Serum and milk samples were collected for hormonal assay. Three Ph. D students are enrolled in the project.

Name of Project: **Production of Breeding Bulls to Improve Milk Production of Nili Ravi Buffalo in Rural Areas of Punjab (Component-III)**

Name of PI/ Institute: **Dr. Rafiq Ahmed**
Research Officer,
Livestock Production Research Institute, Okara

Duration: 20. 12. 2004 to 19. 12. 2007

Financial Status:

Total Cost:	Rs.3.764 million
Funds Released:	Rs.3306000/-
Funds Utilized:	Rs.3156591/-

Objectives:

- Production of genetically superior bulls progeny testing program to improve the milk production rural buffaloes with the semen of superior bulls.
- Motivation of registered buffalo breeders through educational tools like personal contacts, group meetings and discussions.
- Holding farmer days and milk competitions at quarterly intervals among the registered buffalo breeders.

Achievements:

Total 770 Nili-Ravi buffaloes have been registered at three sub centres (261 at Kasur, 257 at Nankana Sahib and 252 atVehari) and ears were tagged and their record of productive and reproductive performance along with pedigree record have been maintained.

The buffalo male calves purchased under the project are reared at LPRI, Bahadurnagar, District Okara. The calves are weighed on monthly basis and their growth rate/ average daily gain is being calculated.

In addition body weight and growth rate of different batches of calves purchased in various phases was recorded at the age of 12, 15, 18, 21, 24, 27 and 30 months.

Sixteen (16) buffalo bulls have been shifted to Semen Production Unit (SPU), Qadirabad for collection of semen. 421 buffaloes have completed their lactations at different sub-centres. 157 registered breeders have been motivated through group discussion/ meeting at different sub-centres running under the project. The farmers have been acquainted with knowledge about keeping of good genetic potential animals, importance of A I, record keeping and taking of preventive measures against different diseases.

Name of Project: **Application of Molecular Techniques for Differential Diagnosis of Rinderpest and Related Diseases**

Name of PI/ Institute: **Dr. Qaiser Mahmood Khan,**
Principal Scientific Officer,
National Institute for Biotechnology and Genetic Engineering (NIBGE), Faisalabad

Duration: 17. 07. 2004 to 16. 07. 2007

Financial Status:

Total Cost:	Rs.2.76 million
Funds Released	Rs.2529975/-
Funds Utilized:	Rs.932605/-

Objectives:

- To develop and apply molecular-based technologies (mainly PCR based) for more effective diagnosis and differential diagnosis of rinderpest and related diseases.
- Designing & Synthesis of primers (universal, nested, hemi nested)
- Devising successful PCR based methods which can be applied to local conditions
- Development of Multiplex PCR
- National level training workshop
- Molecular Epidemiology

Achievements:

PCR based methodology for diagnosis of RP, FMD and PPR was established. Since PCR can amplify DNA template only while for RNA viruses (including PPR, FMD and RP), at first stage viral RNA has to be converted into cDNA by reverse transcriptase enzyme which is then subjected to amplification by PCR. This process is referred as reverse transcription polymerase chain reaction (RT -PCR). This technique was also applied to number of field samples collected from various areas of the Punjab.

Several PPRV positive samples were subjected to molecular epidemiological studies. Molecular Phylogenetic analysis of the sequences obtained after cloning of the amplified fragment of fusion (F) protein gene of PPRV revealed that all the PPR viruses found in tested field samples belong to lineage4 group of PPRV. Another landmark was the successful development of RT -PCR based differential diagnosis of FMD, another very important vesicular disease of animals, from RP. Following RNA extraction and cDNA synthesis the viral genome was subjected to amplification by using universal primers targeting VPl gene. Like PPRV, the test was also successfully applied to the field samples collected from different districts of Punjab. The authenticity of the results was also confirmed through ELISA. PCR products were also cloned and subsequently sequenced. Molecular Phylogenetic analysis of the sequenced product revealed that the virus found in local population was of Type O.

Moreover, scientists from NVL, NARC, CASV AB,VR, UV AS & UAF were trained for PCR based diagnostics. Few workshops and training courses were also organized to provide theoretical and technical training to the participants.

Several M. Phil students have completed their theses and four M Phil and 3 Ph D students are doing their research work under this project. The project diagnosis tests were also developed for other economically important viral diseases including Infectious Bursal Disease (IBD) and Bird flu.

Crop Sciences

Name of Project: **Studies on Monitoring of Contaminants in Exportable Food Commodities**

Name of PI/ Institute: **Dr. Zahida Perveen**
Senior Scientific Officer
Southern Zone Southern Zone Agricultural Research Centre, PARC, Karachi.

Duration: 01. 01. 2005 to 31. 12. 2008

Financial Status:
Total Cost: Rs.4.997 million
Total Releases: Rs.3698000/-
Total Expenditure: Rs.2567000/-

Objectives:

- Standardization of analytical techniques for pesticide and heavy metal residues in fruits/vegetables.
- Monitoring of pesticide/metal residues in fruits and vegetables.
- Identification/ distribution of areas on basis of pesticide contamination.

Achievements:

Fruit/vegetable growers, pesticide dealers, officials of agriculture department in districts Khairpur, Matiari, Badin, Mirpur Khas, Hyderabad and Sargodha were contacted to get information regarding pesticides, its application frequency and spray to harvest waiting period. Samples were collected and transported on the same day to Pesticide Residue Laboratory for analyses of multiple pesticide residues and toxic/essential metal contents.

Vegetable crops receive more pesticide load in terms of spray frequency and pesticide dosage. However, fruit orchards receive fewer pesticides when grown as single crop but increasing tendency for multiple/mix-cropping especially growing vegetables in fruit orchards may lead to higher contamination of fruits also.

Generally exporters avoid providing sample mostly on pretext of unavailability of consignment ready for shipping. However few exporters cooperate and provide samples from consignments ready for shipping. Generally exporters do not care for residue levels, they tend to switch over their export markets from the countries having tough phyto-sanitary regulations to those countries where their product is accepted.

One hundred forty eight samples of fruits/vegetables collected from farmer's fields (62 fruits and 86 vegetables) were analyzed. The results showed an alarming level of pesticides residue contamination (72%) and maximum residue levels (MRL's) violation (35%). Fruit samples were less contaminated as compared to vegetables as most of spraying in fruit orchards is done at flowering stage, so up to maturity of fruit sufficient time interval reduces pesticide residues.

In case of vegetables, leafy vegetables were found highly contaminated. 10 out of 11 samples contained residues of 1 to 4 pesticides. Other groups of vegetables were also found to contain residues at very higher levels. Methamidophos, Endosulfan, Carbofuran and Imidacloprid were the prominent compounds violating MRL's most frequently; however, quantities of residues of other pesticides were within safe limits.

The most common pesticides found were Endosulfan, Methamidophos, Imidacloprid, Deltamethrin, Bifenthrin, Cyhalothrin, Profenophos, Thiophnate- Methyl and Fosety Aluminium.

A total of fifty samples of fruits/vegetables collected from farmer's fields (16 fruits and 34 vegetables) were analyzed for toxic and essential metals. The results showed that fruits samples were negative for Cadmium, Lead, Arsenic, Mercury and Chromium. However, one sample for guava was positive for Lead. In case of vegetables 32 out of 34 samples were positive for Cadmium; while Lead was found in 19 samples.

Name of Project: **In-Situ Evaluation of Indigenous Walnut Germplasm in Malakand Division, NWFP, Pakistan**

Name of PI/ Institute: **Mr. Amjad Khan,**
Research O officer,
Agricultural Research Station, Mingora, Swat

Duration: 19. 08. 2005 to 19. 08. 2008

Financial Status:

Total Cost:	Rs.0.784 million
Funds Released:	Rs.532200/-
Funds Utilized:	Rs.435587/-

Objectives:

- Identify promising walnut genotypes growing wild in Malakand Division.
- In situ evaluate the promising genotypes for phonological, morphological and nut quality traits.
- Collect scion bud wood from the most desirable types for nursery propagation at ARS, Mingora.

Achievements:

Some important walnut growing areas of Malakand division, excluded from the last year's survey, were surveyed to identify and evaluate some more desirable walnut genotypes. More emphasis was given to District Shangla, however, certain locations in Districts Dir, Swat and Chitral were also surveyed. Nut samples from 103 genotypes including 41 from district Swat, 38 from Dir, 22 from Shangla and 2 from Chitral were collected, raising our total collection to 219 genotypes. Chemical analysis for oil, proteins and mineral etc, were performed on 20 genotypes, including 2 exotic and 18 indigenous types. In February-March, bud wood was collected from 32 selected genotypes and grafted onto rootstock at ARS, Mingora. Keeping in view the high percentage of failure in spring grafting, an experiment has been designed to study chip budding and patch budding at various intervals during the growing season. Phonological and morphological data were also collected on the previously selected genotypes.

Name of Project: **Utilization of Genetic Variation in Yield Response to Drought Stress for the Development of Improved Wheat Germplasm**

Name of PI/ Institute: **Dr. Muhammad Yaqub Mujahid**
Principal Scientific Officer
National Agricultural Research Centre, Islamabad

Duration: 08. 09. 2005 to 07. 09. 2008

Financial Status:

Total Cost:	Rs.3.861 million
Funds Released:	Rs.2815900/-
Funds Utilized:	Rs.2453946/-

Objectives:

- To develop the improved wheat germplasm adapted to drought stress though the use of new genetic variability.
- To create genetic variability for drought resistance/tolerance in the wheat germplasm through hybridization.
- Exploration of the amount of appropriate genetic variability for drought resistance in the species.
- To know the physiological and biochemical aspects of drought resistance especially in relation to osmotic adjustment and water relations.
- To identify and recommend desired genotypes for cultivation in rainfed, canal tail end and water shortage areas.
- To identify possible molecular markers for drought tolerance.

Achievements:

Every possible effort was made to get along the approved plan of work for the 2nd year and significant progress has been made in terms of collection of genetic variability from the national and international research centers involved in the relevant research for the development of improved wheat germplasm. The material received from the overseas cooperating scientist/organization has been tested and selections are made for further use in the breeding program at NARC. The recombinants developed last year have been planted at Summer Wheat nursery Kaghan after harvesting from NARC during June 2007 for generation advancement to fix the homozygosity and screening against rusts and powdery mildew. The selected lines from the locally developed crosses and also from the exotic material have been tested in the preliminary and advance line yield trials under rain fed conditions at NARC. Top yielding lines identified with a yield advantage over the local checks will further be tested in the coming years over a number of locations under rain fed conditions and areas with limited water availability. One hundred and eighty five new recombinants were developed through hybridization involving the diverse parental material from national and international sources to incorporate the desirable traits like drought resistance/tolerance, disease resistance specially rusts, yield and yield components for the development of improved wheat

germplasm for the rainfed and water limited areas of Pakistan. Based on the performance in the 1st year (2005-06), an advance line (NR 268) developed at NARC was included for testing in the national trials for the 2nd year (2006-07) crop cycle).

Name of Project: **Development of Heat Tolerant, Early Maturing and High Yielding Mungbean (Vigna radiata (L) Wilczek) Genotypes**

Name of PI/ Institute: **Dr. Gul Sanat Shah**
Senior Scientific Officer
Nuclear Institute for Food and Agriculture, Peshawar

Duration: 01. 07. 2004 to 31. 12. 2007

Financial Status:

Total Cost:	Rs.1.674 million
Funds Released:	Rs.1494200/-
Funds Utilized:	Rs.1323535

Objectives:

- To develop improved mungbean genotypes with traits as bellow:
  - Short duration (60-65 days to maturity)
  - Heat tolerant (above 40 ^{0}C)
  - Short stature (50-60 cm)
  - High seed yield (1.0-1.5 t/ha)

Achievements:

Efforts were made to develop mungbean genotypes tolerant to flowers' shedding under high temperature (above 400^{0}C) with short stature and high yield potential. Genetic variability was created through induced mutation and hybridization of local and exotic germplasm followed by subsequent selection for desired traits.

High yielding mutants/recombinant have been developed and evaluated in multi location yield trials at NIFA, Peshawar, ARS, Karak and ARI, D. I. Khan. Four genotypes have shown higher yield than check variety Ramzan at three locations. These genotypes have the ability to produce more new flowers after the flowers' shedding due to high temperature to compensate dropped flowers but they have no tolerance to retain flowers from shedding under high temperature. Advanced mutants/recombinants developed through the project will be further evaluated in multi location and National Uniform Yield trial for stability and adaptability prior to select one for release as variety in NWFP.

Name of Project: **Integrated Control of Root Rot of Pepper in Peshawar and Malakand Divisions**

Name of PI/ Institute: **Dr. Fazli Raziq**
Associate Professor
Department of Plant Pathology, NWFP Agricultural University, Peshawar

Duration: 27. 01. 2007 to 26. 01. 2010

Financial Status:

Total Cost:	Rs.2.629 million
Funds Released:	Rs.1430500/-
Funds Utilized:	Rs.1194507/-

Objectives:

- To develop a cheap and effective method for mass production of biocontrol agents.
- Field application of biocontrol agents for the control of root rot and root-knot disease of crop plants

Achievements:

In some areas, more than 50% crop mortality due to the disease was recorded. Crop receiving more irrigation (flood irrigation) was more severely affected. In areas with previous history of the disease, farmers reported complete failure in raising nurseries and high mortality in he transplanted plants. However, in fields recently brought under pepper cultivation and irrigated with tube well, the incidence of the disease was negligible. Resultantly, most of the crop was observed to be confined to these areas. In the irrigated plains, the crop has been mostly abandoned by the farmers. Some farmers reported successful control of the disease with the application of Ridomil Gold fungicide. All the necessary arrangements, i.e. purchase of laboratory equipments and chemicals, have been made for isolation and culturing of the pathogen and biocontrol agents for further studies. The isolation process is in progress.

Name of Project: **Characterization to Determine the Adaptive Role of Dehydrance under Drought Stress in Wheat, (*Triticum Aestivum*)**

Name of PI/ Institute: **Dr. Rehana Asghar**
Professor,
Deptt. of Botany, University of Arid Agriculture, Rawalpindi.

Duration: 30. 04. 2006 to 29. 04. 2009

Financial Status:
Total Cost: Rs.2.943 million
Total Releases: Rs.1569000/-
Total Expenditure: Rs.162441/-

Objectives:

- Characterization of dehydrins in the promising cultivars of wheat using immunoplots.
- Isolation of dehydrin genes using Dhn gene probs in genome.
- Determination of adaptive role of dehydrins under drought stress.
- Use of dehydrin antibodies for screening the drought tolerant varieties of wheat.

Achievements:

Wheat seeds (Auqab 2000, Margalla 99, Kohistan 97, Zarlashta 99) were germinated in a growth chamber at 20 ^{0}C at 10 hours photoperiod. Two methods were used for the application of drought stress to the seedlings. In first method, seeds were germinated on filter papers moistened with Polyethylene glycol (PEG) solutions of variable osmolarities and seedlings were harvested at three leaf stage. In the second method, seeds were germinated on moist sand, and seedlings were harvested at three leaf stage. The fresh weight of washed and dried seedlings was measured and then subjected to drought stress by dehydrating the seedlings in moistened environment of saturated Magnesium sulfate solution in desiccators till 40 percent of their fresh weight was decreased. Samples of leaf tissues from stressed and unstressed (control) seedlings were stored at -20 ^{0}C. Frozen samples were used for protein extraction. The amount of protein was estimated. 5 µg protein was used for Polyacrylamide gel electrophoresis. The dehydrin bands were detected at MW ranging from 47 and 22 kDa.

From results it is concluded that in wheat cultivars i.e Auqab 2000 and Margalla 99 showed dehydrins bands. However, Margalla 99 has dehydrins bands at 47 and 22 kDa while Auqab has dehydrins band at 22 kDa and some at low molecular weight. The intensity of these bands was variable among the cultivars investigated. It concluded that the alleles for dehydrins are variable in these to wheat varieties.

Name of Project: **Studies on Breeding Biology Post-Natal Development and Control Trails Against Rodent Damaging Date-Palm Orchards of Balochistan Province**

Name of PI/ Institute: **Syed Muzaffar Ahmed**
Senior Scientific Officer,
Vertebrate Pest Control Research Institute, SARC, Karachi

Duration: 07. 03. 2005 to 06. 03. 2008

Financial Status:

Total Cost:	Rs.3.102 million
Funds Released:	Rs.2380000/-
Funds Utilized:	Rs.2160848/-

Objectives:

- To identify rodent pest species involved in damaging the date-palm trees.
- To quantify the economic losses of date palm caused by the rats.
- To conduct studies on breeding biology, growth, post-natal development/behavioral aspects and food preference.
- To draw an exact picture of the rodent population of the area.
- To conduct control trials for the evaluation of different rodenticides and fumigants to determine their efficacy and to develop a control package against rodent pests.
- To train the farmers and extension staff of the area in Rodent Pest Management.

Achievements:

To ascertain the food habits of *Nesokia species*, faecal samples were collected from the infested date-palm orchards during and after the fruiting season (July-December). Nine different flora of the area were also collected as a reference collection. The results of initial study revealed that diet of *Nesokia sp*. was largely consists on date-palm fruit, stem portions, insects and common grass of the area.

Studies were conducted for the selection of suitable bait base and additive (enhancer) to overcome the drawback of bait shyness and to increase the palatability in rodents. Four food items viz, wheat, rice, maize and sunflower seed were taken in various combinations and tested in no-choice, choice tests which was further divided into two feed test and multiple feed test. Results revealed that *Nesokia sp*. causing colossal losses to date-palm trees was not very consistent in its preferences to particular food. It was also observed that species mostly preferred mixed diet and no grain was totally rejected.

Milk powder, Yeast, Sunflower oil, Fish meal, Brown sugar, Date fruit and Whole egg were, used as bait additives. The experiments were designed as; i) No-choice tests and ii). Choice tests. (Paired choice and three feed choice test). In no choice test milk powder, brown sugar and sunflower oil additive baits were consumed significantly more than fish meal, egg, yeast, date fruit and plain bait. In choice test (paired choice) baits with milk powder additive was significantly consumed over plain bait ($P<0.05$). Baits containing milk powder stood first top most (67.89%), while bait with brown sugar remained second (58.04%) in order of preference.

Population of rats were examined through trapping of the animals in especially design pipe traps made of pieces of PVC pipe with a diameter of 2´ x 2´ and length 10´ and with one end closed with plastic cap for capturing the rats to determine the population index. Generally a figure of 10% catch indicates a high rodent population. A trap success of 10.21 % was recorded in date-palm orchards of Nok kundi. Traps were baited with guava pieces and peanut butter which may be attractive as compared to the tissues of the date-palm tree stem.

Experimental control trials were conducted to determine the efficacy of rodenticidal bait and fumigant against Nesokia sp. To determine the efficacy of bait / fumigant pre and post treatment population censuses work were carried out. Burrows were fumigated and post treatment observations were taken 48 hrs after treatment. Highest mortality (83.90%) was obtained with the use of Aluminum phosphide tablets (3g) in 205 burrows, which proved highly effective followed by brodifacoum. In case of burrow baiting with brodifacoum (0.005%) sachet containing 20 gm bait, reduction in animal activity was recorded 65.38%.

Information on the biology and reproduction give a theoretical basis for applied work. Therefore behavioral and post-natal development studies of the rats causing infestation in date-palm orchards will be helpful in effective rodent control. The observations of breeding biology and post-natal development of Indian gerbil (Tatera indica) were recorded: where average litter size was calculated 4.5 (range 1-11 young /litre). Shortest interval between births recorded was 18 days. The mean interval between birth was 28 days (range 18-40 days). Lower incisors erupted on 9-14 days, while upper at the age of 11-14 days. Eyes opened at the age of 14-20 days and hearing capability developed from day 12-15 days. The nibbling of solid food started from day 18-22 days. Lactation was continued till day 22-32 days (average 26 days). Face washing was occurred on day 5 and self grooming on day 12 but both characters were uncoordinated that became well established after the eyes opening. Rudimentary social grooming among littermates was observed on day 16 that became prominent on day 22. The behavioral characters i.e. righting, grasp reflex, rooting reflex and cliff drop aversion were present since birth. These characters became well developed at the end of 2nd week

Name of Project: **Adaptation And Promotion of Ultra Low Volume (Ulv) Pesticides Sprayer**

Name of PI/ Institute: **Dr. Abdul Rehman Tahir**
Professor/Chairman,
Deptt. of Farm Mechanization & Power, University of Agriculture, Faisalabad

Duration: 21. 10. 2005 to 20. 10. 2008

Financial Status:

Total Cost:	Rs.2.387 million
Funds Released:	Rs.1009000/-
Funds Utilized:	Rs.326185/-

Objectives:

- The overall objective of this study is to transfer ULV sprayer's technology and promote its application among the farmers. Specific objectives include:
- To appraise socio-economic and technical problems being encountered in the adoption of ULV sprayers.
- To transfer ULV sprayers technology by fabricating handheld and tractor mounted ULV sprayers using local materials and workmanship.
- To promote adoption of locally developed ULV sprayers among farmers and agro-industry through field demonstration, seminars, newspapers and electronic media.

Achievements:

To know exactly the problems in adoption of ULV sprayer, a socioeconomic and technical survey of manufacturers, pesticide dealers, scientists and farmers was conducted. Survey reveals that presently, single nozzle handheld Ultra Low Volume (ULV) sprayers are being imported from abroad mostly by Syngenta and therefore; they are not easily available to many farmers. Moreover, awareness of farmers and sprayers manufacturers about advantages of ULV sprayers is very poor which seems to be a major hindrance in the adoption of this sprayer. ULV is mostly being used for 4-5 sprays of cotton out of total 8 to 9 sprays. Survey shows that the use of ULV sprayer has increased during the last 5 years among farmers especially during humid and rainy season when tractor mounted boom sprayers can not be used. Farmers reported that ULV is effective to control bollworms like American bollworm, spotted bollworm, pink bollworm and not good for flying insects (whitefly, mites, thrips, etc.) Further, the efficacy of ULV spray is 80% as compared to 50% in case of knapsack and boom sprayers. Due to its high efficacy the spray interval of ULV is 11 days as compared to 7 days in case of knapsack sprayer. ULV formulations are available and therefore, it's not a problem in the adoption of ULV sprayer.

Most of the farmers and farm supervisors are not fully trained and educated about the use of ULV sprayers. Resultantly, under/over-dozing spoil the crop and farmers attribute this drawback to ULV machine. A major social problem in the adoption of ULV sprayer is its invisible spray drops

which give an impression to the farmers that spray has not been applied since they are used to see mist while using knapsack and boom sprayers. Testing of locally manufactured ULV sprayers have shown leakage problems which not only leads to wastage of pesticide but is also a hazard to human and animal health.

Nozzles supplied by local manufactures are imprecise resulting into overdosing. The spinner speeds are not standardized which could lead to different droplet size and spray density. Measurement of droplet size using water sensitive paper and scanner has been tried with the help of computer software. Microscope coupled with digital camera which is in the process of import will also be used to measure droplet size.

Name of Project: **Screening of Citrus Cultivars Grown in Pakistan Against Citrus Canker and its Management**

Name of PI/ Institute: **Dr. Shahbaz Talib Sahi**
Professor,
Deptt. of Plant Pathology, University of Agriculture, Faisalabad

Duration: 25. 07. 2006 to 30. 06. 2009

Financial Status:

Total Cost:	Rs.2.952 million-
Funds Released:	Rs.1057000/-
Funds Utilized:	Rs.829624/-

Objectives:

- To isolate the bacterium from different citrus cultivars.
- To study the ecology and epidemiology of citrus canker with respect to it occurrence, distribution and loss assessment. Identification of hot spots for further studies.
- To establish relationship between disease severity and different environmental factors.

Achievements:

During the period under report, the infection index of citrus canker disease was recorded from the three districts (Faisalabad, Sahiwal and Sargodha) of Punjab province and three districts (Nawabshah, Sanghar and Noshero Feroz) of Sindh province. The disease ranged from 12 to 31 and 25 to 39.21% in Sahiwal and Sargodha district, respectively, while, the range of incidence of disease was 16.21 to 26.25, 15 to 20.45 and 17.26 to 23.25.25%, from Nawabshah, Sanghar and Noshero Feroz, respectively.

In addition to these, the spots selected for continuous recording of data were visited on weekly basis starting from July to October, 2006. The disease incidence in Faisalabad, Sahiwal and Sargodha ranged from 7 to 18.5, 5.5 to 19.3 and 5 to 20.4%, respectively. It was observed that a range of 29-39, 23.5-38.5 and 24.5-37^{0}C was the most favorable for disease development at Faisalabad, Sahiwal and Sargodha districts, respectively, while 31-37% of relative humidity was found to be the most favourable for disease development in the three districts.

Name of Project: **Utilization of Allelopathic Properties of Sorghum Sunflower and Brassica for Weed Management in Some Field Crops**

Name of PI/ Institute: **Dr. Zahid Atta,**
Professor,
Deptt. of Agronomy, University of Agriculture, Faisalabad

Duration: 19. 08. 2005 to 18. 08. 2008

Financial Status:

Total Cost:	Rs.3.117 million
Funds Released:	Rs.1119600/-
Funds Utilized:	Rs.840044/-

Objectives:

- Conduct the field experiments in different cropping systems.
- Application of crop water extracts on crops.
- Observation and appraisal of field experiments.

Achievements:

Field experiments were conducted to investigate the efficacy of allelopathic water extracts of sorghum, sunflower and brassica for weed management in field corps in different cropping systems of Punjab. Experiments were carried out in important rabi and kharif crops like cotton, maize, rice and wheat on farmer's field (Jhang, Dera Gazhi Khan) as well as research institutes (University of Agriculture, Faisalabad and Punjab University, Lahore). Allelopathic water extracts of sorghum, sunflower, brassica and mulberry were applied alone and in combination with lower rates of herbicides. Results revealed that different combinations of water extracts each at 15-18 L ha-1 combined with lower rates of herbicides were very effective in controlling several rabi and kharif weeds of cotton, maize, rice and wheat crops. Weed control using allelopathic water extracts in combination with reduced doses of herbicides were better or comparable with full doses of herbicides. It is suggested on the basis of these experiments that herbicide dose can successfully be reduced by combining with allelopathic water extracts of sorghum, sunflower and brassica for weed control in field crops.

Name of Project: **Development and Testing of Resource Conservation Tillage Implement**

Name of PI/ Institute: **Dr. Jehangir Khan Sial**
Professor,
Faculty of Agri. Engineering & Technology, University of Agriculture, Faisalabad.

Duration: 01. 10. 2004 to 30. 09. 2007

Financial Status:

Total Cost:	Rs.1.91 million
Funds Released:	Rs.1083825
Funds Utilized:	Rs.594167/-

Objectives:

- Select and test the locally available materials for construction of sweep shovels.
- Investigating variations in different engineering parameters (suction, pitch, lift, angle of attachment and thickness of plate) for design of the shovels.
- Attachment and testing of a depth wheel with the sweep cultivator for facilitating its penetration control.
- Comparative testing of the sweep cultivator developed using local materials and workmanship.
- Information dissemination for adoption of the implement

Achievements:

Extensive field testing of sweep shovels has been conducted at three different soils varying in texture and initial soil conditions like moisture contents, bulk density, shear strength, residue cover etc. Sweep shovels were weighed before and after cultivation for a certain period of time to cultivate designated areas. The field experiments yielded a large bulk of data including wear rates of sweep shovels varying in material, method of treatment and macro shape of the tool in addition to indicating the effects of soil type on rate of wear. Apart from wear losses of different treatments, changes in soil properties due to the treatments were also measured before and after cultivating the fields. It was generally felt that the rate of tool wear was quite faster during first replication, whereas, the same diminished and became constant later. However, the scientific conclusions will be reported after the statistical analyses of the data.

During the same period, depth wheel for the sweep cultivator was also designed and mounted on the cultivator. The depth wheel certainly helped improving the depth control on the cultivator during the field operation and the operator comfortably used the implement without any manipulation of hydraulic control lever. Apart from field studies, extensive computer search for review of literature was conducted both nationally as well as internationally.

Name of Project: **Mapping of Bacterial Diversity in Sindh Agricultural Fields and Desert: at Molecular Level**

Name of PI/ Institute: **Dr. Nuzhat Ahmed,**
Director & Professor,
Center for Molecular Genetics, University of Karachi, Karachi.

Duration: 08. 01. 2005 to 08. 01. 2005

Financial Status:

Total Cost:	Rs.3.466 (Million)
Funds Released:	Rs. 221500/-
Funds Utilized:	Rs.2256870/-

Objectives:

- Cataloguing of bacteria from agricultural and deserted area of Sindh.
  - Analysis of differences (at molecular level) in soil biota from agricultural and deserted area.
  - Selection of bacteria from different geographical positions which have the following characters:
    - Biocontrol agents
    - Bioabsorbent producers and
    - Maintaining N, P and S in soil
  - Preparing a database of diversified bacteria in Sindh region, which may help in conserving the VIII. Bacterial diversity in Sindh. This is important, as Pakistan is a signatory of CBD

Achievements:

To identify and characterize, preserved bacteria was collected from the soil of agricultural fields and desert of Sindh. Bacterial strains from various agricultural fields i.e. from National Nematological Research Centre (NNRC), Karachi University, Memon Goth, Malir, Khokarapar, Jam Goth, Jam Tando, Atomic Energy Research Centre, Tandojam (NIA), Mirpurkhas, Sakrand, Khairpur, Larkana, Ghotki and from different areas of Thar Desert i.e. Naukot, Umerkot and Pithoro. Out of 500 isolated bacteria only 100 strains were characterized for biopolymer production and for their ability to solubilize phosphate. These were selected from different locations and the number was kept so that they would be managed. Further, these bacteria were identified by QTS-24 (indigenous product similar to API).

Name of Project:	**Mass Production of Biocontrol Agents for Field Application**
Name of PI/ Institute:	**Dr. Saleem Shahzad,** Associate Professor, Department of Agriculture, University of Karachi, Karachi.
Duration:	21. 07. 2005 to 30. 06. 2008
Financial Status:	Total Cost: Rs.1.145 million Funds Released: Rs.683400/- Funds Utilized: Rs.552000/-

Objectives:

- To develop a cheep and effective method for mass production of biocontrol agents.
- Field application of biocontrol agents for the control of root-rot and root-knot diseases of crop plants.

Achievements:

During the present study nine different organic substrates viz, rice grains, sorghum grains, wheat grains, millet grains , wheat straw, rice husk, cow dung, sawdust and poultry manure were used for mass multiplication of biocontrol agents viz, Trichoderma harzianum, T. polysporum and T. pseudokoningii, Rhizobium sp; Bradyrhizobium sp; and Gliocladium virens. Sorghum grains were found to be the best substrate for Trichoderma species and Rhizobium sp; millet grains were best for Bradyrhizobium sp; whereas, rice grains were best for Gliocladium virens. Grains were generally found more suitable for multiplication of biocontrol agents than wheat straw, rice husk, cow dung, sawdust and poultry manure. Dextrose and sucrose were found to be the most suitable carbon sources for G. Virens and Trichoderma species, Rhizobium sp; and Bradyrhizobium sp. Similarly, the best nitrogen sources were ammonium nitrate for Trichoderma species, sodium nitrate for G. virens and NPK for Rhizobium sp; and Bradyrhizobium sp. Amendment of selected C and N sources to organic substrates resulted in great growth and significantly higher population than the organic substrates alone.

Name of Project: **Investigation on Disease Control of Die Back/Citrus Decline in NWFP**

Name of PI/ Institute: **Dr. Mahmood Khan,**
Plant pathologist
Agricultural Research Institute Tarnab, Peshawar, NWFP.

Duration: 16. 08. 2005 to 30. 06. 2008

Financial Status:

Total Cost:	Rs.2.838 million
Funds Released:	Rs.2356100/-
Funds Utilized:	Rs.1935629/-

Objectives:

- To find out the biotic and abiotic factors responsible for citrus die back/decline in the major citrus growing areas of NWFP.
- To find the most effective, safe and economical control measures for the solution of the problem.
- Train farmers on the use of integrated disease management practices for citrus die back.

Achievements:

During the period field experiments were conducted at District Mardan and Tangi Khattak at District Nowshera. The treatment kept at both these locations were: Control; Ridomil @ 4gm/L water; Alliette @ 4gm/L water; Furadan @ 8Kg/acre; Ridomil+ Furadan (4gm/L Water+ 8Kg/acre); and Alliette + Furadan (4gm/L Water + 8Kg/acre.

The yield data recorded at the end of December, 2006 revealed great variations from plant to plant with in the same treatment. i.e. at Soaki Mardan a plant in the control treatment produced 20 Kg and the yield of another plant of the same treatment was 130 kg. In a treatment to which Alliette + Furadan were applied a plant gave 8 Kg and another plant in the same treatment gave 100Kg fruits. Similarly the yield data recorded at Tangi Nowshera also revealed great variations for example a plant in control treatment gave 55 Kg while another plant in the same treatment gave 125 Kg. In the treatment to which Ridomil + Furadan were applied a plant yielded 45 Kg while another plant in the same treatment gave 175Kg. Keeping in view these variations it is difficult to draw some conclusion at this stage Field experiments have also been laid out at Mera Tangi, District Charsadda, Sher Khana, Malakand Agency and Chamla, District Bunir. The data will be available after harvest in the month of December, 2007.

The farmers, where the field experiments were carried out and neighboring farmers were trained and educated about the location of the problem and the procedure to treat their diseased plants by applying pesticides to the trunk of the plants instead of applying pesticides to the canopy. Also they were educated to apply all the three major nutrients i.e. NPK in the ratio of 750-500-500

gm/tree. They were further advised to carry out corrective pruning of the diseased branches, try to avoid direct contact of irrigation water to the trunk of the tree and keep exposed the bud union above ground level.

Farmers of the area are now adopting the procedures of applying treatments to the trunk of the diseased trees and are also applying Potassium fertilizer to the citrus orchards, which was not in practice before.

Name of Project: **Sustainable Approaches Toward Adaptatin of Sorghum and Millet Improved Varieties for Grain and Fodder Purpose in Rainfed Areas of Kohat Division**

Name of PI/ Institute: **Dr. Muhammad Khan,**
Director,
Barani Agricultural Research Station, Kohat.

Duration: 10. 04. 2006 to 09. 04. 2009

Financial Status:

Total Cost:	Rs.1.476 million
Funds Released:	Rs.927500/-
Funds Utilized:	Rs.675507/-

Objectives:

- To screen out high yielding and drought tolerant lines/varieties of Sorghum and millet for grain and fodder purposes under rainfed condition of Kohat.
- To screen out and introduce high yielding and best adaptable improved varieties of Sorghum and Millet among the farming community of rainfed areas of Kohat.
- To introduce modern production technology for sorghum and millet, to increase yield, to best utilize soil fertility and to improve the economic status of farming community.

Achievements:

Sorghum and millet are the major Kharif crops of Barani areas of Kohat division for fodder purposes. These crops are also cultivated for the grain purpose for poultry feed, industrial by - products and for seed. The yields are very low due to scarcity of improved varieties, and seed availability in sufficient quantity with the farmers at sowing time is a major problem. Borer attack on old and traditional cultivars is also a headache. Therefore, the introduction of improved varieties, ensuring seed availability and providing a modern package of production technology to the farming community are imperative for increased productivity. For screening and introduction of high yielding sorghum and millet lines/varieties, experiments were designed both at the station and on farmer's fields. Sorghum entries i.e. RARI-S-4, RS-29 and CSL-13 were found the highest grain yielding varieties with grain yields of 4667, 4083 and 4000 kg ha-1 respectively. The yields were 22,6-5 and 4.3% more than control.

Sorghum varieties, JS-2002, JS-263 and Hegari were the highest fodder producers with fodder yields of 28333, 26667 and 25000 kg ha-1 respectively. The yields were 95, 84 and 72% more than control. Two millet lines, RARI-C-4 and PARC-ms-3 were identified producing maximum fodder yields of 12450 and 9545 kg h-1 respectively. The yields were 45 and 11% more than Local Bajra (8567 kg ha-1) respectively. Among the millet varieties, Kohat-98 and Comp-II indicated better adaptability to the rainfed agro-climatic conditions of Kohat division.

Name of Project:	**Development Of Botanical Pesticides From Traditionally Used Plant Derivatives Against Stored Grain Pests.**
Name of PI/ Institute:	**Dr. Ghulam Jilani,** Deputy Director General, IPEP/Chief Scientific Officer, IPEP, National Agricultural Research Centre, Islamabad.
Duration:	01. 07. 2005 to 30. 06. 2008
Financial Status:	Total Cost: Rs.3.385 million Funds Released: Rs.2208000/- Funds Utilized: Rs.1512366/-

Objectives:

- Determination of pest control properties of indigenous plant derivatives.
- Preparation of effective formulations based on active plant extracts/fractions.
- Demonstration of botanical pesticides based Integrated Pest Management of stored grain insects.

Achievements:

Acorus calamus had the highest average repellency of 76.54 percent at 1000 µg/cm^2. *A. calamus* extracts in petroleum, ether acetone and ethanol were also effective repellents showing 84, 83 and 63 percent repellency respectively at 1000 µg/cm^2. A comparison of solvents showed highest average repellency of 47 percent by acetone extracts followed by 45 percent in petroleum ether and 30 percent in ethanol. During first and second weeks, petroleum ether extracts had higher repellent effects than acetone and ethanol. However, during fourth and eighth weeks repellency was comparatively higher in acetone. During first week the highest repellency of 90.50 percent was exhibited by acetone extract of *A. calamus* at 1000 µg/cm^2 which decreased to 86 and 78 percent at 500 and 250 µg/cm^2, respectively. In ethanol extract the highest repellency of 71 percent was indicated by *Azadirachta indica* at 1000 µg/cm^2. Eggs laid by *Triboleum castaneum* in the flour treated with extracts of *S. lappa* or *A. calamus* at all concentrations was significantly lower than those in control. There was significantly higher inhibition of 22 percent egg hatching in ethanol extract as compared with 17 percent in petroleum ether extracts. Acetone extracts had 19 percent inhibition. All the plants had significantly lower number of developed larvae than control except *Skimmer laurel* at 250 ppm. Inhibition of hatched larvae to become developed larvae was 24 percent in *Valerian Atamans* at 500 ppm. There was no significant effect of solvents on larval inhibition. However, there was 12.79 percent larval inhibition in acetone extract as compared with 11.19 and 9.8 percent in petroleum ether and ethanol extracts, respectively. Maximum pupal inhibition of 46.20 percent was recorded in *Azadirachta indica* at 250 ppm whereas only 20.33 developed pupae were obtained from 33.08 developed larvae. Highest adult inhibition of 7.94 percent was recorded in *Pegnum harmala* at 250 ppm.

Name of Project: **Studies on Resistance Monitoring and Insecticide Effects on Chrysopid Predators Chrysoperia Carnea (Stephen) Neuroptera; Chrosopidae)**

Name of PI/ Institute: **Dr. Attaullah Khan Pathan,**
Senior Scientific Officer,
PARC-IMP Sub Station, University College of Agriculture, B. Z. University, Multan

Duration: 26. 08. 2004 to 25. 08. 2007

Financial Status:

Total Cost:	Rs.1.986 million
Funds Released:	Rs.1891100/-
Funds Utilized:	Rs.787413/-

Objectives:

- To monitor insecticidal resistance in Chrysopids from different geographical zones of vegetable and cotton crops.
- To study and compare the predatory potentials of resistant Chrysopid strains with that of susceptible one.
- To study the effect of selection pressure on the developmental rates, fecundity, fertility, sex ratio and on the development of a resistant / tolerant Chrysopid strain.
- To use the information in integrated pest management strategies.

Achievements:

Studies on the insecticide resistance were carried out in the laboratory of IPM Station PARC, Multan. Five locations Multan, D. I. Khan, D. G. Khan, Bahawalpur and Rahimyar Khan, were selected as per frequent availability of the *Chrysoperla carnea*. These collected strains were reared in the laboratory and their F1 have been tested against commonly used insecticides in cropping system i.e. Curacron® (profenofos), Lorsban® (chlorpyrifos), Karate® (lemdacyhalthrin), Bestox® (alphamethrin) and Decis Super® (deltamethrin). The resistance factors were calculated with the reference strain already reared strain at IPM Station PARC, Multan.

Resistance Factor: The data obtained from the studies are summarized; as *C. carnea* of Multan shows resistance factor against above mentioned insecticides as, 33.85, 8.72, 94.85, 81.63 and 10.08, D. I. Khan strain shows 27.23, 10.19, 38.70, 19.45 and 4.26, D. G. Khan strain shows, 56.15, 153.02, 109.26, 75.38 and 22.25, Bahawalpur strain shows, 26.09, 49.06, 28.62, 30.61 and 7.20 and Rahimyar Khan strain shows, 12.86, 39.76, 20.50, 28.68 and 2.96, respectively.

Lethal Dose: LD_{50} of the above listed insecticides were calculated with Microapplicator® against the five strains of *C. carnea* and also against the reference strain already reared strain at IPM Station PARC, Multan. Data obtained from the studies are summarizely presented; *C. carnea* of D. I. Khan showed maximum LD_{50} (3.298) and LD_{95} (78915.86) against alphamethrin and minimum LD_{50} (0.11) was observed against alphamethrin from Bahawalpur strain and minimum LD_{95} (1.29) against chlorpyrifos showed in Multan strain.

Larval Mortality (%age) Through Food Treatment/Ingestion Method: Data reveals that the larval mortality (%age) vary when fed with treated eggs of *Sitotroga cereallela* as 90.0, 60.0, 16.67, 6.67 and 13.33 when treated with profenofos, chlorpyrifos, lambda-cyhalothrin, alphamethrin and deltamethrin, respectively. Number of eggs laid by each female was 103.3, 225.3, 356.7, 426.3, 395.3 and 439.3 and hatching (%age) was 25.33, 53.33, 87.33, 90.33, and 97.67 when treated with profenofos, chlorpyrifos, lembda-cyhalothrin, alphamethrin, deltamethrin and control/check respectively. The results showed that the OP group affected every stage of the *C. carnea* as compared to the pyrethroid group. Hence the pyrethroid group is better when survival of the natural enemies in cropping system is considered.

Predatory Potential of Resistance and Susceptible Strain: Data reveal that the treated larvae of *C. carnea* showed different predatory behavior against different pest, each larva of *C. carnea* consumed 133.3, 129.7, 131, 128.7, 137.3 and 100.3 white fly nymph, 76.67, 75.67, 77, 79, 73.33 and 61.67 jassids, 140, 133.7, 133.3, 137 and 97 aphid and 8.67, 8.67, 8.33, 7.67, 8.67 and 5 mealy bugs when treated with Curacron® (profenofos), Lorsban® (chlorpiryfos), Karate® (lembda-cyhalothrin), Bestox® (alphamethrin) and Decis Super® (deltamethrin), respectively at MFD /different doses. The data showed that the treated larvae were found more active and consumed more insects as compared with susceptible strain under laboratory conditions.

Name of Project: **Investigation of Citrus Decline and Preliminary Management Studies in Punjab**

Name of PI/ Institute: **Ms. Khurshid Burney,**
Senior Scientific Officer,
CDRP, National Agricultural Research Centre, Islamabad

Duration: 21. 07. 2005 to 30. 06. 2008

Financial Status:

Total Cost:	Rs.2.801 million
Funds Released:	Rs.2150600/-
Funds Utilized:	Rs.1990747/-

Objectives:

- Investigation of pathogens (Bacterial, Fungal, Viral, Nematode) and stress factors causing citrus decline in the Citrus growing areas of Punjab.
- Pathogen city test of fungi isolated and screening rootstocks against isolated pathogens.
- Preliminary studies on the development of a strategy for the management of citrus decline.

Achievements:

Surveys of citrus growing areas of Punjab comprising of Sargodha, Sahiwal, Toba Tek Singh Faisalabad, Jhang and Kasur (Patoki) were conducted for the assessment of citrus decline and collection of diseased plant and soil samples. The decline in citrus is being investigated through multidisciplinary approach. During the first year surveys it is noticed that citrus nematode is prevalent in all the citrus grooves except on Sweet lime (Mehta). Kinnow and Rough lemon are highly susceptible to citrus nematode.

Declining trees show symptoms of a number of plant diseases including Gummosis, Foot rot, Citrus canker, Citrus Greening, Triestze and Spiroplasma citri. Diseased plant samples were plated on blotter paper and Potato dextrose agar for isolation of plant pathogenic fungi. The percentage of different fungal pathogens of the 152 plant samples analyzed was Fusarium 59, Nattrassia 10, Diplodia 4 and Phytophthora 2. An average of 26% of diseased leaf samples tested positive for Spiroplasma citri by amplification of the pathogen DNA using universal primers for mycoplasma.

Soil was analyzed for the presence of plant parasitic nematodes by Baermans funnel technique. A total of 152 soil samples revealed that most frequently present plant parasitic nematode in the soil is Tylenchulus semipenetrans being present in 38% of soil samples. Among the districts 100% samples from Jhang are infested with this pathogen and the least infested district is Sahiwal. Seven citrus nurseries were vested in Pattoki and soils of three have been found infested with T. Semipenetrans. The rootstock Rough Lemon and Sour Orange that are mostly used for citrus are both found to be highly susceptible to the nematode.

Other plant parasitic nematodes found associated with citrus soils are *Helicotylenchus* sp; *Hoplolaimus* sp; *Longidorus* sp; *Radolpholu*s sp; *Trichodorus* sp; *Tylenchorhyncus* sp; *Xiphenima* sp; and *Zygotyllencus* sp. A number of free living nematodes were also isolated whose further analysis will help in determining the soil health status.

Fungi isolated are being assessed for their pathogenicity in available environmental conditions on different citrus rootstock that are already being used with new ones.

Soil samples from different districts are being analyzed for NPK and micro nutrients, Boron, Zinc, Manganese and Iron.

Name of Project: **Characterization of Pakistani Isolates of Chili Veinal Mottle Potyvirus (Chivmv) and Cucumber Mosaic Cucumovirus (CMV) Infecting Chili Crop**

Name of PI/ Institute: **Dr. Hussain Shah,**
Scientific Officer,
IPEP, NARC, Islamabad

Duration: 26. 08. 2004 to 25. 08. 2007

Financial Status:

Total Cost:	Rs.2.933 million
Funds Released:	Rs.1627500/-
Funds Utilized:	Rs.1315494/-

Objectives:

- Serological characterization of Pakistani isolates of ChiVMV and CMV
- To study the biology of ChiVMV and CMV
- Antisera production against ChiVMV and CMV
- Management through identification of source of resistance against ChiVMV and CMV in available Capsicum germplasm

Achievements:

Chili pepper samples (501) were collected from NWFP (district Swat, Lower Dir and Malakand) and were tested through ELISA against ChiVMV and CMV. The relative incidence of ChiVMV and CMV was 15.7% and 7.8% respectively. Two isolates of each were also preserved. 257 chili pepper samples were also collected from Punjab (Chakwal, Fatehjang, Talagang, Mu1tan, Faisalabad, Lodhran, Bahawalpur) and were tested through ELISA against ChiVMV and CMV. The relative incidence of ChiVMV and CMV was 3.1 and 8.5% respectively. Co-infection of both viruses was observed in Bahawalpur area (0.4%). Eight isolates each of ChiVMV & CMV were also preserved.

Two different procedures (Chirgwin et al. 1994 & Chomczynski and Sacchi, 1987) were applied for extraction of total cellular RNA from the host. Attempts were made to synthesis DNA of ChiVMV but so far no amplification has been made. For screening of local/exotic chili germplasm, 32 lines/varieties were inoculated with mixture of CMV isolates (Sindh and Punjab) under glasshouse conditions. Data on symptom observations after first inoculation have been recorded and further experiment is in process.

Name of Project: **Identification of Superior Soybean Cultivars for Different Agro-ecologies of Pakistan**

Name of PI/ Institute: **Dr. Muhammad Ashraf,**
Senior Scientific Officer,
Oilseed Program, NARC, Islamabad

Duration: 20. 10. 2004 to 30. 06. 2008

Financial Status:
Total Cost: Rs.2.796 million
Total Releases: Rs.2205300/-
Total Expenditure: Rs.1744525/-

Objectives:

- To collect and acquisition various germplasm.
- To develop base material with high yield potential for future breeding needs.
- To screen/evaluate soybean germplasm for specific cropping systems.
- To enhance land utilization and farmers income through induction of soybean in various cropping system.

Achievements:

Collection and acquisition of germplasm: Collected from National Centre for Soybean Improvement, Nanjing, China small quantity of seed (10 g) of each 12 new advance lines tested in their regional trials.

*Seed multiplication (autumn**):*** Forty cultivars/varieties including 30 cultivars (top yielder over 10 location) were multiplied at NARC, Islamabad, Oilseed Research Institute (ORI), Faisalabad and Agricultural Research Station (ARI), Mansehra. The germplasm comprised 240 accessions were also multiplied at NARC, Islamabad and ORI, Faisalabad for future use.

Screening & evaluation of soybean germplasm; Morphological traits: Significant genetic variation among 213 genotypes was observed in all present studied quantitative traits. The magnitude of genetic variation for qualitative traits was reasonable except for growth habit. Grain yield per plant showed significantly positive correlation with days to maturity, number of branches per plant, number of filled pods per plant, 100-seed weight, oil content, biological yield per plant and harvest index. Out of 30 cultivars selected from different agro-ecologies (Mangora, Mansehra, Gilgit, Rawlakot-AJ&K, Gujrat, Sialkot, Faisalabad, Bahawalpur, Tandojam and Quetta) of the country, 18 out yielded from 400g to 600g per plant were selected for evaluating in replicated trial at Quetta, Faisalabad, Gujranwala, Rawlakot, Mansehra and Islamabad.

Profilation of seed protein using Sodium Dodecyl Sulphate (SDS-PAGE): Genetic diversity on the basis of molecular marker revealed 17 protein bands. Out of these nine bands showed monomorphic nature and eight were polymorphic. The profile of each accession consisted of 13-17 bands. The dendogram based on data revealed eight clusters. First 10 principal component analyses contributed 67**%** of variation in 139 accessions.

Biochemical composition: Analysis of variance of 30 selected cultivars for biochemical composition of seed at three locations (Islamabad, Mingora and Faisalabad) showed significant genotype x environment interaction in all traits viz. ash content, fiber content, moisture content, protein content, oil content and carbohydrate content. Significant variability was also observed over the locations in all studied traits except moisture and carbohydrate content while non-significant variation was observed among the genotypes except oil and carbohydrate content.

Enhancement and utilization of farmer's income through induction of soybean in various cropping system: To increase the farmer income, an experiment was conducted at Sialkot, Gujranwala (potato growing area), Gujrat, Rawalpindi (rainfed) and Multan (cotton) on farmers fields. The grain yield was 3085, 2970, 3210, 1860 and 2650 $kgha^{-1}$ respectively at these locations. The grain yield was very promising except at Gujrat where low yield was recorded as compared to other locations due to heavy weed observed.

Name of Project: **Biochemical and Molecular Approaches to Study the Effect of Pesticide on Nitrogen Fixing Bacteria in Legumes**

Name of PI/ Institute: **Mr. Sohail Hameed,**
Principal Scientist,
Biofertilizer Division, National Institute of Biotechnology and Genetic Engineering, Faisalabad

Duration: 03. 08. 2005 to 02. 08. 2008

Financial Status:

Total Cost:	Rs.1.650 million
Funds Released:	Rs.996000/-
Funds Utilized:	Rs.815000/-

Objectives:

- Isolation and development of pesticide resistant bacterial strains from mungbean (spring and summer crop) and pea (winter crop) legumes.
- Selection of beneficial bacterial strains and pesticides with low toxicity.
- Evaluation of these resistant bacterial strains in vivo.
- Improvement of biofertilizers with pesticide resistant bacterial strains and their application in the field.

Achievements:

A mungbean field experiment was conducted to evaluate the effect of pesticides on bacterial inoculants and role of these pesticides and bacterial inoculants to enhance the grain yield. Mungbean plant showed excellent grain yield of 1318kg/hectare with the inoculation of nitrogen fixer (Brady) rhizobium, where as, there was no adverse effect of pesticide on bacterial population and plant growth. Previously isolated pesticide resistant strains were characterized in vitro. Out of these fifteen strains, seven were IAA positive, whereas five strains were able to solubilize phosphate. Pesticide resistant bacterial strains i.e. M2, M4, M5 and M6 were identified through molecular marker of 16S Rrna gene as Bacillus subtitles, Bacillus simplex, Agro bacterium tumifacien and Bacillus subtilis, respectively. DNA profiling of similar bacterial species i.e. M2, M6 and Tal-102, MN-S was done through Random amplified Polymorphic DNA (Rapd). The pattern of amplified DNA was different in both the sets of species, showing that the species are varying at strain level. Moreover, Potent bacterial strains were fully resistant to pesticide, as there was no DNA damage due to pesticides in microgel photographs.

Name of Project: **Molecular Marker Facilitated Pyramiding of Bacterial Blight Resistance Genes in Super Basmati Rice**

Name of PI/ Institute: **Dr. Muhammad Arif**,
Senior Scientist,
National Institute of Biotechnology and Genetic Engineering, Faisalabad

Duration: 16. 08. 2005 to 15. 08. 2008

Financial Status:

Total Cost:	Rs.3.458 million
Funds Released:	Rs.2360000/-
Funds Utilized:	Rs.2358977/-

Objectives:

- Evaluation and identification of IR24 based near isogonics lines with single major gene or gene combinations effective against virulent Xoo strains in Pakistan.
- Incorporation of four bacterial blight resistance genes into high yielding commercial Super Basmati rice variety

Achievements:

In rice season 2006, the IRBB lines multiplied in 2005 were grown in three replications with 10 plants in each replication. These lines were challenged with two different virulent strains of BB pathogen identified from the study conducted by the researchers at National Institute for Agriculture and Biology (NIAB), Faisalabad. However, no symptoms of the bacterial blight were found suggesting that conducive environment could not be developed which is required for the multiplication of pathogens. The BC_1F_1 seeds harvested during the growing season of 2005 were subjected to molecular survey. A number of plants were found carrying different number of genes with different combinations. However, we selected only those plants which carried our four required genes. These plants were backcrossed with the Super Basmati and Basmati-385. The resulting BC_2F_1 seeds were then again sown during the December 2006. The plants were again selected by molecular survey using SSR markers. The required plants were then backcrossed with the respective parents to restore the Basmati background. The BC_3F_1 seeds were harvested and stored under controlled temperatures. These plants were sown during the rice season 2007 and after molecular analysis selection of required plants will be made. Finally those plants will be selected for backcrossing program which will resemble phenotypically to Super Basmati plants.

Name of Project: **Application of DNA Fingerprinting for Drought Tolerance in Wheat**

Name of PI/ Institute: **Dr. Mehboob-ur-Rehman,**
Group Leader,
National Institute for Biotechnology and Genetic Engineering (NIBGE), Faisalabad

Duration: 04. 09. 2004 to 03. 09. 2007

Financial Status:

Total Cost:	Rs.5.696 million
Funds Released:	Rs.2275742/-
Funds Utilized:	Rs.1915052/-

Objectives:

- Screening of wheat germplasm for drought tolerance.
- Development of segregating population by crossing the most tolerant and susceptible wheat genotypes.
- Application of DNA fingerprinting tools like RAPD, AFLP, ESTs and SSRs to find DNA polymorphisms among the selected wheat genotypes.
- Development of genetic linkage map for different traits conferring drought.

Achievements:

Ninety five wheat genotypes and 100 synthetic wheat genotypes were sown. Wheat genotypes were also sown in green house conditions for imposing drought stress at seedling stage. The analysis for cell membrane stability of 95 wheat genotypes synthetic tetraploids and 100 synthetic for cell membrane stability were completed. Wheat samples have been harvested at maturity and data analyzed. Tentative FI crosses between the tolerant and sensitive wheat genotypes were made. F2 seed have been sown for population development. DNA has been isolated from F2 population. Completed the analysis of osmotic potential on F2 plants. Re-sown the segregating population and completed DNA extraction of 60 wheat genotypes. 21 Micro satellite loci were surveyed on the genotypes. A dendrogram has been constructed. Two genotypes, MH-97 and Kohistan from the cultivated varieties, and one synthetic wheat genotypes Var-257 and Opata (drought sensitive) have also been subjected to DNA fingerprinting. 100 RAPD primers have been surveyed on MH-97 and K-97; while 21 SSRs were surveyed on the Var-257 and Opata 100 more RAPD primers have surveyed on the wheat parents. All the available RAPD primers (520) have been surveyed on the parents. The polymorphic primers are being surveyed on F2 population.

Name of Project: **Hybrid Seed Production of Rice**

Name of PI/ Institute: **Dr. Muhammad Akhtar,**
Rice Botanist
Rice Research Institute, Kala Shah Kaku, Punjab

Duration: 08. 10. 2005 to 07. 10. 2008

Financial Status:

Total Cost:	Rs.1.483 million
Funds Released:	Rs.1237300/-
Funds Utilized:	Rs.1036359/-

Objectives:

- To develop Basmati and coarse rice hybrids in the Punjab.
- To develop hybrid rice seed production technology.
- To enhance per hectare yield in the Punjab.
- To increase the farmers income from the same piece of land.
- To boost up rice export and foreign exchange earnings.

Achievements:

Ten rice hybrids have been developed and evaluated for yield and grain quality characteristics. From 170 testcrosses, 7 restorers, 33 partial restorers, 19 partial maintainers and 10 maintainers were categorized. Fourteen back crosses were attempted from the back cross nursery. And thirty four new back crosses were made. One hundred sixty nine entries were evaluated in Source Nursery-1 and 218 lines were planted in Source Nursery-2 and 3. Desirable lines from source nursery were utilized for making 152 fresh testcrosses. Out of these, 148 successful test crosses were harvested for further evaluation in 2007. Twenty two CMS lines were maintained along with their maintainers. From these, IR58025A, IR7956A, IR68897A, IR68886A were selected for the development of hybrid rice on the basis of their better floral and agronomic characteristics. Basmati 385, 99722, 40265, PK 3699-43 and LG 22 were identified as potential restorers. For hybrid seed production, the ratio 2:10 (Restorer: CMS) gave the maximum seed yield i.e. 1.5t/ha.

The TGMS line IR73834-21-26-15-25-4 produced the maximum seed (0.815kg) at Swat and (0.47kg) at Farhatabad followed by IR75589-31-27-8-33 which produced 0.598 kg seed at all the locations. Seven hundred and eighty six (786) lines from AxR and RXR crosses of F2 to F7 filal generations were studied. At maturity, 790 single panicles were selected on field performance basis for further studies in the subsequent filal generations. Seven uniform lines were also selected. Very good lines have been identified which can be successfully used as a pollen parent for the production of test hybrid. We have very good collaboration with IRRI, Philippines and NARC, Islamabad. There is a need to establish strong collaboration with some of the rice breeding Institutes in China also. As China is a pioneer in hybrid rice.

Name of Project: **Production of Doubled Haploids of Wheat by Using Wheat X Maize Crosses Technique**

Name of PI/ Institute: **Dr. Abid Mahmood,**
Director,
Barani Agricultural Research Institute, Chakwal

Duration: 26. 07. 2005 to 30. 06. 2008

Financial Status:

Total Cost:	Rs.3.817 million
Funds Released:	Rs.3295400/-
Funds Utilized:	Rs.3003475/-

Objectives:

- Reduction of variety evolution period (breeding period) from 12 to 4 years.
- To increase the durability of varieties by having 100% homozygosity which is not possible by conventional breeding method.
- Cost for the evolution of new varieties will be reduced due to reduction in time, space and labour.
- Transfer of this modern technology to other scientists in the country will be done.
- Production of drought tolerant, good quality and high yielding varieties for Barani areas.
- Creating maximum variability to develop germplasm of specific nature for the utilization of lines in crossing programme.

Achievements:

Collection of Wheat Genotypes: During first year of project collected thirty genotypes and screened for drought and disease tolerance. On the basis of preliminary screening, executed ten wheat x wheat crosses. The seed of these genotypes was evaluated for quality parameter (Protein percent).

Evaluation of Wheat Genotypes for Protein Percent: The above mentioned thirty five wheat genotypes were evaluated for protein percent. The protein percent was calculated from the N-contents estimated through Kjeldahls method.

Hybridization of Wheat Genotypes: Ten wheat x wheat crosses attempted last year (on the basis of preliminary results), were made this year also. These crosses involved 2KC050, Inqlab-91, Rawal-87, Bhakkar-2001, 2KC050, Chakwal-86, Margalla-99 and 00FJ03 parents. Among the other parents, GA-2002 selected on the basis of protein percent, was also included in hybridization programme.

Wheat x Maize Crosses: Six wheat cultivars and ten F1 crosses were planted after 10 days interval starting from first September to 31st December. Five open pollinated Maize genotypes were planted at 10 days interval to ensure pollen supply at the time of pollination. Emasculated wheat spikes were pollinated with maize pollen.

Following methods for 2, 4-D application were used.

- After pollination 100mg/1 of 2, 4-D solution was injected to the uppermost internodes of wheat spikes. One drop of 2, 4-D solution was applied to each pollinated floret.
- Spikes were sprayed with 100 ppm 2, 4-D on one and two days after pollination.

Tiller injection method proved better where tiller were injected with 100mg/1 of 2-4, d Solution to the uppermost inter-node of wheat spikes. One drop of 2, 4-D solution was also applied to each pollinated floret.

Fourteen to eighteen days old seed (caryopsis: light green in colour) produced haploid embryos of optimum size. Harvested embryos were cultured on MS and B5 salts (Gamborg et al. 1968) supplemented with 20 g litre-1 sucrose and 8 litre-1 agar. Embryos were incubated at 18-240C (in the dark). A total of 3252 wheat heads were pollinated with maize witch produced 37410 caryopsis. Only 442 embryos were recovered from these caryopsis.

Name of Project: **Increasing Oil Content in Sunflower Germplasm**

Name of PI/ Institute: **Mr. Mukhdoom Hussain**
Director,
Oilseed Research Institute (AARI), Faisalabad

Duration: 01. 07. 2005 to 30. 06. 2008

Financial Status:
Total Cost: Rs.0.768 million
Total Releases: Rs.301500/-
Total Expenditure: Rs.156000/-

Objectives:

- To increase the level of oil percentage in the sunflower germplasm through recurrent selection cycles.

Achievements:

The existing material of sunflower (77 CMS+73 Restorer) inbred lines were analyzed for their oil contents. Eleven CMS and 4 restorer inbred lines having more than 45% oil were selected. The seed of above inbred lines was bulked and sown in isolation for natural crossing during spring 2006. Cycle 0 population was sown in autumn 2006. Six hundred plants were bagged, out of which about five hundred plants with desirable traits were harvested separately. The seed of these plants was analyzed for their oil contents. The plants with more than 48% oil were bulked and sown in isolation for random mating to increase the frequency of genes for high oil content. This will produce seed for cycle 1 population.

Name of Project: **Coordinated Project "National Plant Genomic Research Project" DNA Bases Genetic Characterization of Cotton Germplasm, Component-I**

Name of PI/ Institute: **Dr. Yousuf Zafar,**
Director,
Plant Biotechnology Division, NIBGE, Faisalabad

Duration: 16. 10. 2004 to 15. 10. 2007

Financial Status:

Total Cost:	Rs.4.384 million
Funds Released:	Rs.2941442/-
Funds Utilized:	Rs.2578602/-

Objectives:

- Training of the students at the graduate and postgraduate level
- Assessment of diversity and relatedness in the germplasm and breeding material.
- Preparation of documents on DNA profiles of crop germplasm.

Achievements:

In order to characterize cotton germplasm with known Micro satellite loci (SSRs), 95 G hirsutum and 33 G arboreum cotton genotypes were collected. Completed extraction of cotton genomic DNA. For synthesis of new SSRs, a total of 20 SSRs have been surveyed. A total of 15 RAPD primers have been surveyed on G arboreum and cotton genotypes. Additional 35 RAPD primers were surveyed. Also 15 SSRs were surveyed on the cotton genotypes. Additional 10 SSRs, 15 SSRs, 15 SSRs and 10 SSRs were surveyed on the cotton genotypes.

Resistant sources (LRA-5166 & CP-15/2) have been collected from six different cotton research stations for estimation of heterogenecity within primary source of resistance from different breeding institutes. Extraction of genomic DNA has been completed. The genomic DNA of two stations has been surveyed while survey of the cotton parents with RAPD primers to detect heterogeneity continued. Heterogeneity was found in the genotypes of two centers with six primers.

Genomic DNA of G arboreum var Ravi has been extracted and RAPD analysis has been completed. Cloning of 20 loci has been completed. Cloning of another 80 loci has also been completed. Sequenced around 80 clones and designed 22 new SSRs, and started surveying on cotton genotypes. The newly identified SSRs were named as PGMB series and surveying on G hirsutum genotypes has been started. These SSRs is also being surveyed on cotton species.

In order to develop cluster among different elite/noval strains/varieties, cluster for G arboreum genotype has been worked out. Cluster for G hirsutum germplasm has been constructed

Name of Project: **Molecular Characterization of Rice Germplasm using RAPD Analysis (Component-III)**

Name of PI/ Institute: **Dr. M. Ashiq Rabbani,**
Senior Scientific Officer,
PGRP, IABGR, NARC, Islamabad

Duration: 01. 10. 04 to 30. 09. 07

Financial Status:

Total Cost:	Rs.6.561million
Funds Released:	Rs.4188967/-
Funds Utilized:	Rs.4053000/-

Objectives:

- Assessment of genetic diversity in local germplasm of rice at molecular level.
- Documenting DNA profiles of Pakistani rice varieties and obsolete cultivars.
- Training of the students at the graduate and post graduate level in the field of biotechnology.

Achievements:

Around 50 commercial varieties and primitive cultivars belonging to aromatic (Basmati), non-aromatic (course) and japonica type were used during investigation. Genetic diversity was investigated at the DNA level using random amplified polymorphic DNA (RAPD) technique and at the phenotypic level using morphological characteristics. Total genomic DNA was extracted from dry seed samples. Each cultivar consisted of 3-5 grains for extracting DNA from bulked samples. After isolation, concentration and quality of DNA was determined using NanoDrop ND-1-000 Spectrophotometer at a wavelength of 260 and 280 nm. Genomic DNA of each cultivar was diluted to a working concentration of 20 ng/ul to be used for PCR analysis. Twenty-three morpho-physiological traits were recorded from transplanting till harvest of the crop.

After an initial screen, 25 random primers which gave clear and consistent products were ultimately selected to amplify the DNA of each variety/cultivars. RAPDs exhibited several bands that were shared among the Basmati and fine cultivars, whereas a few bands were shared among 'indica' and 'japonica' cultivars of rice. Two japonica cultivars 'Kinmaze' and 'Nipponbare' shared limited number of bands with all the other cultivars, showing their more distant relationship to indica rice varieties. Twenty-five primers used generated a total of 208 RAPD fragments, of which 186 (89.4%) were polymorphic. The number of amplification products generated by each primer varied from 4 to 16 with an average of 8.3 bands per primer. The level of polymorphism was high and ranged from 40% to 100% for primers used. Pair-wise estimates of similarity for 40 varieties and cultivars ranged from 0.50 to 0.96. Based on analysis performed on similarity matrix using UPGMA, 40 commercial varieties and primitive cultivars were grouped into several clusters and a few independent cultivars. Similarly, Swat-2 grouped with japonica cultivars instead with other indica cultivars. Interestingly, a number of commercial varieties and obsolete cultivars originating

from various parts of Pakistan did not form well defined distinct groups and were interspersed with one another in the cluster analysis, indicating no association between the RAPD patterns and the geographic origin of the varieties/cultivars used.

Phenotypically, all the commercial varieties and primitive cultivars were classified into four major groups corresponding to the forms of indica rice cultivated in Pakistan, i.e., aromatic (Basmati) and non-aromatic (Non-basmati) with few exceptions. Clustering of the varieties did not show any pattern of association between the morphological characters and the origin of the cultivars. Instead cultivars groups were associated with their morphological similarities and type of indica rice cultivated in various regions of Pakistan. Besides commercial varieties and primitive cultivars of Pakistani rice, around 172 local landrace genotypes of rice were also evaluated for agro-morphological traits under field conditions.

In general large variation was observed among local collections for most of quantitative traits measured. Pattern of variation among the accessions was different for various morphological traits. The largest variation was recorded for days to 50% flowering and maturity, leaf area, plant height, seed-setting percentage, grain and straw yield/plant. Relatively, low level of variability was observed for leaf width, total and productive tillers/ plant, panicle length, spikelets/panicle and harvest index.

Name of Project: **Selection of Zinc Efficient Wheat Genotypes for a Balance Human Nutrition**

Name of PI/ Institute: **Dr. Muhammad Imtiaz,**
Senior Scientific Officer,
Nuclear Institute of Agriculture, Tandojam.

Duration: 11. 10. 2005 to 10. 10. 2008

Financial Status:

Total Cost:	Rs.1.705 million
Funds Released:	Rs.997600/-
Funds Utilized:	Rs.819650/-

Objectives:

- To adapt the strategy to tailor the plant to fit the soil rather than to tailor the soil to fit the plant.
- To assess Zn contents in the seed of wheat cultivars existing in Pakistan.
- To assess the capability of different wheat cultivars for absorbing Zn from Zn deficient medium.
- To study the mechanism(s) which govern the utilization efficiency of Zn in wheat.
- To carry out the molecular markers studies (RAPD & AFLP).

Achievements:

During the period under report, the relative Zinc (Zn) efficiencies of 20 more wheat genotypes were determined by growing them in chelate-buffered nutrient solution. The relative zinc efficiency, determined by growth in a Zn-deficient solution relative to that in a medium containing an adequate concentration of Zn, was found to vary between 12.5 and 60.9% amongst the cultivars tested. The most Zn-efficient cultivars included: Sindh-81, NR-73 and NR-122 while the most Zn-inefficient included: Bhitai, Soghat-90 and SI-97-71. Ten wheat genotypes (classified as Zn efficient and Zn-inefficient in hydroponics study) were tested under field condition to assess any change in their Zn efficiency or in their response to Zn fertilization. The efficiency of these genotypes was enhanced under field as compared to the hydroponics conditions which varied between 48.5 to 94.2%. However, these genotypes maintained their ranking of Zn efficiency assigned to them in hydroponics study. In another study the mechanism of Zn efficiency was determined using higher levels of P and by assessing the mycorrhizal infection on roots. The results showed that Zn efficient genotypes have extracted 72 and 17% higher Zn at P 25 and 250 mg kg-1 soil respectively, compared to Zn inefficient genotypes. The roots of Zn efficient genotypes have greater association with mycorrhiza and have up to 96% infestation at lower level of P and Zn, however, the infestation was reduced to 23% with heavy application of P even in the presence of Zn. Zinc inefficient genotypes have significantly lower infestation ranging from 10% to none.

Name of Project: **Evaluation of Chickpea Germplasm Against Aggressive Isolates of Aschochyta Rabiei Identified by Biological and DNA Molecular Marker Techniques and Disease Management Through Induced Systemic Resistance**

Name of PI/ Institute: **Dr. Farhat Fatima Jamil,**
Dy. Chief Scientist,
Plant Protection division, Nuclear Institute for Agriculture and Biology, Faisalabad

Duration: 25. 07. 2006 to 30. 06. 2009

Financial Status:

Total Cost:	Rs.3.909 million
Funds Released:	Rs.1738200/-
Funds Utilized:	Rs.1211253/-

Objectives:

- Characterization of pathotypes/races of Ascochyta rabiei through biological pathotyping and genetic analysis.
- Identification of virulent A. rabiei isolates from different chickpea growing areas and Screening of Chickpea germplasm against them to identify chickpea germplasm having durable resistance.
- Enhancing resistance in high yielding, good quality chickpea cultivars by inducing systemic resistance with safe chemicals/reagents.
- Geographical demarcation of A rabiei pathotypes in Pakistan to facilitate selection of appropriate host cultivars for different regions and developing possible methods of disease forecasting.

Achievements:

Survey of chickpea crop in Jhang, Bhakkar, Khushab, Mianwali, D.I.Khan, Chakwal, Attock, NARC Islamabad, Peshawar, Swabi and Karak was conducted during March-April, 2007 to know the incidence of diseases and collection of blight disease samples. It was observed that blight disease has reappeared and even 100% infection was recorded in some areas due to conducive weather conditions which is an alarming situation and may prove a big threat in coming years. A number of isolates have been purified while others are in the process of isolation. The purified isolates are being maintained at-80^{0}C for further biological pathotyping and genetic studies. Ten Ascochyta rabiei isolates obtained from disease samples collected during 2006 were tested for virulence using a host differential set. Data recorded on 9 point rating scale revealed that two isolates were highly virulent, six moderately virulent and two were less virulent. Resistance screening of 37 host genotypes revealed that 3 entries were moderately resistant 20 tolerant, 11 moderately susceptible and 3 were susceptible.

Name of Project: **Development of High Yielding, Disease Resistant Varieties of Groundnut Through Hybridization and Mutation Breeding along with Nodulation Studies for N2 Fixation under Rainfed Conditions**

Name of PI/ Institute: **Mr. Naeem-ud-Din,**
Pulses Botanist,
Barani Agricultural Research Institute, Chakwal, Punjab

Duration: 22. 07. 2005 to 30. 06. 2008

Financial Status:

Total Cost:	Rs.3.221 million
Funds Released:	Rs.2640600/-
Funds Utilized:	Rs.2384145/-

Objectives:

- To enhance the production per unit area by developing high yielding, disease resistant, drought tolerant, good quality varieties of groundnut.
- To minimize the use of nitrogenous fertilizers through enhancement in nodulation ability.
- Provision of good quality seed to groundnut growers.

Achievements:

Six F1 progenies of groundnut were sown along with parents. Crossed plants were harvested and the pods were collected for sowing next year as F2 segregating generations. Fifty two plants of M2 progenies of 01CG001, 02CG002 & 02CG005 irradiated @ 25 kr and 35 kr, were sown along with parental material. Fifty three desirable segregated mutated plants from different progenies were selected for further studies as M3 during next year. Nine promising lines were tested for their yield potential against check varieties under rain fed conditions Highly significant differences were found among varietals means for dry pod yield. Only two entries gave higher pod yield than check variety Golden (3101 kg/ha).

Eighteen advance lines along with two check varieties; BARI-2000 and Golden were evaluated for incidence of Cercosporal leaf spot disease under field conditions. The data revealed that the groundnut genotypes exhibited significant response to disease incidence. The genotype 2KCG017 showed minimum disease incidence of 5.56, 5.0 and 1.67 under all the three scales. The check varieties viz; BARI-2000 and Golden exhibited disease incidence of 3.0, 6.0 and 6.67 under the three scoring scales.

Eighteen advance lines along with two check varieties; BARI-2000 and Golden were evaluated for incidence of Crown rot disease under field conditions. The data revealed that maximum seed germination was observed in the variety BARI-2000 and an advanced line 02CG001 (72%) followed by variety Golden (71.67%). Minimum plant mortality was observed in 2KCG 006 (6.0) followed by 01CG009 and 02CG007 (6.67).

Sixteen lines were tested for their nodulation ability at Barani Agricultural Research Institute, Chakwal during Kharif-2006. The entries 2KCG020 and 02CG005 produced good nodulations, like the previous year (2005).

A study was conducted in the field to find the appropriate dose of NPK fertilizer with fixed dose of 500 kg gypsum/ha for two promising lines of groundnut viz. 02CG005 and 2KCG020 keeping Golden as check variety. Two hundred and seventeen plant progenies out of 518 single plant progenies were selected for further evaluation as pre-basic seed production of BARI-2000. The progeny blocks will be sown next year for production of quality seed.

Name of Project: **Conservation and Sustainable Utilization of Agro-biodiversity of Under-Utilized Crops**

Name of PI/ Institute: **Dr. Zahoor Ahmad,**
Principal Scientific Officer,
Plant Genetic Resources Institute (PGRI), NARC, Islamabad.

Duration: 01. 07. 2003 to 30. 06. 2007

Financial Status:

Total Cost:	Rs.1.896 million
Funds Released:	Rs.1697698/-
Funds Utilized:	Rs.1617237/-

Objectives:

- To expand germplasm collections of underutilized crops (upto 10 species)
- Evaluation of collected germplasm (10 to 50) for various morphological and agronomic traits.
- To increase the yield of under utilized crops through selection/ breeding and substantially increasing the income of small farmers.
- To open up marginal lands by cultivating underutilized crops.

Achievements:

During the project period, 1172 accessions of 10 under utilized crops were collected and conserved in the gene bank. The material has been properly documented. Most of the germplasm has been evaluated at PGRP's field and data recorded on various qualitative and quantitative characters reported in the report.

One hundred and sixteen accessions of Guar (*Cyamopsis tetragonoloba)* have been evaluated and characterized for traits like number of branches per plant, number of pods per plant, pod length, number of seeds per pod, biomass, plant height and seed yield, whereas harvest index was computed and 100 seed weight was recorded. High genetic variability was recorded in quantitative traits i.e., number of branches per plant, number of seeds per capsule, plant height, biomass and seed yield. Eleven accessions (21702, 22161, 22202, 22204, 22205, 22206, 22210, 22220, 22221, 3500 and 3551) were selected based on their performance to particular traits and suggested for future use in hybridization and breeding programs and for cultivation at farmer's fields. The germplasm was also evaluated for total seed protein through SDS-P AGE marker.

Forty six accession of Kenaf (*Hibiscus cannabinus*) have been evaluated and characterized for two consecutive years (2004 and 2005) and data was recorded. High genetic variability was observed in plant height, biomass and seed yield whereas medium to low level of variability was recorded for other characters.

Out of total gene pool (102 accessions) of Linseed (*Linum usitatissimum*), one hundred accessions have been evaluated and characterized for various traits. It was concluded that central Punjab is the centralized area of maximum yielding accessions of linseed.

Ninety eight accessions of the total gene pool of Kalongi (*Nigella sativa* L.) have been evaluated and characterized for a number of quantitative characters. Based on the results, a number of accessions (20561, 20557, 20585, 20569, 20646, 20781, 20868, 20876, 20985, 21224, 21312, 21395 and 21554) have been identified as high yielding ones. Significant diversity was recorded for plant height, days to flowering, days to maturity, biomass, capsule weight, seed yield, 1000 seed weight and harvest index.

Forty four out of 107 accessions of the total gene pool of Ispaghol (*Plantago ovata*) have been evaluated and characterized. Based on the quantitative data a number of high yielding accessions (596479, 596492, 596477, 596486, 596483, 596484, 596480, 543826, 596475, 596494 and 596490) have been identified as high yielding ones.

Thirty three accessions of Castor (*Ricinus communis*) were evaluated. SDS-P AGE study was also conducted on this germplasm. It was concluded that evaluated germplasm have diversity independent of origin or source.

In an agronomic trial two accessions of Castor (*Ricinus communis*) were tested for different levels of Nitrogen (N) and Phosphorus (P) in randomized complete block (RCB) design replicated thrice. Four treatment, used wereT1 (control), T2 (N@ 20 kg/acre, P@ 15 kg/acre), T3 (N@ 30 kg/acre, P@ 20 kg/acre) and T4 (N@ 40 kg/acre and P@ 25 kg/acre). It was concluded that yield and other agronomic traits gave best results in T4 (N@ 40 kg/acre and P@ 25 kg/acre) as compared to T1 (control), T2 (N@ 20 kg /acre, P@ 15 kg/acre) and T3 (N@ 30 kg/acre, P@ 20 kg/acre).

PGRP maintained a total of 216 accessions of Sesame (*Sesamum indicum*). Out of this 141 accessions have been evaluated for. Qualitative data revealed that 87.32 % of germplasm were top-branching, 59.85 % were sparsely hairy, 97.88 % were having square shaped stem, whereas seed coat colour was white in 61.97 % of the germplasm under study.

Fifty five accessions of Fenugreek (*Trigonella foenumgraecum*) germplasm have been evaluated and data recorded on nine quantitative traits. Based on the collected data a number of accessions (20639, 21071, 21176, 21370, 21487, 21605, 21748 and 21986) were identified as high yielding ones.

Forty one accessions of Cowpea (*Vigna unguiculata*) were evaluated and characterized for a number of quantitative characters. Based on the data a number of high yielding accessions (14612, 14639, 14750, 14782, 19061, 14672, 14671 and 14679) were identified. SDS-PAGE studied was also conducted on cowpea germplasm.

To access the performance of some under-utilized crops and create awareness among farmers about their economic return, low input cost and crop diversification, the demonstration plots of Kalongi and Ispaghol were planted at farmer's fields in the districts of Vehari, Hasilpur, Jhang and Lahore.

Name of Project: **Development and Evaluation of a Mobile Flat-Bed Dryer for Sunflower and Canola**

Name of PI/ Institute: **Dr. Munir Ahmad,**
Principal Scientific Officer,
FMI, NARC, Islamabad

Duration: 01. 07. 04 to 30. 06. 07

Financial Status:

Total Cost:	Rs.2.55 million
Funds Released:	Rs.2330800/
Funds Utilized:	Rs.2166478/-

Objectives:

- To develop and evaluate a drying technology for sunflower and canola in order to reduce post harvest losses.
- To develop a mobile flat-bed dryer for sunflower and canola.
- To evaluate the performance of this dryer by drying sunflower and canola.
- To perform the economic analysis of the mobile flat-bed dryer.
- To demonstrate this dryer to sunflower and canola growers and local manufacturers.

Achievements:

A mobile flat-bed dryer has been developed under the project at Farm Machinery Institute, NARC, Islamabad. The dryer consists of wheel adjustment assembly, a frame, a plenum chamber, a grain container, an engine, a diesel fired furnace, and an axial flow fan to force hot air through plenum to grain bed. The grain container holds 1250 kg of sunflower at a depth of 30 cm

A sunflower drying trial using the newly developed mobile flat-bed dryer was conducted at Faisalabad in November and December, 2005. During the typical tests, on average the dryer took three hrs to dry 1250 kg sunflower grains from 30.2% to 9.6% moisture content. The drying capacity of the dryer was worked out, about 2.5 tons in 8 hrs (one day). The economic analysis revealed that the cost of drying sunflower is about Rs.1.25/kg. A canola drying trial using newly developed mobile flat-bed dryer was conducted at Lunda, Tamman, tehsil Talagang. During this trial two types of experiments were conducted. Firstly, the canola was dried using heated air, secondly, the canola was dried using ambient air. During the heated air drying of canola, the dryer took 1.75 hrs to dry 1.3 tons of canola from 22.95% moisture content to 12.18%. The cost of drying one kg of canola using heated air was predicted Rs.0.91. During the ambient air drying of canola, the dryer took 3.2 hrs to dry 1.3 tons of canola from 17.62% moisture content to 12.22%. The predicted cost of drying canola using ambient air was Rs.0.65/kg.

The mobile flat-bed dryer was demonstrated on November 9, 2006 at Kandiwal-Lalian Road, Chiniot to about 250 sunflower growers, manufacturers and academicians. A field seminar-cum-demonstration of mobile flat-bed dryer for canola was organized on May 7, 2007 at Lunda, Tamman, Tehsil Talagang where about 260 canola growers, manufacturers, extension specialists attended the seminar.

Name of Project: **Molecular Characterization of Available Germplasm of Wheat in Pakistan**

Name of PI/ Institute: **Dr. Iftikhar Ahmad Khan.**
Dean,
Faculty of Agriculture, University of Agriculture, Faisalabad

Duration: 07. 10. 2004 to 06. 10. 2007

Financial Status:

Total Cost:	Rs.5.23 million
Funds Released:	Rs.3986433/-
Funds Utilized:	Rs.3776951/-

Objectives:

- Assessment of diversity and relatedness in the germplasm and breeding material of wheat.
- Documentation of DNA profiles of wheat germplasm.
- Training of the students at the graduate and postgraduate level.

Achievements:

Two hundred and eighty wheat germplasm accessions were planted in the field in pots. Data on various morphological traits was recorded. Five single plants of germplasm were harvested separately. Threshing of the single plant was conducted. All available microsatellite primers have been optimized for annealing temperature and other PCR conditions. Growth and yield parameters of all the accessions were compiled for phenotypic characterization of the accessions.

DNA extraction of another batch of 98 accessions was carried out. Assaying of the previous batch of 82 accessions with the 57 polymorphic SSR primer pairs has been completed. Assaying of the fresh batch of 98 accessions has also been completed. The optimized profile of the 79 SSR primer pairs is available.

Counting of bands of all batches of the germplasm accession assayed with almost all SSR primers have been completed. Six more SSR primers are being used for the PCR assaying of 50 accessions. Data recording and analysis, compilation of results and review of literature is being pursued actively.

Name of Project: **DNA Marker for Wilt (Fusarium Oxysporum) Resistant Genes in Chickpea**

Name of PI/ Institute: **Dr. Mohammad Saleem**
Associate Professor
Plant Breeding and Genetics, University of Agriculture ,Faisalabad

Duration: 05. 07. 04 to 04. 07. 07

Financial Status:

Total Cost:	Rs.2.893 million
Funds Released:	Rs.2838300/-
Funds Utilized:	Rs.2821794/-

Objectives:

- Identification of DNA markers from intraspecific crosses and their utilization in marker assisted breeding program for wilt (Fusarium oxysprumr) resistance.

Achievements:

Fusarium wilt is a serious disease of chickpea. The use of resistant cultivars to control wilt disease is the best and cheapest method. A large number of germplasm accessions/diverse materials have been screened against Fusarium wilt and elite germplasm lines have been earmarked which to be used in further hybridization programme for transfer of wilt resistant genes in existing commercial varieties. Field screening of Chickpea International Fusarium Wilt Nursery (CIFWN) has shown entries 29101, 29132 and 29208 to be resistant genotypes whereas 29153, 29224 and 29245 appeared to be susceptible to wilt. From the advanced lines developed, 810, 96052 and 98144 were found to be susceptible and 1089, 5226 and 205 were moderately resistant.

Genetic recombinations between susceptible and resistant types were made to study the mode of inheritance of the pathogen. The F_1 material was sown to rise F_2 generation. The F_1 material was studied at the molecular level for DNA fingerprinting and for tagging the gene. The level of DNA polymorphism was different with different primers. After scoring the results, similarity matrix was developed after multivariant analysis using Nei and Li's (1979) coefficient. The similarity coefficients were used to develop a dendrogram by UPGMA analysis in order to determine the clustering of the varieties. The study on DNA polymorphism in 21 genotypes using RAPD primers revealed that these primers were unable to exhibit DNA polymorphism in these genotypes. The cluster analysis showed that these genotypes were similar to each other.

A dendrogram of 6 parents and 15 F_1 crosses showed that two susceptible parents 29153 and AUG-98144 and their F_1 cross 29153 belonged to same group which indicated that they had narrow genetic diversity. It may also be that both parents were derived from same source. The parents and their crosses which cluster in same group should not be used in any further breeding programme. Chickpea germplasm and advance lines screened and ear-marked will be exchanged/exploited in national breeding programme which will increase and stabilize pulses production in the country. The promising material will ultimately be adopted by the pulses growers for increased productivity.

Name of Project: **Development of Integrated Pest Management for Subterranean Termites in agro-ecosystem**

Name of PI/ Institute: **Dr. Sohail Ahmad,**
Assistant Professor,
Department of Agri Entomology, University of Agriculture, Faisalabad.

Duration: 01. 07. 2004 to 30. 06. 2007

Financial Status:

Total Cost:	Rs.2.625 million
Funds Released:	Rs.1619000/-
Funds Utilized:	Rs.1572131/-

Objectives:

- To determine the like range of biotic and abiotic factors that will influence termite establishment.
- Applied research, using knowledge of the basic biology and behavior of termites to develop and assess control strategies, that precisely target the economically important subterranean termites in the crops, and that minimize the use of pesticides in and around structures, and crops.

Achievements:

The following studies were conducted under the project:

- Studies on effect of intercropping on termites' foraging and damage in major crops.
- Intercropping of medicinal pants in wheat at Karor (Layyah)
- Use of organic wastes as soil amendments for their effect on foraging of termites in sugarcane
- Comparison of pesticides, IPM and no-treatment plots of groundnut at Talaganag (Chakwal and Karor (layyah)
- Comparison of pesticides, IPM and no-treatment plots of Mungbean at Layyah and Bhakkar
- Field evaluation of different baits for recruitment of ants for predation on termites

The results of the above studies confer that; intercropping of brassica and wheat with sugarcane may be encouraged to command the maximum utilization of available land in katcha area of the Bhakkar. In the field of high termites activity, intercropping of wheat with sounf can be done successfully as sounf is already popular in Karor (Layyah). Intercropping of Alsi *(Linum usitatissimum*), Garlic (*Allium sativum*), Sarsoon (*Brassica compestrss*), Maithra (*Trigonella foenumgraecum*) in sugarcane was also proved effective than no intercrop in reduing the termites' damage at Fasialabad. Addition of threshed maize cobs, rotavated sugarcane stubbles; manure with spores of *Metarhizium anisopliae* can help to prevent damage to sugarcane setts. Following set of practices constituted IPM of termites in Groundnut**:** i) Seed rate: 24 kg acre^{-1} and treated with Imidacloprid @2 g kg^{-1}, ii) R x R distance: 30 cm, iii) Treatment with plant chemicals Decoction of Ak in water (1:2) was drenched into the soil around the base of the plant, Surghab @ 2 lit. acre^{-1}

was applied into the rows for the control of weeds and iv) Hoeing

Following set of practices constituted IPM of termites in mungbean**:** i) Seed rate: 24 kg acre^{-1} and treated with Imidacloprid @ 2 g kg^{-1}, ii) R x R distance: 30 cm; 2 irrigations, iii) Treatment with plant chemicals; Decoction of Ak in water (1:2) was drenched into the soil around the base of the plant, Surghab @ 2 lit. acre^{-1} was applied into the rows for the control of weeds, iv) Hoeing with kasola. Three IPM plots had non-significant difference among them but were significantly different from control plot in damage and termites' count. Control had high seedling damage and white heads. Augmentation of activities of ants by using baits (CSL+ protein hydrolysate + guar (1+1+0.1 parts) gluten + molasses + sugar (1+2+1 parts; CSL + molasses + protein hydrolysate + jelly (1+1+1+0.1 parts) reduced the foraging activities of termites in the groundnut. Among three sets of practices addition of poultry manure + slaughter house waste + cowdung (500 kg each in 4 kanals) chlorpyrifos 200 ml per tank for spray on setts, intercropping with sarsoon, Ak/Aksin spray, when termite population was seen on monitoring station / pipes; applied around the seedling with knapsack before irrigation was best in reducing bud damage in sugarcane. IPM models have been studied for termites in sugarcane, chickpea, and wheat in various ecological zones. Farmer's gathering and distribution of information in the form of a pamphlet depicting the above said models were also carried out.

Name of Project: **Sustainable Cropping Patterns for Pothowar Plateau**

Name of PI/ Institute: **Dr. Shahbaz Ahmad,**
Professor,
Department of Agronomy, University of Arid Agriculture, Rawalpindi.

Duration: 01.05. 2003 to 30. 04. 2007

Financial Status:

Total Cost:	Rs.3.036 million
Funds Released:	Rs.1957800/-
Funds Utilized:	Rs.1681917/-

Objectives:

- Identification of cropping patterns for efficient soil moisture and fertility use under rainfed conditions.
- Identification of the most ruminative cropping pattern under rainfed conditions.
- Demonstration and popularization of the best cropping pattern to the farmers.

Achievements:

During fourth year (2006-07), experiment was laid out at three locations i.e University of Arid Agriculture, Rawalpindi (UAAR), Barani Agricultural Research Institute, Chakwal (BARI) and Groundnut Research Station, Attock (GRS). There were ten cropping patterns including wheat, canola, groundnut, sunflower, maize (grain/fodder), mungbean and fodder oat crops. Each trial was replicated thrice at all locations.

The results of 2005 showed that the yield and the monetary benefit of groundnut based cropping patterns fit well for high and medium rainfall regions. The results of spring 2005 indicated that groundnut performed better at BARI and GRS than all other locations. The lowest groundnut yield was recorded at BARI. While during the year 2006 spring groundnut performed better at UAAR followed by BARI. The yield and the monetary benefit of groundnut showed that groundnut based cropping patterns fit well for high and medium rainfall regions.

Kahrif 2005 indicated that sunflower performed better under high rainfall conditions (UAAR) followed by medium rainfall zone (BARI-Chakwal). Sunflower has not performed well in low rainfall zones because of low soil moisture and poor textured soil. Mungbean can be grown in the low rainfall zones if planted as sole crop. Similarly maize can be cultivated in high and medium rainfall zones without much difference in the yield. The monetary benefits of kharif crops were better in high rainfall zones and the medium rainfall zones; however, the monetary benefits for growing mungbean crop at GRS were profitable if it is grown as sole crop. Intercropping sunflower and mungbean is possible alternative for maize as their economic return was 4-5 times higher than maize.

Name of Project: **Mutation Breeding for High Grain Yield, Improved Quality and Earliness in Non-Aromatic Rice (*Oryza sativa L*)**

Name of PI/ Institute: **Mr. Abdul Wahid Baloch,**
Principal Scientific Officer,
Nuclear Institute of Agriculture, Tandojam, Sindh

Duration: 01. 08. 2003 to 31. 12. 2006

Financial Status:

Total Cost:	Rs.1.112 million
Funds Released:	Rs.846000/-
Funds Utilized:	Rs.846000/-

Objectives:

- To evolve new rice varieties with
  - Early maturity
  - Superior grain quality
  - High yield and
  - Tolerant to biotic and abiotic stresses.

Achievements:

Ionizing radiation was successfully utilized to develop 6 mutant lines for earliness in maturity, 8 mutant lines for improved grain quality and 14 mutant lines for high grain yield. On the basis of overall yield performance, mutant line Shua-92-157/N had produced 23.73 kg per plot and showed 47 and 46% higher paddy yield than its parent (Shua-92) and check (Sarshar). The mutant lines IR 8-202/E (2.01), Shua-92-l56/N (2.05) and Shua-92 (2.03) have high value 2 in quality index and these mutant lines fall in the slender grain quality group. A bio-stress study indicated that the mutant line Sarshar 1513/H showed an increased yield of 14, 21, 22, 35 and 42% over other mutant lines such as Shua-153/E, Shua-92-203/E, IR8-258/H, IR8-2515/N and check variety Pokkali. These mutant lines were tested under saline condition of pH 7.66 and EC 8.02. The studies on the screening of 16 mutant lines were conducted for resistance to stem borers under field conditions. The results revealed that larval damage varied significantly amongst mutant lines and check variety. The mutant lines IR8-154IN, Sarshar 209/H, Shua-92-157/N, Sarshar-202/N and Sarshar 203/N were comparatively resistant to stem borer attack and produced high yield. The results suggest that cultivation of tolerant mutant varieties can play significant role in integrated pest management system in rice.

Name of Project: **Evolution of Wheat Varieties for Low Water Requirements Using Conventional and Mutation Breeding Techniques**

Name of PI/ Institute: **Mr. Mahboob Ali Sial,**
Senior Scientific Officer,
Nuclear Institute of Agriculture, Tandojam, Sindh

Duration: 26. 07. 2004 to 25. 07. 2007

Financial Status:

Total Cost:	Rs.1.944 million
Funds Released:	Rs.1479140/-
Funds Utilized:	Rs.1239592/-

Objectives:

- To identify high yielding genotypes at low water requirements.
- To identify genotypes with early maturity and increased grain filling period.
- To develop germplasm tolerant to drought for future breeding.

Achievements:

To evolve genotypes, those could produce sustainable yield at low water availability, eighty-four newly evolved wheat genotypes evolved through conventional and radiation-induced mutations at NIA, Tandojam were screened under low water requirements. Genotypes were thoroughly screened under various water stress conditions. Selection for drought-tolerant lines was made on the basis of their better field performance withholding irrigation during various critical growth stages. Of these, only drought tolerant, 21 better performing lines were selected for further evaluation. Twenty one selected genotypes/mutant lines along with 4 drought-tolerant check varieties were screened under 4 different irrigation levels at NIA, Tandojam. Simultaneously, the multi-location trials were also conducted at 5 different water stress environments in Sindh. The experiments were repeated at NIA, Tandojam and various locations in Sindh. Four experiments were conducted at NIA, Tandojam, whereas, multi-environmental trials were conducted at 6 locations including NIA in Sindh province during rabi 2005-06. The results indicated that nine genotypes produced significantly the highest overall grain yield (>3800 kg/ha) under various water stress conditions. Ten genotypes produced the highest overall mean grain yield (>3000 kg/ha) than all genotypes under multi-environmental trials. Genotypes NIA-I0/8, NIA-8/7, BWS-78, MSH-14, ESW-9525, MSH-36 and BWM-3, produced overall higher yields. To confirm the results, experiments were repeated during 2006-07. Similarly, same 25 genotypes were evaluated at various irrigation levels at NIA, Tandojam, whereas, nine out of 21 drought tolerant genotypes were evaluated in multi-environmental trials with 3 local checks at various locations in Sindh during 2006-07.

Name of Project: **Quality Characterization of Oilseed Crops through NIRS**

Name of PI/ Institute: **Mr. Iftikhar Ali,**
Principal Scientific Officer,
Nuclear Institute for Food and Agriculture (NIFA), Tarnab, Peshawar

Duration: 05. 07. 2004 to 04. 07. 2007

Financial Status:

Total Cost:	Rs.2.013 million
Funds Released:	Rs.1762500
Funds Utilized	Rs.1746157

Objectives:

- To establish NIR technology based oilseed quality analysis facilities and services for oilseed researchers, industry and growers.
- To increase the profitability of oilseed crops growing through the increased capability, availability and adoption of NIR technology based non-destructive quality analysis.
- To develop consistency in quality of oilseed crops through NIR technology based check.
- To develop calibration to determine oil, protein, moisture, fatty acids and glucosinolate on NIR instrumentation for major oilseed crops in Pakistan.

Achievements:

Successfully demonstrated the assessment of quality characteristics in whole seeds of oilseed crops through non-destructive NIR technology. A database of core collection of 2000 accessions of oilseed crops including rapeseed, mustard, canola, sunflower, sesame and soybean developed. All the seed samples of core collection screened for successful routine prediction of quality characteristics through the indigenously developed calibration equations on NIR system at NIFA. The base of core collection enhanced up to total 2350 different accessions of oilseed crops during January to June 2007. The quality profile of 75 more seed samples determined through the lab chemistry techniques. Total 300 seed samples representing the different species analyzed by "wet chemistry" for content of oil, protein, glucosinolate and fatty acid profile. The information on these 300 samples used to develop NIRS reference libraries for each above mentioned constituent in each species. To develop prediction equation comparative investigations made and the Partial Least Squares regression method (PLS) is used to develop prediction equation on NIRS FOSS 6500. So the task of development of calibration /validation equations and routine prediction through non-destructive method on NIR system for oil, protein, glucosinolates content and fatty acid profile successfully accomplished.

A two days workshop for general awareness among the stakeholders of agriculture organized on "Non-Destructive Analysis of Agricultural Products" from June 19-20, 2007 at NIFA in collaboration with Department of plant Breeding and Genetics, NWFP Agricultural University, Peshawar. A total 45 participants from 25 different research organizations and educational institutions of the country participated in the workshop.

Name of Project: **Better Utilization of Food for Healthy and Productive Life in Agriculture Sector**

Name of PI/ Institute: **Dr. Alam Khan,**
Professor,
Department of Human Nutrition, NWFP Agricultural University, Peshawar

Duration: 01. 07. 2004 to 30. 06. 2007

Financial Status:

Total Cost:	Rs.2.278 million
Funds Released:	Rs.2277500/-
Funds Utilized:	Rs.2276368/-

Objectives:

- To know the eating pattern/habits, intake levels of energy, macro and micro nutrients of the agriculturists residing in the plain districts of NWFP.
- To analyzed the foods of agriculturists for macronutrients (Protein, Carbohydrate and Fat) and micronutrients i.e. vitamins A, C and Folic Acid and minerals Calcium, Iron and Zinc.
- To know the energy distribution amongst the macronutrients.
- To assess the nutritional status of agriculturists from the collected (questionnaire) and analyzed (duplicate samples) data.
- To prepare guidelines for good eating habits and develop methods for balanced diet from the findings of the research project for the Agriculture communities of the plain districts of NWFP.

Achievements:

To collect the dietary recall data on food intake, collection of duplicate food samples and samples of prepared dishes from farmers, three villages namely Hatala, Purova and Punyala in district of D. I. Khan were selected for the third year study of the project. One hundred farmers from each village were selected for the survey. Twenty percent duplicate food samples from each village of the already selected farmers were collected for chemical analysis. Prepared dishes of 20 percent of the selected farmers of each village were also collected for chemical analysis. The dietary recall data was compiled. The data indicated that farmers of villages were at fair level of nutrients intake. However, the actual analysis of duplicate food samples indicated that intake level of both macro and micro nutrients were deficient in farmers of all the villages. The prepared dishes analysis indicated that their fat content is really low.

Name of Project: **Introduction and Yield Improvement of Mothbean (*Vigna unguiculate L*) in NWFP**

Name of PI/ Institute: **Mr. Muhammad Mansoor,**
Scientific Officer,
Agricultural Research Institute, D. I. Khan

Duration: 01. 05. 2004 to 31. 10. 2007

Financial Status:

Total Cost:	Rs.1.030 million
Funds Released:	Rs.1023140/-
Funds Utilized:	Rs.906321/-

Objectives:

- Screening of mothbean lines/ germplasm for yield and Yellow Mosaic Virus (YMV).
- Study of yield reducing as well as yield enhancing factors of moth bean.
- Acclimatization studies of moth bean for wider adaptation.

Achievements:

Mothbean yellow mosaic resistant lines identified during last year experimentation were planted to study various traits along with yield limiting factors. Four promising Mothbean lines were also planted in isolation for seed multiplication and purification in replicated form along with susceptible checks. The yellow mosaic resistant lines had again shown resistant while susceptible lines were badly attacked by the YMV. Consequently, the selection response was quite positive, with regards to confirmation of YMV resistance and its resistance level.

Name of Project: **Investigation on Barley Yellow Dwarf Virus (BYDV) in Wheat Crop in Pakistan (Component-I)**

Name of PI/ Institute: **Dr. Shamim Iftikhar,**
Senior Scientific Officer
IPEP, NARC, Islamabad.

Duration: 01. 07. 2003 to 31. 12. 2006

Financial Status:
Total Cost: Rs.4.069 million
Total Releases: Rs.2761700/-
Total Expenditure: Rs.2756739/-

Objectives:

- Assessment of distribution, incidence and severity of foliar diseases of wheat in different agro ecological zones of Pakistan.
- To understand variability in the pathogen causing foliar disease in relation to resistance in host.
- Identification of new source of multiple disease resistance with other promising traits.
- Devise an integrated strategy for foliar disease management.

Achievements:

Surveys for foliar spot of wheat were conducted at two growth stages (seedling stage and booting stage) of crop. Out of 12 zones where wheat is cultivated, the surveyed zones were 3 & 4 in Sindh, zone 5, 6 & 7 in Punjab, zone 9 & 19 were in NWFP and zone 11 in Gilgit and Skardu area.

The studies conducted on pathobiology of foliar blights of wheat in Pakistan and their management revealed that the most suitable stage of survey to assess the distribution and collection of foliar blight diseased samples of wheat is the booting stage of the crop. Zone 5, 6 and 9 were found with high prevalence of foliar blight. The high incidence of foliar blight in year 2005 is due to high humidity and optimum temperature which was prevailed in that year.

Bipolaris sorokiniana is found the most dominant pathogen causing foliar blight in all agro-ecological zones. Two pathogens namely *Colletotrichum graminicola* and *Dilaphospora alopecuri* have been identified first time in Pakistan. These are new addition to the group of spot blotch causing organisms.

In-vitro tests tube method has been standardized for pathogenicity test and aggressiveness analysis of the pathogen because of its simplicity and accurate results. The most aggressive isolate has black colour with suppressed colony while the least aggressive one has white albino with fluffy colony. P2-9 is found the most aggressive isolate on three commercial wheat varieties (Wafaq-2001, Inqlab 91 and Bhakhar 2001).
Eleven genotypes of synthetic hexaploide (Elite-II) have been found moderate resistant to local

most aggressive isolate of *B. sorokiniana*. Three accessions of durum parents are found moderate resistant. These may further be exploited in breeding programme. One commercial wheat variety (Kiran-95) is found moderate resistant to *B. Sorokiniana.*

A population of 169 lines after Mayoor & Flycatcher cross and 171 lines after Mayoor & Opata was obtained. The increased seeds of two populations are available for further use for in-vitro testing and field assessment under artificial inoculation in future and for selection of best agronomic plants which can serve as a good source of resistance for incorporation in national breeding program.

The most conducive temperature for pathogen (*B. sorokiniana*) growth is 25^0 C. Soil borne nature of the pathogen (*Bipolaris sorokiniana*) causing foliar spots on wheat has been confirmed during these studies. Oat and barley have been found the other hosts of B. sorokiniana.

The bed planting sowing technology is found the most suitable one to minimize the pathogen causing foliar blight. The lab experiments showed that high inoculum pressure causes high rate of mortality. So that we can conclude that if the inoculum level in the field reached to high level can cause severe yield losses in wheat.

Name of Project: **Identification of Sources of resistance to Karnal Bunt Disease of Wheat (Component-IV)**

Name of PI/ Institute: **Mr. Javed Iqbal Mirza,**
Senior Scientific Officer,
CDRP, IPEP, NARC, Islamabad

Duration: 01. 07. 2003 to 31. 12. 2006

Financial Status:
Total Cost: Rs.2.540 million
Total Releases: Rs.2060000/-
Total Expenditure: Rs.1648000/-

Objectives:

- Identification of Karnal Bunt disease resistance source.
- Making available Karnal Bunt resistant germplasm to breeders.

Achievements:

Main objective of the study was to identify sources of Karnal Bunt disease resistance by using pathogen isolates from diversified wheat growing areas of Pakistan. Keeping in view enriched genome of the wheat wild relatives for genes of resistance to biotic stresses, a number of Synthetic Hexaploid wheat lines were screened for their resistance against Karnal Bunt disease.

Tilletia indica spores germination protocols were standardized. Best spore germination was achieved with liquid nitrogen of pH 9 pre-plating treatment. Karnal Bunt disease survey of the wheat growing areas not only identified hotspots of the disease but also helped in the collection of diversified pathogen samples. The disease was present in wheat growing areas of Sialkot, Gujranwala, Lahore, Kasure, Multan, Bahawalpur, Bahawalnagar, Mianwali, Charsadda, Takhtbhi, Hathian and Mardan. Infested grains from all the locations served as diversified incoculum source for screening of the germplasm to be evaluated. Commercial wheat varieties, candidate wheat lines from National wheat breeders (NUWYT lines), Durum wheat lines (AABB), accessions of the synthetic Hexaploids (2n=AABBDD), "A" genome Synthetics (2n=AAAABB) and Bread wheat x Synthetic Hexaploid wheat lines were screened to identify reliable resistance source against Karnal Bunt disease. Commercial wheat cultivars and NUWYT lines were poor in resistance to Karnal Bunt under field and glasshouse conditions. Out of 95 commercial wheat lines only four were showing field resistance to Karnal Bunt. Repeated field and glasshouse screening of the Synthetic Hexaploid wheat lines and a set of Durums parents however, identified reliable Karnal Bunt resistance sources in *Aegilops squarossa* accessions. This resistance is ready to use in breeding program as Synthetics (2n= AABBDD) have genetic compatibility with bread wheat. Set of eleven synthetics identified as resistant in earlier evaluation and retested in stringent field and glasshouse conditions can confidently be used as source of Karnal Bunt resistance; these lines have better thrashing quality and acceptable agronomic traits. Screening of the "A" genome Synthetics provided other sources of Karnal Bunt resistance in "A" genome lines. Resistance identified in a

number of “A” genome Synthetics (2n=AAAABB) is difficult to transfer from these lines due to unknown meiotic behavior of the chromosomes. *T. bioticum* and *T. monococum* accessions in pedigrees of the resistant lines can, however, be directly crossed with bread wheat liens to transfer and make available resistance of these lines.

Analysis of the lines carrying resistant genes provide a targeted approach for the deployment of such genes in desired background. A mapping population was developed by using maize mediated double haploid technology to estimate resistance genes in a Synthetic line TKSN1081//*Ae. Squarosa* (222). Analysis showed that there is a single gene for resistance in these lines which is drawn from Durum parent TKSN1081.

Karnal Bunt resistant Synthetic Hexaploid (2n=AABBDD) x Breadwheat (2n=AABBDD) along with resistant mayor flycatcher lines are excellent lines of valuable importance to be used in breeding for Karnal Bunt resistance, as these lines carry resistance against other biotic stresses like leaf rust.

Name of Project: **Investigation on Barley Yellow Dwarf Virus (BYDV) in Wheat Crop in Pakistan (Component- II)**

Name of PI/ Institute: **Dr. Shahid Hameed,**
Senior Scientific Officer,
CDRP, IPEP, NARC, Islamabad

Duration: 01. 01. 2004 to 31. 12. 2007

Financial Status: Total Cost: Rs.3.892 million
Total Releases: Rs.2691700/-
Total Expenditure: Rs.2526396/-

Objectives:

- Epidemiological studies on BYDV.
- Characterization of Pakistan isolates of BYDV.
- Identification of source of resistance against BYDV.

Achievements:

During 2004-05 wheat cropping season, seventeen fields were sampled in Sindh, 89 in Punjab, 21 in NWFP and 2 in Balochistan. The overall incidence of BYDV was around 36.63%. In Punjab, Sindh, NWFP and Balochistan the values of incidence with DAC-ELISA were 19.61, 18.04, 56.29, and 11 respectively. The plants found to be infected with BYDV-PAV strains were; *Zea mays* (maize), *Avena sativa* (oats), *Saccharam officinarum*, *Sorghum halepense*, *Echenocloa colonum*, *Eragristis mino* and wheat var. (Fakhar-e-Sarhad). The data for the average of response of wheat genotypes to the BYDV infection in field test indicated differences in resistance level. Out of fifteen wheat lines, seven were found moderately resistant and remaining showed various levels of susceptibility. The same fifteen wheat lines obtained from ICARDA were also screened using aphid vector under controlled conditions at NARC and scored for virus presence/absence by DAC-ELISA. Two genotypes did not get infected namely BW-11 (113.1/MLT/TUI) and CHA4/tam2000/rsk/fkg15 suggesting that they could be resistant and remaining showed various levels of susceptibility. A molecular marker for the Bdv2 gene conferring resistant to BYDV in wheat was also standardized. The PCR screening with markers provides a quick efficient method that could be used to screen thousands of wheat lines for BYDV resistance based on Bdv2 and possibly to identify resistances bases on other genes like Bdv1.

Name of Project: **Investigations on Indian Crested Porcupine, *Hystrix indica*, Damage to Forest Flora and Development of Prevention Practices in Tarbela-Mangla Watershed Areas (Component-II)**

Name of PI/ Institute: **Mr. Rafiq Massih,**
Principal Scientific Officer,
VPCL, NARC, Islamabad

Duration: 01. 07. 2003 to 31. 12. 2006

Financial Status:
Total Cost: Rs.2.866 million
Total Releases: Rs.2254600/-
Total Expenditure: Rs.1574000/-

Objectives:

- To quantify porcupine damage to tree stockings, trees, surface vegetative cover (plant communities) and crops.
- To study reproductive biology, population structure, home range and food habit preferences.
- To develop environment friendly and sustainable management strategies to prevent porcupine infestations and damage.
- To train forest and irrigation staff and stakeholders (farmers) on the management of porcupine damage.

Achievements:

To quantify porcupine damage, six forest ranges (Abbottabad, Hawalian, Sherwan, Batagram, Balakot and Gari Habibullah) in Tarbela Watershed Management areas were surveyed covering an area of 80 ha. The results indicated that plants of *Pinus sp*. below the age of 6 years were the most preferred food for porcupine, with an average damage of 38.1% to -1 year old plantation and 24% to 1-6 years old plantations. The damage to adult plants was negligible.

Survey was conducted to study the damage of porcupine to field crops (maize, wheat, peas, potato, tomato, radish and cauliflower). The results revealed that damage was noticed only at maturity stage of the crop to maize (0.56%) and potato (4.23%).

Analysis of faecal contents indicated that there were 25 plant species, which constitute the major portion of porcupine diet. The most preferred food of the porcupine was *Malia azaderach* with mean frequency of 82.5 followed by *Pinus roxburghii* 72, *Diospyrus lotus* 58, *Triticum aestivu*m 36, Z*ea mays* 33.25, *Hordeum vulgare* 26.25 and *Sorghum vulgare* 23.75. The analysis of faecal contents on the parts of plants consumed by porcupine indicated that the stem (19.40%) was the most commonly used part in the diet of porcupine followed by roots (18.75%) and fruit (14.36%).
Stomach contents analysis of 20 animals indicated that the preferred food included more than 29 plant species. Among them five most preferred plant species were *Pinus roxburghii* with mean

frequency of 117.5 followed by *Sorghum helepense* 89.5, *Zea mays* 66.75, *Malia azadrach* 64.75 and *Zizyphus numularia* 37.75. The analysis carried out on the parts of the plants consumed by porcupine indicated that the fruit portion (18.03%) of plants was the most preferred part of the plant in the diet of the porcupine followed by stem (17.54%) and root (15.56%)

To estimate the porcupine burrow density a total of 122 ha area was surveyed. An average number of burrows recorded was 0.08 burrows per ha. Average number of porcupines occupying a single burrow system was estimated to 1.8 porcupines per burrow.

Body snares and live traps were evaluated as physical or non-chemical methods for control of porcupine. Body snares showed 3.4% and live traps 20% capturing/trapping success respectively.

The results of fumigation showed that out of 69 burrows fumigated with calcium cyanide approximately 90% success was achieved. Only seven burrows were re-opened.

To evaluate the most preferred food for porcupine in Tarbela-Mangla watershed areas, the results showed high preference of cracked groundnut. The 2nd preferred food was maize grain. Among the fresh food guava was at the top.

The results of poison grain bait and fresh guava bait with acute rodenticide (zinc phosphide) and chromic rodenticide racumin (coumatetraly1) showed racumin grain bait 80% reduction in porcupine activity while zinc phosphide grain bait showed 30-50% reduction. Fresh guava poison bait of zinc phosphide at 2% concentration reduced 50-60% porcupine activity.

Two models on porcupine population management have been developed for the management and control strategies of porcupine population in pine seedlings and maize crop. Training of farmers, forest functionaries, watershed management staff, irrigation staff and other agricultural stake holders was conducted on the management of porcupine population through the implementation of IPM models, demonstrations of control strategies and use of multimedia etc. 522 participants including farmers and other agricultural stakeholders were trained at Tarbela-Mangla watershed management areas.

Three research papers have been published under the project.

Name of Project: **Biology and Management of Porcupine, Hytrix indica in Centeral Punjab.**

Name of PI/ Institute: **Dr. Afsar Mian,**
Dean,
Faculty of Sciences, University of Arid Agriculture, Rawalpindi.

Duration: 01. 07. 2003 to 31. 12. 2006

Financial Status:

Total Cost:	Rs.2.094 million
Total Releases:	Rs.1921500
Total Expenditure:	Rs.1463100

Objectives:

- To quantify porcupine damage to tree stockings, trees, surface vegetative cover (plant communities) and crops.
- To study reproductive biology, population structure (distribution, density, etc) and food habit preferences, energy budgeting and seasonality.
- To develop environment friendly and sustainable management strategies to prevent forest and irrigation staff and stakeholders (farmers) on the management of porcupine damage.

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Achievements:

In order to assess the damage caused by Indian crested porcupine, surveyed seven irrigated forest plantations of central and southern Punjab. The surveys suggested incidence of damage to mature *Eucalyplus alabra, Dalbergia sissoo* and *Morus alba* plantation average at 8.02%, 8.84% and 14.2%, respectively, and an overall losses remained around 10%.

Porcupine damage, sampled over 235 ha of wheat crop in Potohar belt, was estimated at 8.5$\pm$0.96%. The damage was higher in periphery (10.0$\pm$1.55%) as compared to centre (6.9$\pm$ 0.61%) of the field.

The study conducted, suggests a wide distribution of porcupine in the central Punjab. An average burrow density of 0.56$\pm$0.17/ha was estimated for total area surveyed. The species is totally herbivore and depends on a wide variety of plant species, adjusting its diet with the seasons and geographical location. The species appears to have a wide base of its food and at least 26 species were identified from stomach/contents and faecal pellets. The plant species, like, *prosopis juliflora (20.79%), Zea mays (12.80%), Arachus hypoge\ea (10.9%), Triticum aestivum (5.12%), Ziziphus jujube (4.72%), Hordeum vulgare (4.26%) and Sorghum vulgaris (4.03%)* were more frequently consumed.

The feeding trials conducted at the opening of 14 live burrows, through multiple choice test, suggested that groundnut was the most preferred, followed by barley, wheat, rice, sorghum, maize and black gram seeds. Out of five seasonal vegetables, potato was the most preferred, followed by

carrot, radish, turnip and onion is the least preferred vegetable.

Observations on anatomy of reproductive tract of male and female showed that the testes are abdominal and the resting penis is posteriorly directed. The female has a biramous uterus. Maximum of two fetuses have been recovered, from same or different uterine horns.

The analysis of the testosterone levels in a limited number of males suggests a higher hormonal level during March, as compared with August.

Fifteen different parameters of 40 animals indicated that there is no significant morphological difference between the male and female, expect for a significant higher weight, larger total length, front foot length and crown diameter in males.

Field experiments were conducted to determine the efficacy of two poison baits (0.0375% coumatetraly1 or racumin and 2% zinc phosphide) and two fumigants (carbon monoxide and calcium cyanide power) against the species in forest plantations, rangelands and sandy deserts, Carbon monoxide, calcium cyanide power and coumatetraly1 were equally effective and caused high mortality (99-100%). Zinc phosphide baits were less effective and poorly consumed by porcupines, yet were cost effective. The use of two fumigants and maize grain racumin impregnated bait offered an excellent technique for the control of porcupine in different habitats.

Two-ingredient phrotechnic fumigant based on the release of carbon monoxide was tested by employing a new delivery system in Daphar Forest Plantation (District Gujrat), Islamabad and in sandy desert areas of Bhakhar. One hundred and two live porcupine dens were fumigated with 375, 350 and 250 gm device. Post treatment data indicated that re-opening of dens was zero after four days of treatment, giving 100% control.

Four students of M. Sc. (Zoology) completed their thesis research work on different biological aspects of the Indian crested porcupine under the project. One Ph. D student of the University of Arid Agriculture, Rawalpindi and one M. Phil student of Quaid-i-Azam University, Islamabad was provided maximum cooperation in the project to complete their thesis research on different aspects of Porcupine Biology and Management.

Seven research papers have been published under the project in various national research journals.

Name of Project: **Development of Low Cost Plant Protection Technologies through Integrated Pest Management Approaches and Use of Sacrificial Crop/ Plants in Sindh**

Name of PI/ Institute: **Dr. Abdul Sattar Buriro,**
Entomologist,
Agricultural Research Institute, Tandojam, Sindh

Duration: 29. 04. 2004 to 28. 04. 2007

Financial Status:

Total Cost:	Rs.2.877 million
Total Releases:	Rs.2505000/-
Total Expenditure:	Rs.2149000/-

Objectives:

- To develop IMP package for cotton and okra crop.
- To minimize pesticide use in cotton and okra based on low cost plant protection technologies.
- Dissemination of proven pest control technologies among farmers & Extension workers through extension approaches.
- Development of linkage between growers, research and extension workers.

Achievements:

Developed IPM packages for Cotton & Okra. The IPM technologies viz use of resistant varieties, augmentation and release of *Trichogramma* and *Chrysopa* sp; use of botanical pesticides, sex pheromones and trap crops viz Bajra, Marigold, Sunflower and Maize were practiced. With these technologies the use of pesticides was reduced by 75%.

The mass rearing of *Trichogramma* & *Chrysopa sp*. being successfully done in the Lab. conditions and augmentation and releases were done in cotton & okra crop. The releasing methods, timing and frequency were also determined.

The impact of mixing crop has been studied for cotton & okra crops. The results indicated that in cotton, bajra, maize and sunflower harbored more natural enemies and birds reduced pest infestation considerably. Thus use of pesticides was minimized. Similarly in okra, marigold, maize and sunflower, supplemented natural enemies and kept pest pressure under control without use of pesticides.

In service training was arranged on "Fruit flies management & mass rearing of natural enemies" in collaboration with NARC Islamabad. Also arranged a seminar on cotton in collaboration with Transfer Technology Institute, PARC, Tandojam. A field day arranged on organic farming of Okra for growers of Sindh Province. A pamphlet on "History of IPM in Pakistan" and "IPM Research through ALP" in Sindh was published.

Three Ph. D Students are being facilitated for their research studies in the project.

Name of Project: **Bread Wheat (*T. aestivum L.*) Improvement for Late Planting/ Terminal Stress and High Yield Potential.**

Name of PI/ Institute: **Mr. Tila Muhammad,**
Principal Scientific Officer,
Nuclear Institute for Food and Agriculture (NIFA), Peshawar

Duration: 01. 07. 2004 to 30. 06. 2007

Financial Status:

Total Cost:	Rs.1.868 million
Total Releases:	Rs.1691000/-
Total Expenditure:	Rs.1463000/-

Objectives:

- Evaluation and screening of local/exotic bread wheat germplasm for tolerance to late planting/terminal heat stress.
- Creation of genetic variability for tolerance to late planting and terminal heat stress.
- Identification of plant traits showing high association with grain yield and late planting/heat stress.
- Development of early maturing wheat genotypes/varieties with high grain yield, biomass yield, high 1000-grain weight, wide adaptation and disease resistance for different wheat growing areas of NWFP.

Achievements:

Evaluation of 123 wheat genotypes along with three check varieties for different plant and yield characters under normal and late sowing conditions during 2004-05 at NIFA, Peshawar resulted in the identification of 56 promising wheat genotypes. These 56 wheat genotypes on the basis of their good performance under both normal and late planting conditions were further evaluated for different agronomic parameters in 4 Preliminary Yield Trials (PYT) again under normal and late planting irrigated conditions during 2005-06 at NIFA, Peshawar. Out of 56 wheat genotypes 16 were identified as promising on the basis of their genetic stability, earlier heading and maturity, appropriate plant height, high 1000 kernel weight, high number of spikes/m^2, high biological and grain yield, acceptable grain color and resistance to leaf and strip rusts. These genotypes were then included and evaluated in two Advanced Short Duration Yield Trial ASDYT-I & II) at three different planting dates under late planting condition at NIFA, Peshawar and at three different locations in NWFP during 2006-07. Based on their genetic stability earlier heading and maturity, appropriate plant height, high 1000-kernal weight, high number of spikes/m^2, high biological and grain yield, acceptable grain colour and resistance to leaf and stripe rusts, 6 wheat genotypes have been finally identified as potential candidate varieties for late planting in NWFP. These lines will be further evaluated for different parameters in Micro Plot trials under late planting at multiplications in NWFP during 2007-08. These lines will also be used as parents for contribution to earliness, high 1000-kernel weight and high number of spikes/m^2 in the NIFA wheat varietals development programme through cross breeding. Selections for desirable recombinants and

mutants were made in the hybridized/mutagenized populations of different adapted wheat varieties/advanced lines.

One student of Plant Breeding & Genetics Department, NWFP Agricultural University, Peshawar has completed his M. Sc (Hons) degree under the project.

A paper has been prepared from project work and is accepted for publication in Pak. Journal of Botany.

Name of Project: **Developing Forage-plus-Grain Winter Wheat Production System for the Northern areas**

Name of PI/ Institute: **Dr. Iftikhar Hussain Khalil**,
Associate Professor,
Department of Plant Breeding & Genetics, NWFP Agricultural University, Peshawar.

Duration: 26. 08. 2004 to 25. 08. 2007

Financial Status:

Total Cost:	Rs.1.458 million
Total Releases:	Rs.1075000/-
Total Expenditure:	Rs.787000/-

Objectives:

- To introduce winter wheat germplasm for forage-plus-grain production in severe winter regions of Northern Areas.
- To develop dual-purpose (forage-plus-grain) winter wheat production system in Northern Areas.
- To increase and diversify source of income of the farmers of the Northern areas by raising both livestock and wheat.

Achievements:

During 2006-07, forty five (45) winter wheat lines selected from previous year's trials were evaluated under cut and uncut treatments at different locations in NWFP. These winter wheat lines were received from the Wheat Breeding Programs of the Oklahoma State University (USA), Kansas State University (USA) and Wheat Germplasm Enhancement Project of CIMMYT at Oklahoma State University. The locations used were Agricultural Research Station (North), Minogra (Swat), Farmer's field at village Kishwara near Malam Jabba (Swat), Hazara Agricultural Research Station, Abbottabad, Agricultural Research Station, Baffa (Mansehra), Agricultural Research Station, Chitral and NWFP Agricultural University, Peshawar.

The results from research trials conducted during 2006-07 and the previous 2-years at different locations in the northern areas show great potential of winter wheat to be used for the dual-purpose of forage-plus-grain. The three years research trials show that selection merit exists for forage production and re-growth potential after clipping among the winter wheat lines obtained from Oklahoma State University, Kansas State University and other wheat breeding programs. However, moderate to severe reduction in yield and yield components due to forage clipping during vegetative period was noticed in most winter wheat lines evaluated.

Good green forage producing winter wheat genotypes were OK00610 (6111 kg ha^{-1}), Intrada (5000 kg ha^{-1}), OK02518 (4440 kg ha^{-1}), OK00310 and OK02507 (each with green forage of 3889 kg ha^{-1}) and 05KIN11 (333 kg ha^{-1}). Plant height of winter wheat genotypes was in acceptable range of 80

to 105 cm. A general reduction from 2.0 to 12 cm in plant height of winter wheat genotypes was observed due to forage cutting. Similarly, spike emergence (heading) and maturity were also delayed due to forage cutting. Critical yield components like single spike weight, spike length and number of spikelets spike^{-1} were also reduced in cut than uncut treatment of trials. Analyses of biological and grain yield in these trials also showed reduction in these important traits due to forage clipping. However, the results indicated that, if managed well, grain yields at acceptable level or more than the national average can be obtained even after green forage clipping from the introduced winter wheat lines. For example, when averaged over 10 to 25 wheat lines, mean grain yields were 2824 vs 4060, 1875 vs 2368, 1828 vs 2780, 1770 vs 3090 and 1392 vs 2725 kg ha^{-1} under the cut and uncut treatments in different trials during 2005-06. Statistical analysis of yield and important yield components from 2006-07 trials at different locations carried out to make valid conclusions.

A research paper titled "Effect of Forage Clipping on Grain Yield and Associated Traits in Winter Wheat under Agro-Climatic conditions of Abbottabad" prepared from project work has been accepted for publication in the Sarhad Journal of Agriculture vide No. 172/SJA/2007.

Two students enrolled in Plant Breeding & Genetics conducted research work for thesis writing under the project and completed M. Sc. (Hons) degrees.

Name of Project: **Enhancement and Evolution of Germplasm for Stressed Environment Through the use of Agro-Biodiversity**

Name of PI/ Institute: **Dr. Shafqat Farooq,**
Principal Scientific Officer,
Nuclear Institute for Agriculture and Biology, Faisalabad

Duration: 01. 04. 2004 to 31. 03. 2007

Financial Status:

Total Cost:	Rs.4.468 million
Total Releases:	Rs.4315000/-
Total Expenditure:	Rs.4125000/-

Objectives:

- To collect, create, and characterize diversity in the form of varieties/land races/and lines related with wheat and incorporating their agronomically important characters(s) including low fertilizer and irrigation requirement, salt and water deficiency tolerance into commercial cultivars.
- To develop system and techniques for characterization of created and acquired biodiversity using molecular markers, stress proteins, and anti-oxidant enzymes,
- To streamline production and continuous availability of stress tolerant germplasm for developing environment friendly, sustainable and profitable agriculture for all times to come.

Achievements:

Three new wheat genotypes have been produced under the project and crossed *Aegilops geneculata* accession that turn out to be water deficiency tolerant with one of our line WL-1076 and produced "Drought Tolerant Line (DTL), which can be grown with one-sowing irrigation.

Crossed a line 886 with one of the F2 plants of Pasban-90 x W4909 and produced short stature (18 inches height) and short duration (require 3 months to mature) wheat which is suitable for cultivation after harvesting of cotton at the end of January with achievable yield 35-40 mounds.

Crossed durum wheat with one of the salt tolerant accession of *A. geneculata* and produced "Durugen" which combines salt and water deficiency tolerance and is good for poverty alleviation. This is a new wheat species which is produced naturally in an artificial cross almost 6000 years after the present day bread wheat originated. DURUGEN is a natural all polyploid with 4 genomes and is a major out come of the project.

Two students one M. Sc. and one M. Phil have produced their thesis under the project.

Name of Project: **Development of High Yielding, Long Grain Varieties of Rice for Par Boiling Purpose**

Name of PI/ Institute: **Mr. Akbar Ali Cheema,**
Deputy Chief Scientist,
Nuclear Institute for Agriculture and Biology, Faisalabad.

Duration: 11. 05. 2004 to 10. 05. 2007

Financial Status:

Total Cost:	Rs.1.696 million
Total Releases:	Rs.1648000/-
Total Expenditure:	Rs.1312000/-

Objectives:

- Induction of high yielding, long grain germplasm/varieties of rice for parboiling purpose.

Achievements:

Dry dormant paddy seeds of three Basmati rice varieties, namely Basmati-370, Basmati-Pak and Super Basmati were exposed to 150, 200, 250, 300, 350 and 400 Gy of gamma rays from 60 ^{0}C source at 13% moisture during the years 2004-05 and 2005-06 and radiation effects were studied in M1 generation on germination percentage, seedling growth parameters (emergence percentage, root length and shoot length), plant height, spikelets per panicle and panicle fertility etc. No pronounced radiation effects were observed on germination. Seedling growth parameters had detrimental effects particularly at higher doses (300 Gy and above). All the varieties showed dose depended response to plant height, spikelets per panicle and panicle fertility.

For isolation of long/extra long grain mutants, M2 populations of three Basmati varieties (Basmati 370, Basmati Pak and Super Basmati) were raised at 150, 200 and 250 Gy doses of gamma rays. Three long/extra long grain mutants were isolated in variety Basmati Pak at 250 Gy dose of gamma rays during 2005-06. The selected mutants had lesser plant height (131-142 cm) as compared to parent Basmati Pak (153.0 cm). Panicle fertility among the mutants was much lower ranging from 66.21 to 76.41% as compared to parent (92.06%) but they had long paddy (13.14 mm to 13.70 mm) as compared to 10.13 mm in parent. During 2006-07, five mutants were selected in M2 generation from variety Basmati Pak at 200 Gy dose of gamma rays. Panicle fertility among the mutants was much lower in most of the mutants ranging from 58.57 to 83.33% as compared to parent (94.61%) but they had long paddy (13.22 mm to 14.24 mm) as compared with 10.20 mm in parent.

Three mutants selected from variety Basmati Pak during 2005-06 in M2 generation were all the mutants bred true for long grain character. The panicle fertility in mutants 1 and 3 was 82.65 and 82.03% respectively as compared to parent (90.56%) and grain length was 13.02 and 13.22 mm respectively as compared with 10.13 mm in the parent. The selected mutants may be utilized for developing long grain Basmati rice and also to create germplasm for breeding purpose.

Name of Project: **Management of Weeds in Wheat-Maize Cropping System in Barani Areas of Potohar (Component-I)**

Name of PI/ Institute: **Dr. Tahira Z. Mahmood,**
Principal Scientific Officer,
IPEP, NARC, Islamabad

Duration: 01. 04. 2004 to 31. 03. 2007

Financial Status: Total Cost**:** Rs.4.036 million
Total Releases**:** Rs.2776000/-
Total Expenditure**:** Rs.2387000/-

Objectives:

- Development of integrated weed management for wheat and maize.
- Development of integrated management in farmers field.
- Transfer of long term weed control technologies to farmers in Barani areas of Potohar.

Achievements:

The weed problem in wheat (*Triticum aestivum L.*) has increased with the introduction of dwarf varieties. At NARC and Fatehjang, all herbicides showed sufficient control of weeds. Effect of sowing dates of wheat on the control of weeds shows that early planted crop could compete with weeds much better than late planted crop.

In experiments on integrated weed management (IWM) in wheat at NARC, amongst the herbicides lowest weed density was recorded from the plots where Buctril-M was sprayed as a post-emergence herbicide. In the final year's demonstration plots, pure/clean seed of wheat variety GA2002 was obtained and sowing was done on 25th October. Buctril-M and Puma super post emergence along with hand weeding (a month later) gave very good yield. Economic analysis gave a Cost Benefit Ratio of 2:1 (IWM : Weedy Check).

In the experiment carried out on integrated weed management in maize at NARC and Fatehjang, it was found that the lowest weed density was recorded from plots where wheat straw mulch was used. This was followed by Primextra (metolachlor + atrazine) sprayed as a pre - emergence herbicide. Significant difference was found in the treatments in terms of weed biomass.

Nutgrass, *Cyperus rotundus* is regarded as the world's most widespread weed as well as one of the world's 10 worst weeds. Within the arable ecosystem there are many beneficial organisms that feed on crop pests to the extent that pesticide use may be reduced or made unnecessary. Nutgrass is infested both by *Bactra spp*. (*B. venosana, B. truculenta* and *B. minima*) that was first recorded on 02. 08. 2004. The infestation peak was reached in the first week of August and lasted till the second week of August. Field collected/ lab reared pupae and adults were released in the field to increase the population of the insect and to put pressure on the density of the weed. Approximately 10,000 insect stages were released. They established and gave a good control of the weed in the next season. Description of a large number of weeds collected from Rawalpindi Islamabad has been written for reference.

Name of Project: **Integrated Weed Control for Major Rabi Crops (Wheat and Rapeseed) and Fellow Land in Pothowar (Component-II)**

Name of PI/ Institute: **Dr. Muhammad Azim Malik**
Professor,
Deptt. of Agronomy, University of Arid Agriculture, Rawalpindi.

Duration: 09. 07. 2004 to 30. 06. 2007

Financial Status:

Total Cost:	Rs.2.236 million
Total Releases:	Rs.1708000/-
Total Expenditure:	Rs.1241000/-

Objectives:

- To evaluate different integrated weed control methods for wheat, canola and fallow land in Barani areas.
- To enhance the overall productivity of wheat and rapeseed by weed control in Barani areas.
- To enhance the efficiency of fallow land by weed control in Barani areas.

Achievements:

Comparative Study of Weed Control Methods in Canola at Rawalpindi & Chakwal: Canola trials (weedy check, weed free, hand weeding once, chemical alone, chemical + hand weeding, kasola and khurpa) were planted at Chakwal and Rawalpindi locations in RCBD with strip plot arrangement in net plot size of 10x7 ft for comparative study of weed control.

Fertilizer Placement Methods: Data regarding weed density m-2, weed biomass, plant height, number of primary branches plant^{-1}, number of secondary branches plant^{-1}, number of pod plant^{-1}, number of seeds pod^{-1} and grain yield (Kg ha^{-1}) were recorded and data analyzed.

Integrated Weed Control in Rainfed Wheat: The wheat trials were planted at Chakwal and Rawalpindi locations in RCBD, strip plot arrangement on 05. 11. 2006 and 02. 11. 2006, respectively, in net plot size of 10x7 ft and recorded data.

Fertilizer Placement Methods: Data regarding weed density m-2, weed biomass at harvest, plant height, number of spikelets spike^{-1}, number of grains spike^{-1}, 1000 grain weight, grain yield (Kg ha^{-1}) and biological yield (Kg ha^{-1}) were recorded in fertilizer used through broad cast (BC), with seed (WS) and below seed (BS) method.

Integrated Weed Control in Rainfed Wheat: Data regarding weed density m-2, weed biomass at harvest, plant height, number of spikelets spike^{-1}, number of grains spike^{-1}, 1000 grain weight, grain yield (Kg ha^{-1}) and biological yield (Kg ha^{-1}) were recorded in integrated weed control experiments in rainfed condition. The data collected regarding various yield and yield components are under

analysis process.

Comparative Study of Different Post-emergence Herbicides in Wheat: The wheat crop was sown at Rawalpindi in Randomized Complete Block Design on 08. 11. 2006 in net plot size of 8 x 6 ft applying different herbicides. Data regarding weed density m-1, weed biomass at harvest, plant height, number of spikelets spike^{-1}, number of grains spike^{-1}, 1000 grain weight, grain yield (Kg ha^{-1}) and biological yield (Kg ha^{-1}) were recorded. The data collected regarding various yield and yield components are under analysis process.

Comparative Study of Different Herbicides Application Rates in Wheat: Data regarding weed density m-2, weed biomass at harvest, plant height, number of spikelets spike^{-1}, number of grains spike^{-1}, 1000 grain weight, grain yield (Kg ha^{-1}) and biological yield (Kg ha^{-1}) were recorded in the experiments where different herbicides were applied at different rates in wheat. The data collected regarding various yield and yield components is under analysis process.

Integrated Weed Control in Canola by Increasing Fallow Land Efficiency: In this experiment, different canola trials were planted at Chakwal and Rawalpindi sites in RCBD on 19. 11. 2006 and 28. 10. 2006 respectively, in net plot size of 7m x 5m. Non-selective herbicide Roundup @ 1900 ml/acre was applied during the Kharif season. Data regarding moisture conservation at different soil depths, weed biomass at harvest, plant height, number of primary branches plant^{-1}, number of secondary branches plant^{-1}, number of pod plant^{-1}, number of seeds pod^{-1} and grain yield (Kg ha^{-1}) were recorded. The data collected regarding various yield and yield components are under analysis process.

Integrated Weed Control in Wheat for Increasing Fallow Land: In the experiment, different wheat trials were planted at Chakwal and Rawalpindi sites in RCBD on 21. 11. 2006 and 04. 11. 2006, respectively, in net plot size of 7m x 5m. Non selective herbicide Roundup @ 1900 ml/acre was applied during Kharif season. Data regarding moisture conservation at different soil depths, weed biomass at harvest, plant height, number of spikelets spike^{-1}, number of grains spike^{-1}, 1000 grain weight, grain yield (Kg ha^{-1}) and biological yield (Kg ha^{-1}) were recorded during the course of study.

Name of Project: **Integrated Weed Management in Wheat, Cotton, Rice and Pulses in Punjab (Component-III)**

Name of PI/ Institute: **Muhammad Sarfraz Iqbal,**
Director,
Agronomic Research Institute, AARI, Faisalabad

Duration: 26. 08. 2004 to 29. 08. 2007

Financial Status:

Total Cost:	Rs.2.120 million
Total Releases:	Rs.1505000
Total Expenditure:	Rs.1218432

Objectives:

- To establish authentic weed spectra for the Wheat, Cotton, Rice and Pulses in the Punjab based on survey.
- To find out effective cultural and chemical weed control methods for various weeds of Wheat, Cotton, Rice and pulses in the Punjab.
- To impart training to extension workers and farmers about weed control methodology of Wheat, Cotton, Rice and Pulses.

Achievements:

Survey regarding weed flora of wheat, cotton, rice and pulses was carried out in different crop zones of Punjab. Thirty eight demonstration plots were sown on farmer's fields regarding weed control in wheat, cotton, rice and pluses in different zones.

A weed bank was established at research area of Plant Physiology Section, in which 30 weeds were grown. Each weed was grown in separate bed for demonstration, identification and seed production purpose. Seeds of 30 weeds were collected and preserved for identification. Seeds of weeds being provided to the researchers and students of weed science for research purpose.

Prepared checklist of weeds of Wheat, Cotton, Rice and Pulses and enlisted about 200 weeds. In addition checklist of approved herbicide along with their recommended dose, stage of application, target weeds and year of approval prepared. Up-till now 130 herbicides have enlisted.

Ten (10) research workers were trained regarding lay out of herbicides trials, calibration of water for spray & adjustment of nozzle, precaution for herbicidal spray. Two hundred (200) extension workers were trained regarding weed control technology. One hundred and fifty (150) farmers were provided information regarding losses due to weeds and weed control technology. Radio talks were recorded and broadcasted about weed control practices in Wheat, Cotton, Rice and pulses.

Name of Project: **Integrated Weed Control in Cereals (Wheat and Maize), Peshawar - Component-IV)**

Name of PI/ Institute: **Dr. Nasir ud din,**
Director,
Cereal Crops Research Institute, Pirsabak, Nowshera

Duration: 17. 08. 2004 to 16. 08. 2007

Financial Status:

Total Cost:	Rs.2.154 million
Total Releases:	Rs.1133000/-
Total Expenditure:	Rs.705336/-

Objectives:

- To identify weeds problems and losses caused in wheat and maize.
- To develop integrated weed management technology for wheat and maize.
- To demonstrate integrated weed management on farmer's fields.
- To transfer weed management technology to the farmers and users through print and electronic media and field days.

Achievements:

During the reporting period, nine experiments and eleven adaptive trials were conducted in various parts of the NWFP. Three experiments were on maize while six experiments were conducted on wheat. Ten adaptive plots were conducted on wheat and one was on maize.

In wheat experiment on "Effect of three row spacing and chemical weed control on wheat yield" conducted at CCRI, Pirsabak, the lowest weed dry weights were recorded in the herbicides treated plots as compared to the control. The highest grain yield was recorded in plots treated with herbicide in 15 cm row spacing.

The second experiment "Efficacy of different herbicides on weed control in wheat" was conducted at CCRI, Pirsabak. The application of herbicides controlled the weeds and increased wheat grain yield as compared to weedy check. The results indicated that the plots sprayed with mixture of Buctril Super + Topik gave the highest yield. The lowest yield was given by the weedy check plot.

The third experiment was on the "Effect of different dates of sowing and different seed rates on weed control and on the grain yield of wheat". Results indicated that number of weeds/m^{-2} was increased as sowing date was delayed and highest weed density was recorded in plots sown on 5th December (D5) while the lowest density was observed in plots sown on 25th October (D1). Seed rate also affected the weed density and the plots with lowest seed rate had maximum weeds/m^{-2} as compared to the plots with higher seed rates. Highest weed density was recorded in seed rate of 100 kg/ha while the minimum was recorded in 162.5 kg/ha seed rate. The highest grain yield was obtained when sowing was done on 5^{th} of November, while the lowest yield was obtained when

sowing was done on 15th December.

The fourth experiment "Efficacy of different herbicides on weed control in wheat" was conducted at ARS, Serai Naurang. The application of herbicide controlled the weeds and increased wheat grain yield as compared to weedy check. The lowest weed population was recorded in plot sprayed with mixture of Puma Super + Buctril Super. The lowest grain yield was obtained from the weedy check plot.

The fifth experiment conducted at ARI, Tarnab, Peshawar on the "Efficacy of different herbicides on the weed control and grain yield in wheat", showed that in the plot sprayed with Buctril Super + Puma Super controlled the weeds efficiently followed by affinity. Similarly the plot sprayed with the mixture of Buctril Super and Puma Super produced the highest grain yield followed by affinity. The lowest yield was obtained from the untreated plot.

Another experiment conducted at ARI, Tarnab, Peshawar was on "Effect of row spacing and weed control methods on weed control and grain yield of wheat" where the results indicated that the lowest weed populations were recorded in the herbicides treated plots as compared to the weedy check and the highest grain yield was obtained in plots treated with herbicides followed by manual weed control. Interaction between row spacing and weed control practices were significant and more grain yield was recorded with 25 cm row spacing with chemical method of weed control followed by 30 cm row spacing with chemical weed control while the lowest grain yield was recorded in row spacing 35 cm with no weed control practice was untreated plot.

Name of Project: **Weed Management Studies of Wheat and Cotton Crops in Sindh (Component-V)**

Name of PI/ Institute: **Mr. Allah Ditta Jarwar,**
Plant Physiologist,
Agriculture Research Institute, Tandojam, Sindh

Duration: 13. 05. 2004 to 12. 05. 2007

Financial Status:

Total Cost:	Rs.2.154 million
Total Releases:	Rs.1957000/-
Total Expenditure:	Rs.1955794/-

Objectives:

- To study different methods of weed control including cultural, mechanical and chemical for wheat and cotton crops.
- To determine weed crop competition periods and their effects on yield of wheat and cotton crops.
- To determine the economic (cost benefit ratio) of different weed control methods.
- To develop modern weed control technology for farming community.
- To disseminate technology developed to the farming community.

Achievements:

The achievements made under the project as a result of experimental studies conducted are summarized as under:

Cotton: Sugarcane trash mulch method controlled weed in cotton crop and increased the yield compare to wheat bhusa mulch method. *C*hemical weed control in cotton showed that the weedicide Dual Gold 960 EC controls the weeds effectively at 2.5 lits/ha, as compared to standard product Stomp 330 E.C. at 2.5 lits/ha.

In an experiment of weed competition studies, it was observed that maximum yield and minimum weed density/m^2 was obtained when crop kept weed free up to 1^{st} boll formation stage.
Experiment of different integrated weed management practices in cotton shows that manual interculturing (2 interculturing) with spade, give better yield and minimum weed denstity/m^2 than manual interculturing by ploughing with bullocks (2 ploughings) between the rows of cotton sown by drilling method.

It was observed from the economic analysis of the mulching method experiment that per hectare benefit with maximum B/C ratio was obtained by the sugarcane trash mulch, which is found economical to grow regarding controlling the weeds in cotton crop.

Wheat: Experimental results from the chemical weed control in wheat show that weedicide Topik-

240 E.C controls narrow leaved weeds than weedicide Ptoton-50% W.P. Both weedicide are recommended to control narrow leaved weeds.

Integrated weed management studies show that close row sowing method with 15 cm apart along with the application of weedicide Buctril Super 60 E.C at 625 ml/ha controls the weeds effectively and yielded maximum than other treatments.

Screening of weedicides for the best control of broad leaved weeds in wheat, it was observed that weedicide Buctril Super 60 E.C at 625 ml/ha showed better to control the broad leaved weeds specially, Noxious weed, Bind weed *Convolvulus arvensis*, lambs quarter *Chenopodium album*, White sweet clover *Melilotus alba*, Shepherds clock *Anagallis arvensis*, Wild onion *Asphodelus tennifolius.* Weedicides Chroma 6.9% E.W @ 1250 ml/ha, Puma super @ 625 ml/ha and Faster 5-7% E.C @ 1250 ml/ha showed better performance for controlling of both type weeds in wheat crop.

Three field seminars at wheat growers' fields and one on cotton production technology organized with the collaboration of other ALP projects at Agricultural Research Institute, Tandojam. Three training programs were also organized at Mirpurkhas, Sanghar and Sakrand for Agriculture Officers, Field Assistants and growers.

Eight students completed M. Sc. (Hons) thesis on weeds and weed management studies on wheat & cotton crops under the project.

Name of Project: **Integrated Weed Management in Wheat and Vegetables (onion & tomato) (Component-VI)**

Name of PI/ Institute: **Mr. Qazi Bashir Ahmed**
Director,
Fodder Pulses & Special Crops, Agriculture Research Institute, Sariab, Quetta.

Duration: 28. 07. 2004 to 27. 07. 2007

Financial Status:

Total Cost:	Rs.2.154 million
Total Releases:	Rs.1808000/-
Total Expenditure:	Rs.1703000/-

Objectives:

- Development of integrated Weed Management Technology for wheat, onion and tomato.
- Demonstration of Integrated Weed Technology of wheat, onion and tomato at Farmer's field.
- Transfer of long-term weed control techniques to the Extension staff and Farmers in various districts of Balochistan.

Achievements:

Experiments were conducted in different growing areas of Balochistan i.e. Quetta, Kalat, Sibi and Loralai. A diagnostic survey of wheat, onion and tomato crop was carried out to determine the effects of farm management cropping systems, crop rotation, cultural practices and existing weed control system.

Three years study data on weed management in wheat through chemical control at ARI, Quetta, Kalat and Sibi, revealed that the combination of Buctril super and topic gave best result in controlling the weeds population. Data of experimental trial "weed management in wheat through cultural control" showed that seed rate and row spacing of 225 kg/ha and 15 cm respectively successfully reduced the weeds population and maximum grain yield tons/ha was at seed rate of 175-200 kg/ha with a row spacing of 15-20 cm at Quetta. At Sibi, the minimum weeds population was also at seed rate and row spacing of 225 2kg/ha and 15 cm respectively. However, the maximum grain yield tons/ha was at the seed rate of 200 kg with row spacing of 15 cm.

During the year 2005 and 2006, maximum grain yield tons/ha was at Usta Muhammad through spraying Buctril-Super @ 1000ml/ac followed by Sibi and Kalat with a comparison to the farmer's practice. During 2007 at Sibi, the grain yield tons/ha was maximum followed by experimental trial on weed management in transplanted onion through chemical control.

The data of the trail on weed management in tomato at two locations i.e. Quetta and Loralai revealed that treatments T7 (four hand weeding) followed by T6 (three hand weeding) and T1 (stomp @1000ml/ac) is recommendable for better yield in tomato crop at Quetta and T7 (four hand weeding) followed by T6 (three hand weeding) are recommendable at Loralai.

Name of Project: **Screening of Drought Tolerant Wheat Genotypes and Estimation of Genetic Basis**

Name of PI/ Institute: **Dr. Muhammad Munir**
Professor
Department of Plant Breeding & Genetics, University of Arid Agriculture, Rawalpindi.

Duration: 01. 07. 2004 to 30. 06. 2007

Financial Status:

Total Cost:	Rs.1.967 million
Total Releases:	Rs.1861000/-
Total Expenditure:	Rs.1571000-

Objectives:

- To screen drought tolerant wheat genotypes.
- To incorporate the character of drought tolerance in high yielding drought susceptible genotypes.
- To study the genetic basis of drought tolerance.

Achievements:

During testing and screening of genotypes for drought tolerant wheat accessions viz. 00FJ03, Margala 99GA 2000 and 99FJ03 showed tolerance to drought stress while Iqbal 2000, Rawal 87 and 3C061 showed susceptibility to drought stress. For the selection of potential and desirable parents the incorporation of genes for drought tolerance into high yielding varieties was done and genetic mechanisms controlling drought characters in various crosses were studied.

During the study of genetic basis of drought tolerance over dominance was observed in case of all characters studied. Genotypes viz 00FJ03, Margalla 99, 99FJ03 and Iqbal 2000 performed better out side the tunnel on the basis of osmotic potential, relative water contents, and total grain weight and possessed dominant genes for these characters. Whereas cross of 00FJ03 x 3C061, Margalla 99 x Iqbal 2000, Iqbal 2000 x 3C061 and Rawal 87 x 3C061 perform better out side the tunnel on the basis of osmotic potential, relative water contents, and total grain weight and carry dominant genes for these traits.

Genotypes like 00FJ03, Margalla 99, Iqbal 2000 and 3C061 performed better on the basis of osmotic potential spikelets per spike and total grain weight when sown inside the tunnel and showed more dominant traits. Crosses of 00FJ03 x Iqbal 2000, 00FJ03 x 3C061, Margalla 99 x Rawal 87, Iqbal 2000 x 3C061 and Rawal 87 x 3C061 performed better on the basis of osmotic potential, relative water contents and total grain weight when sown inside the tunnel and possessed dominant genes for these traits. These selected lines and their progenies can be utilized in crop improvement and breeding programs in rainfed areas for future studies.

Two students enrolled for M. Sc. (Hons) Agriculture have completed their degrees successfully.

Name of Project: **Nematodes of Fruit and Vegetable Crops and their Management in Karachi and Hyderabad Districts Using Plant Extracts**

Name of PI/ Institute: **Dr. Aly Khan,**
Principal Scientific Officer,
Crop Diseases Research Institute, SZARC, Karachi

Duration: 01. 01. 2005 to 31. 12. 2007

Financial Status:

Total Cost:	Rs.2.641 million
Total Releases:	Rs.2032000/-
Total Expenditure:	Rs.1448000/-

Objectives:

- Collection of root and soil samples of mango, papaya, chili, tomato and onion.
- Identification of plant parasitic nematodes.
- To test efficacy of plant extracts in pot and field trials.
- Analysis of data using different statistical procedures to achieve environmental safety.

Achievements:

The nematodes associated with tomato in Karachi and Hyderabad districts were *Helicotylenchus indicus; Meloidogune javanica; Meloidogne incognita; Hopolaimus indicus; Basiria graminophila; Longidorus dipsaci.*

The dendrogram derived from agglomerative clustering shows two major groups, group 1 and group 2. Group 1 is characterized by the localities of abundance of species *Meloidogyne incognita*. On the other hand group 2 contains localities where species *Ditylenchus dipsaci* is dominant in the nematode communities associated with tomato root zones. In chili seedling nurseries located at different localities of these two districts, *Helicotylenchus* was highly prevalent genus, most likely reflecting the plasticity of this genus. Pot experiments on plant growth criteria of chili & papaya seedlings and reproduction of *Meloidogyne incognita* in different plant extracts was studied.

Ethanol Plant Extracts of *Withania somnifera* were most significant in controlling population of nematodes associated with tomato in field trials.

Four research papers have been published in national journals while two are accepted for publication and one is submitted for approval. One Research Fellow is working in the project for Ph. D studies.

Name of Project: **Management of Apple Spider Mites in NWFP**

Name of PI/ Institute: **Dr. Inamullah Khan,**
Assistant Professor,
Department of Plant Protection, NWFP Agricultural University, Peshawar.

Duration: 01. 10. 2004 to 30. 09. 2007

Financial Status:

Total Cost:	Rs.1.408 million
Total Releases:	Rs.1150000/-
Total Expenditure:	Rs.836000/-

Objectives:

- Rate of consumption, and functional and numerical responses of the predators, *Stethorus pauperculus*.

Achievements:

Predation is an important component of ecological aspects because through predator the flow of energy continues throughout a community. An effective biological agent is mainly selected on the basis of its rate of consumption functional and numerical responses to its prey.

The rate of consumption by the adults and immature stages by *S. pauperculus* was observed at various densities of prey mite eggs and adult females. The total number of mites egg consumed by 1^{st}, 2^{nd}, 3^{rd} and 4^{th} larval instars were 27.93 + 1.1, 50.12 + 1.0, 71.64 + 1.5, and 152.36 + 1.6 respectively. This compared with the numbers consumed by adult males, pre-ovipositing females, ovipositing females and post-ovipositing females of 63.53 + 0.4, 94.25 + 0.5, 142.69 + 0.53 and 57.1 + 0.6 eggs per day respectively.

All motile stages of *S. pauperculus* responded positively to prey density and showed a type-II functional response. Their numerical response was measured by the successful completion of immature stages and the reproductive response of adult females. To assess reproductive response, both gross and net oviposition rates were recorded at all prey densities. The gross fecundity was higher than net fecundity at low prey densities, because the adult predators were cannibalistic, eating their eggs because of lack of suitable prey. However, both gross and net fecundity increased linearly until they reached a plateau at higher densities.

Name of Project: **Transgenic Tomato with Resistance to Bacterial Wilt**

Name of PI/ Institute: **Dr. Zubaida Ch.,**
Scientific Officer,
ABP, NARC, Islamabad.

Duration: 25. 10. 2004 to 24. 10. 2007

Financial Status:

Total Cost:	Rs.4.085 million
Total Releases:	Rs.3301000/-
Total Expenditure:	Rs.2262000/-

Objectives:

- Amelioration of tomato cultivars through Agrobacterium mediated transformation to develop resistance against bacterial wilt disease.
- Selection of desired R1 & R2 transgenic lines in the glass house.

Achievements:

The work was started with three tomato cultivars (Roma, Rio grande and Money maker). Its source material was maintained in vitro through out the research period. Tissue culture studies for direct regeneration from leaf discs and hypocotyls explants were carried out. The project focused on development of resistance against bacterial wilt in tomato cultivars by Agrobacterium mediated transformation. Results obtained by glasshouse evaluation of transgenic plants produced by Agrobacterium mediated transformation containing gene for disease resistance of three tomato cultivars (Money maker, Roma & Rio grande) were recorded. The transgenic plants are compared with control plants for various agronomic traits. There is no significant morphological difference between transgenic plants and control plants of these two varieties. Although transgenic plants showed late flowering compared to control plants in regeneration, the number of seeds harvested /fruits in both transgenic plants and control plants are almost same. Similarly, genomic DNA from 4 independently obtained transgenic plants one each of cvs Roma, Money maker and two of cv Rio grande, along with a control (non-transgenic) plant was subjected to PCR analysis for presence of introduced gene. Two specific primer sequences for the hygromycin coding region were designed to amplify hygromycin gene from genomic DNA. All the samples from transgenic plants gave the predicted DNA fragment band of (670 bp) of the hygromycin gene. No DNA amplification was detected in the samples from the control plant. This work is also compiled in a research article "Agrobacterium Mediated Transformation in tomato cvs Riogrande and Roma for Resistance against Bacterial Wilt".

Name of Project: **Introducing of Soft Fruits (Strawberry, Black berry, Rasp berry, Black currant) in the Potential Areas of Pakistan for Economic Returns**

Name of PI/ Institute: **Mr. Sudheer Tariq,**
Senior Scientific Officer,
IFHC, NARC, Islamabad.

Duration: 01. 07. 2003 to 30. 06. 2007

Financial Status:

Total Cost:	Rs.4.000 million
Total Releases:	Rs.3301200/-
Total Expenditure:	Rs.2794324/-

Objectives:

- The primary objective of the programme is the introduction of improved exotic planting material of soft fruits.
- To select the best adapted one to local climatic soil and biotic condition for commercial exploitation.
- To develop appropriate production technology.
- To established plants nursery for production of pedigree plants.

Achievements:

Germplasm of strawberry, black berry, rasp berry, black currant were collected from Malam Jabba, Matta, Bakain, Mingora, Peshawar, Murree, Rawalakot, Ghari Dopatta, Muzafrabad, Soan valley and Islamabad surrounding areas. Plants were multiplied through different propagation techniques and planted in green house and are being maintained for research purpose at NARC. Plants multiplied at NARC were distributed to ARI, Mingora and ARI, Tarnab, Peshawar. Experimental trials were conducted to observe growth behavior of cultivars at NARC. Following data regarding vegetative and reproductive growth were repeated during report year and being collected.

- Response of strawberry cultivars to different chilling and duration.
- Effect of different environment on growth and yield of strawberry.
- Effect of crown size of various wild soft fruit species.
- Characterization of various wild soft fruit species.
- Comparison of strawberry cultivars under Islamabad condition.

Observations were made on number of runner produced per plant, leaf area, leaf fresh and leaf dry weight, number of fruits per plant, fruit weight and fruit size. Data showed that chilling treatment increased vegetative and reproductive growth. Plants chilled at 4 ^{0}C performed better comparatively and plants grown under green house yielded earlier compare to other environment. Results showed that chilling caused increased in vegetative and reproductive growth of strawberry. The difference in vegetative and reproductive growth may also be associated in some way with difference in growing environment. During survey it was observed that specious soft local germplasm available at various sites needs attention and promotion for commercial cultivation.

Name of Project: **Development and Promotion of Improved Technology for Sorghum and Millet Production through Participatory Research in Dryland Areas of Pakistan and AJK**

Name of PI/ Institute: **Dr. Javed Fateh**
Senior Scientific Officer,
Maize, Sorghum & Millet Program, NARC, Islamabad

Duration: 28. 04. 2004 to 27. 04. 2007

Financial Status:

Total Cost:	Rs.2.121 million
Total Releases:	Rs.1370000/-
Total Expenditure:	Rs.1126000/-/-

Objectives:

- To develop and promote improved technology of sorghum and millet through participatory research.
- To establish a participatory Sorghum and Millet seed production and dissemination program.

Achievements:

As core activity of the project, continued distribution of quality seed of improved varieties of sorghum and millet. The seed of Bajra Super-I (Millet) and Johar (Sorghum), the best improved and approved varieties, was increased at NARC, Islamabad in huge quantity. More than four tons seed of sorghum and more than five tons seed of millet was distributed to more than 1700 farmers in project areas viz. Rawalpindi/Islamabad, Chakwal, D. I. Khan, Bahawalpur, Bhimber & Mirpur and Umarkot. The seed was supplied to selected farmers for 700 acres.

Seed production cum demonstration blocks of improved and pipeline varieties of sorghum and millet were grown at NARC, research stations and fields of progressive farmers in the project area. Seed obtained from these blocks was stored at research stations and with progressive farmers for further distribution.

A farmer-to-farmer seed production and dissemination at such scale will improve the farmers' income which will help in alleviating the poverty in the dry land areas of Pakistan. Also, as a result of project activities, the local low yielding varieties are being replaced by the high yielding improved varieties of these crops.

The technologies have been tested and adopted on much larger scale. Six improved varieties each of sorghum and millet were selected on the basis of their excellent performance in National Uniform Yield and other trials. The Mother-Baby trials methodology was adopted for these trials. The replicated Mother trials were conducted at the research stations, and in few cases at the fields of the progressive farmers. The baby trials, the non-replicated subsets of the mother-trials, were planted at the farmer's field. The entries in the baby trials were directly compared with the farmers own variety or with improved local check. A pamphlet in Urdu language "*Jawar aur Bajray Ki Padawar Barhane kai Sunehri Osoul"* was distributed in large numbers among the farmers of the project area.

Name of Project: **Utilization of Seaweeds in the Biological Control of Soil Borne Pathogens and Growth of Crop Plants**

Name of PI/ Institute: **Prof. Dr. Viqar Sultana,**
Professor,
Biogeochemistry, University of Karachi, Karachi.

Duration: 26. 07. 2004 to 31. 12. 2007

Financial Status:

Total Cost:	Rs.1.780 million
Total Releases:	Rs.1220150
Total Expenditure:	Rs.974000

Objectives:

- To collect and identify the potential seaweeds having nematicidal and fungicidal activity.
- To use potential seaweed as organic amendments alone or with microbial antagonists in green house, micro-plots and farmer's fields for the control of plants parasitic nematodes and root infecting fungi, instead of hazardous pesticides which will result in better crop production in safe environment.
- To compare the efficacy of seaweeds with chemical fertilizers and pesticides.
- To develop a simple and cost effective method for the field application of seaweeds.
- To produce seaweed-based agrochemicals such as seaweed-extract products and seaweed fertilizer.
- To isolate and characterize fungicidal and nematicidal compounds from potential seaweeds.

Achievements:

Seaweeds, the marine macro-algae are rich and varied source of pharmacological active natural products and have been known to aid and stimulate growth of vegetables, fruits and other crops. They contain all major and minor plant nutrients as well as bio-control properties. During the study 12 species of seaweed namely *Dictyota dichotoma var. indica, Dictyota dichotoma var. velutricata, Sargassum polycystem C. Ag; Jolyna laminarioides (Brown), Caulerpa cheminitzia (Esper). Lamour; Caulerpa scalpelliformis, Codium shameelii, Enteromorpha prolifera (mull) J. Ag; Ulva rigida C. Ag. (Green), Calliblepharis fimbriata Grev. Kutz; Melanthamnous afaqhusainii Shameel, Sarcodia dichotoma Borg. (Red)* were collected from coastal areas of Karachi.

Out of 10 water extract of seaweeds tested, *Ulva fasciata* caused 100% larval mortality within 24 hours at 10 mg/ml whereas at 1mg/ml *U. fasciata* caused 60% larval morality within 48 hours. *Enteromorpha prolifera, Jolyna laminarioides, Melanothamnus afaqhusainii, Dictyota dichotoma var. velutricata, Caulerpa scalpelliformis and Colpomenia sinuosa* caused larval mortality 20% or more within 48 hours at 10 mg/ml. Of the 5 ethanol extract of seaweed tested, some of them showed strong nematicidal activity by killing the second stage juveniles of nematode at varying degree. Nematicidal activity was increased with an increase in exposure time and concentration. After 24 hours, brown seaweeds *Dictyota haukiana, Sargassum swartzii and S. wightii* caused 40% or more larval mortality at 10 mg/ml. Whereas *Caulerpa chemnitzia* caused 31.6% mortality at 10

mg/ml. *Dictyota haukiana and Sargassum wightii* caused 100% larval mortality within 48 hours at 10 mg/ml. *Sargassum swartzii* caused 46.6% and *Melanthamnous afaqhusainii* 56.6% larval mortality within 48 hours at 10 mg/ml. Three ethanol extracts of seaweed tested for fungicidal activity, *Caulerpa chemnitzia* inhibited the radial growth of *Macrophomina phaseolina and Fusarium solani* by producing the zone of inhibition.

Efficacy of several seaweeds for the control of root rotting fungi and root knot nematode and growth of crop plants were tested in green house, in field plots and at farmer's fields. Application of some brown, one red and one green seaweed as soil amendment showed significant suppressive effect on root infecting fungi *Macrophomina phaseolina, Rhizoctonia solani and Fusarium solani* by reducing their infection on test plants like chili, cotton and soybean by reducing number of galls per root system and or nematode penetration in roots. Seaweeds in most of the experiments showed stimulatory effect on plant growth and significantly increased plant height and fresh shoot weight. Efficacy of some seaweed was comparable with chemical fertilizers like urea and potash.

Soil amendment with some seaweed significantly increased rhizosphere population of fluorescent pseudomonas, plant growth promoting rhizobacteria. However, suppression of root rotting fungi and root knot nematode with seaweed soil amendment did not correlate with the rhizosphere population of plant growth promoting rhizobateria associated with tomato, chili and soybean roots. Application of one red and one brown potential seaweeds tested at farmer's field at Kathor, Malir, Karachi showed significant suppressive effect on root rotting fungi of tomato and chili and enhanced plant growth. In field trails, the efficacy of seaweeds on tomato was comparable with Topsin-M, a commercial fungicide. Field trails of seaweed formulation for the control of root diseases and growth of crop plants are underway.

Natural Resources

Name of Project: **Use of Nitrogen Fixing, Plant Growth Promoting Rhizobacteria (PGPR) for Development of Bio-Fertilizer for Crops on Economic Importance - Umbrella Project (NARC Component - I)**

Name of PI/ Institute: **Dr. Muhammad Aslam,**
Senior Scientific Officer,
Soil Biology & Biochemistry, LRRP, INRES, NARC, Islamabad

Duration: 01. 03. 2005 to 28. 02. 2008

Financial Status:
Total Cost: Rs.4.230 million
Funds Released: Rs.2397000/-
Funds Utilized: Rs.757435/- (up to 31. 12. 2006)

Objectives:

- To exploit the role of plant growth hormones (induced or produced) in rhizosphere on growth and yield of wheat and sugarcane for improving quality of biofertilizers.
- Isolation, identification and selection of bacterial strains showing high nitrogen fixing activity and phytohormone production in pure culture.
- Evaluation of promising strains showing beneficial effects on their respective host crops under lab. as well as field conditions and development of crop specific biofertilizers based on single multiple strains in a carrier material for wheat and maize.
- Identification and quantification of phytohormones produced by rhizobia associated with wheat and maize and their beneficial effects on plant growth.
- The influence of wheat root exudates application on the growth of rhizobia and their promotion for phytohormone production.
- Selection of beneficial strains of rhizobia (most efficient in plant growth promoting hormone production) for biofertilizer production for wheat.

Achievements:

Twenty four wheat rhizosphere soil samples were collected from 8 sites of Faisalabad (Shahkot), Toba Tek Singh districts and Kala Shah Kaku area. Twenty two rice rhizosphere soil samples were collected again from rice areas of northern Punjab (i.e. Kala Shah Kaku, Sheikhupura and Norowal). Isolation of plant growth promoting rhizobacteria (PGPR) from these samples was done by dilution plate method. The plates were incubated at 26-28^{0}C 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. The strains were characterized from gram staining, growth hormone production and phosphate solubilizing capabilities. The purified strains were then preserved on slants and stored for further testing/evaluation. Screening of four isolates of each, wheat and rice PGPR isolates was done by method adopted by Farah et al (2005) using tryptophan as precursor in the culture media. Development of pink color was an indication. The hormones produced were estimated by standard IAA graph. Identification of

hormones was done at HPLC by procedure of Tien et al (1979) using UV-detector and tech sphere 5-ODS C-18 column at Quaid-e-Azam University, Islamabad.

Twelve PGPR isolates of each wheat & rice have been acquired and added in the already existing microbial gene bank. Most of the wheat PGPR isolates were rod-shaped gram -ve bacteria with irregular colony size/shape. Forty percent of these isolates also had phosphate solubilizing ability. All of the rice PGPR were rod-shaped gram -ve bacteria. Out of 20 tested isolates 6 had phosphate solubilizing ability. All the isolated produced reasonable amount of IAA growth hormone that ranged 18 - 30 mg l^{-1} of solution. Analysis of other growth hormones (Kinetin & gibberlin) has been completed.

In a pot study three isolates were tested, alone and in mixture, with and without recommended mineral fertilizers, for their effects on rice growth and yield. Although all the isolates were successful in increasing rice yield over control, the isolates RPR-51 was the most effective. However, mixture of all three isolates was even more effective that increased rice yield over control by 66%.

In Rabi season again three wheat rhizospheres isolate were evaluated for their effects on wheat growth and yield; first in the pots and then in the field at two sites i.e. NARC and Fateh Jang. In the pot study there was significant increase in wheat growth by all three isolates. However, the crop could not be mature since it was growth in off season in the lab. under growth chamber. However, in the field there was clear increase in the growth as well as grain yield of wheat by all the three isolated. Again the mixture of all three isolates was more effective.

Name of Project: **Use of Nitrogen Fixing, Plant Growth Promoting Rhizobacteria (PGPR) for Development of Bio-Fertilizer for Crops on Economic Importance - Umbrella Project (NIBGE, Faisalabad Component-II)**

Name of PI/ Institute: **Dr. M. Sajjad Mirza,**
Principal Scientist,
National Institute for Biotechnology and Genetic Engineering (NIBGE), Faisalabad

Duration: 19. 03. 2005 to 18. 03. 2008

Financial Status:

Total Cost:	Rs.3.2538 million
Funds Released:	Rs.2438400/-
Funds Utilized:	Rs.2018396/-

Objectives:

- The main objective of the study will be the development of crop-specific biofertilizer for sugarcane and cotton based on nitrogen-fixing, plant growth promoting rhizobacteria (PGPR).
- Specific objectives are production of biofertilizers based on beneficial bacteria (nitrogen-fixing, phytohormones producing bacteria) for sugarcane and cotton.

Achievements:

Roots of cotton and sugarcane were collected from different cropping areas for isolation of plant growth promoting rhizobacteria (PGPR). Among the isolates from sugarcane two have been identified as *Azotobacter* on the basis of morphological characteristics as well as by PCR amplification of partial nifH gene which is responsible for nitrogen fixing enzyme (nitrogenase). Twelve isolates were identified as *Pseudomonas* strains on the basis of cell shape, motility and colony morphology while the remaining five isolates could not be identified. From cotton four new isolates of *Azospirillum brasilense* were obtained. Both the *Azotobacter* strains from sugarcane and four *Azospirillum* strains from cotton showed acetylene reduction activity in pure culture, confirming their identification as nitrogen fixer. All the isolates produced phytohormone indoleacetic acid (IAA) in the growth medium containing tryptophane as a precursor of IAA biosynthesis. For rapid screening of the isolates for plant-beneficial traits the isolates from sugarcane were tested on heterologous hosts (millet, soybean sorghum, and *Brassica*) as well as on sugarcane while nitrogen-fixing, phytohormone *Azospirillum lipoferum* strain CN1 isolated from cotton was used as inoculant for original host (Cotton) in a pot experiment. Performance of the isolates tested as inoculants in the present study as reflected by the beneficial effects on inoculated plants was comparable to that of standard PGPR strains used as positive control.

Nitrogen-fixing, Phytohormones producing bacteria showing plant-beneficial traits in short experiments have been identified. These selected strains will be tested as inoculates for field (microplot) grown plants.

One student has completed his M. Phil thesis under the project while one is currently doing his research work in the lab.

Name of Project: **Management Strategies for Metal Contaminated Soil Receiving City Waste Effluent for Sustainable Crop Production and Food Security**

Name of PI/ Institute: **Dr. Abdul Ghafoor, Professor,**
Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad.

Duration: 01. 7. 2005 to 30. 06. 2008

Financial Status: Total Cost: Rs.4.211 million
Funds Released: Rs.2198900/-
Funds Utilized: Rs.2144803/-

Objectives:

- Quantification of metal uptake and accumulation in different parts of cereal and fodder crops grown on contaminated soil.
- Identification of plant species from areas receiving sewage having hyper- accumulation capabilities for metals.
- Effectiveness of organic and inorganic amendments to retard the bio-availability of metals in contaminated soils.

Achievements:

The natural and planted vegetation and soil samples from the sewage irrigated areas around Faisalabad, Gujranwala, Kasur, Multan and Lahore were collected during winter season 2005-06 and 2006-07. Chemical analysis showed that Ni concentration was <5 ppm in plants namely Puthkanda (*Achyranthus aspara*), Madhana grass (*Dectyloctenum aegyptium*), Shahtoot (*Morus alba*), Neem (*Azadirachta indica*), Wheat (*Triticum aestivum*), Sweat lime (*Citrus aurantifolia*), Shishan (*Delbergia sisso*), Mango (*Mangifera indica*), Sunhemp (*Crotalaria juncea*), Bamboo (*Bambusa bambus*) and Khabal grass (*Cynodon dactylon*), while it was >10 ppm in Beri (*Zizyphus jujube*) and Sorghum (*Sorghum vulgaris*) shoots. In some plant species, Ni concentration was even 17100 ppm. Cadmium concentration ranged from 0.00 to 1.20 ppm. Overall there is big variation among plants for Ni and Cd concentration in above ground parts indicating biodiversity for absorption of metals.

Sewage samples collected from Faisalabad, Multan, Gujranwala, Lahore and Kasur were found unfit for irrigation owning to high EC, SAR, RSC and several metals. Soil samples collected from fields receiving untreated sewage showed that Zn and Cd concentrations were within safe limits. Gradual decrease in metal concentration was observed with an increase in soil depth. Nickel application beyond 30 mg L^{-1} significantly decreased the yields of wheat and barley. Wheat prove better Ni accumulator than barley grown under hydroponic conditions. Wheat proved better nickel accumulator than barley.

In both the field and pot studies inorganic amendments were effective in alleviating cadmium toxicity to wheat and rice by decreasing plant available cadmium in sandy clay loam and loamy sand soil. This ultimately decreased the cadmium concentration in plants but improved the yields

of both the crops. Monoamonium phosphate and gypsum remained more effective than the other additives (lime, Diamonium phosphate, Sulphur, H_2SO_4, CaO rock phosphate and potassium dihydrogen phosphate) for lower absorption of cadmium.

Nickel application not only increased the nickel concentration in maize but also disturbed the balance in concentration of other micronutrients (copper in maize). Application of organic amendments (press mud, farm yard manure and activated carbon) to nickel contaminated soil also help decrease the uptake of different metals (nickel, copper, manganese and zinc) by maize grown in nickel contaminated soil.

Four students completed their M. Sc thesis during 2006-07 after doing their research work under the project. One paper is being published and one is accepted to publish. An article in Urdu language has also been written.

Name of Project: **Impact of Tillage Systems, Legume and Mulches on Soil Profile Moisture Dynamics and Wheat Production**

Name of PI/ Institute: **Dr. Safdar Ali,**
Professor,
Department of Soil Science, University of Arid Agriculture, Rawalpindi

Duration: 01. 07. 2005 to 30. 06. 2008

Financial Status:

Total Cost:	Rs.2.000 million
Funds Released:	Rs.1027500/-
Funds Utilized:	Rs.834344/-

Objectives:

- To monitor the impact of different tillage systems, legumes and mulches on soil profile dynamics under three soil series of rainfed wheat production system.
- To investigate the effect of soil moisture and fertility status etc. on wheat production.
- Economic analysis of different factors under study for wheat production under rainfed conditions.

Achievements:

Field experiments were conducted in Pothwar at three locations viz. University of Arid Agriculture, Rawalpindi (UAAR), FatehJang and Chakwal areas. Summer treatments are conventional tillage, deep tillage and no-till as main plot treatments and fallowing, legume (mung bean) and mulching of wheat straw @ 4 Mg ha^{-1} in sub plots. During, winter, all the plots come under wheat. The results so far, indicated that volumetric water content (VWC) differed significantly among sampling stages. The trend varied with the site depending upon rainfall incidence and soil type. The differences for VWC among applied agronomic practice were non-significant at any chosen stage. Nitrate-N content was consistently higher under legume as compared to fallow and mulch, however it was not affected by tillage practices. Soil organic carbon differed non-significantly among the treatments. Biomass yield was significantly higher under deep tillage followed by non-till and then by conventional tillage. Among sub-plot treatments, legume gave significantly higher biomass followed mulch and then by fallow. Grain yield was also significantly higher under DT followed by NT and then by CT, however it did not vary among sub-plot treatments except at UAAR site where legume produced statistically highest grain yield. It could be concluded from the results that deep tillage at summer start and plantation of legume during summer season helps to improve soil nitrate content and winter wheat yield.

Soil samples have been taken regularly with the help of king tube from 0-30 and 60-90 cm depths from three experimental sites. Sap samples for determination of nitrogen fixation by xylem solute technique have been collected. Harvest of mung bean was carried during September 2006. After wards wheat was sown during November 2006 and harvested by the end of April 2007. The soil samples were collected at sowing and harvest of wheat. After harvest of wheat, installation of summer treatments for third experimental year has been completed at all the three sites. Simultaneously, analysis of soil and plant samples collected carried out.

Name of Project: **Studies on IPM with Reduced Chemical Beekeeping Approach to Avoid Related Treatment Resistance of Parasitic Mites, Honeybee Diseases and Pests**

Name of PI/ Institute: **Dr. Elizabeth Stephen Waghchoure,**
Senior Scientific Officer
Honey Bee Research Program, INRES, NARC, Islamabad

Duration: 07. 11. 2006 to 06. 11. 2009

Financial Status:

Total Cost:	Rs.3.517 million
Funds Released:	Rs.993000/-
Funds Utilized:	Rs.918045/-

Objectives:

- Identification of Parasitic mite distribution and behavior.
- To develop reduced Chemical Beekeeping (RCB) management system.
- Breeding of resistance honeybee colonies.
- Assess the combination of Integrated Pest Management (IPM) control methods.
- Train beekeepers / workers for the management of honeybee colonies with modern techniques to obtain maximum yield by exploiting the mite resistant vigor in the colonies.
- Using the results of the above to devise an Integrated Pest Management Strategy for brood mite control. This information could be produced as a leaflet for distribution for beekeepers.

Achievements:

To identify parasitic mite distribution and behavior, extensive survey conducted in the beekeepers apiaries in Chakwal and Dudial areas. Brood and bee samples were collected from five colonies from each apiary. Out of forty apiaries visited only eight were allowed to be sampled. These beekeepers were made aware of the non chemical method of monitoring mites in the colonies and their control.

In order to develop reduced chemical beekeeping (RCB) management system, queen caging method on five colonies was tested as a non toxic method of organic beekeeping to control parasite mite *Tropilaelaps clareae*. Also carried out comparative study of formic acid and thymol treatment where formic acid group gave better control and honey yield.

Selected three colonies for further breeding to be used for propagation of resistant or tolerant bees through quality queen breeding. Some 50 quality queen were bred successfully from the three breeder colonies and placed in colonies for comparative study on mite control and honey yielding.

Name of Project: **Assessment of Productivity Potential and Utilization of Rangelands and Sown Pastures in Pothowar Plateau**

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

Duration: 27. 09. 2004 to 30. 06. 2008

Financial Status:

Total Cost:	Rs.3.580 million
Funds Released:	Rs.2326500/-
Funds Utilized:	Rs.2211407/-

Objectives:

- To carry out various studies of grass/legume pertaining to different agronomic physiological and utilization aspects.
- To find out the present status of range vegetation through phytosociological surveys and quantitative observation on vegetation dynamics.
- To determine the forage production/utilization characteristics and performance of gazing lambs.

Achievements:

Data on different research studies being conducted was collected, analyzed, and processed. Depending upon the establishment response, biomass production, palatability value, and propagation technique, buffel (*Cenchrus ciliaris*) and *Setaria anceps* grass species are recommended for further range reseeding trials in the semi-arid conditions of Pabbi Hills, Kharian. Mot grass (*Pennisetum purpureum* var. Mott) produced 74.73 Mg ha^{-1} dry matter and out yielded other grasses in the deep fertile soil and irrigated conditions of University of Arid Agriculture, Rawalpindi, hence is strongly recommended for planting in the irrigated conditions to enhance fodder productivity in Pothwar area. Sixteen grass species from three project locations were collected and their proximate composition on dry matter percent basis was evaluated. Highest crude protein percentage was recorded in buffel grass (*Cenchrus ciliaris)* followed by green panic grass (*Panicum maximum* var. Tanzania). In vegetation dynamic study, a considerable improvement in grass species was observed over the short period of one year only suggesting that rangeland grazing potential could be improved substantially through protection from grazing and cutting. However, it is recommended to discourage growth of unpalatable, fast growing, and gregarious tree/shrub species like that of mesquite to facilitate growth of palatable grass and other herbaceous plant species.

Name of Project: **Micronutrients Management in Apple and Citrus Orchards in Swat Valley**

Name of PI/ Institute: **Dr. Zahir Shah,**
Professor
Department of Soil and Environmental Sciences, NWFP Agricultural University, Peshawar

Duration: 22. 08. 2006 to 30. 06. 2009

Financial Status:
Total Cost: Rs.3.829 million
Funds Released: Rs.2212500/-
Funds Utilized: Rs.2183633/-

Objectives:

- To determine the soil fertility status of apple, citrus, peaches and apricot orchards in Swat Valley and nutrients status of plants especially the micronutrients, and prepare their maps.
- To evaluate the effect of deficient micronutrients on the yield of apple and citrus fruits by field trials and formulate fertilizer recommendations on the basis of soils and plant tissue analysis and field trials.

Achievements:

Four surveys were conducted to assess the micronutrients (Zn, Cu, Fe, Mn, B) deficiency and soil fertility status of apple, citrus, peaches and apricot orchard in Swat valley of NWFP during July 2006 and June 2007. In each survey general observations on orchard were recorded. Soil and leaf samples collected and analyzed for micronutrients. Soil samples were also analyzed for fertility and other soil characteristics.

The results of 52 apple orchards surveyed suggested that apple orchards in Swat were found deficient in varying levels of micronutrients. Zinc was deficient in 39%, Cu in 4%, Mn in 58%, and B in 44% orchards. 50 citrus orchards surveyed, were also found deficient in micronutrients. Zinc was deficient in 100%, Cu in 56%, Mn in 96% and B in 24% orchards. No proper correlation was found between the soil and plant tests for diagnosing micronutrient deficiencies in apple and citrus orchards. Based on literature reports, plant test was considered more reliable than the soil test for diagnosing micronutrient deficiency in apple and citrus orchards. Organic matter contents were generally sufficient in the surface but deficient in the lower soil depth of both apple and citrus orchards. Available P and K were also deficient in most of the apple orchards. Low organic matter contents in the lower depths together with widespread deficiency of extractable P and K were likely responsible for unavailability of micronutrients to apple and citrus plants. The alkaline pH's in citrus orchards further aggravate micronutrients availability to plants.

Name of Project: **Increasing Crop Production Through Humic Acid in Rainfed and Salt Affected Soils in Kohat Division (NWFP)**

Name of PI/ Institute: **Professor Dr. Riaz A. Khattak,**
Dean,
Faculty of Crop Production Sciences, NWFP Agricultural University, Peshawar

Duration: 01. 10. 2004 to 31. 12. 2007

Financial Status:
Total Cost: Rs.4.179 million
Funds Released: Rs.3311900/-
Funds Utilized: Rs.3302445/-

Objectives:

- To study the effect of different levels of lignitic coal derived humic acid (HA) alone and in integration with different levels of chemical fertilizers on the growth and yield of wheat and maize crops in rainfed conditions, and cotton and sugar beet in saline irrigation system.
- To understand the mechanism of the beneficial effect of HA on soil condition and crop production, with respect to soil microbial and enzymatic activities.
- To develop the facility of extraction of humic acids from lignitic coals of various location of Pakistan for large-scale utilization in crop production.
- To formulate recommendations for the application of lignitic coal derived humic acid for low fertility and salt-effected arid zone soils.

Achievements:

Five field experiments were completed during summer (kharif 2005) on maize, cotton and groundnut at three locations of Nasimabad and Jalalabad in Lachi (Kohat) and Tarkha Kohi (Karak). The experiments aimed to quantify beneficial effects of humic acid (HA) on yield of crops and chemical composition of plants and soils and its appropriate levels under saline field conditions. In Rabi 2005-06, another five experiments executed on wheat and sugar beet on the same locations but on different fields. Attempt was made to design effective application method of HA and confirm previous results on the beneficial effects and appropriate levels of HA for optimum yields of sugar beet and wheat. Laboratory experiments were also conducted to investigate the mechanism(s) of the beneficial effect of HA.

Results of experiments conducted in field and laboratory are encouraging and may prove a promising option in terms of increasing crop production through HA in salt affected soils. The results obtained so far showed that alone application of HA increased wheat, maize, groundnut and seed cotton yields by 11.6 to 14.55, 5.1 to 21.0, 11.6 to 16.7 and 10.5 to 21.1%, respectively over control. Combining HA with NPK showed additive effect of increasing yield of these crops by more than 15% over NPK alone. Alone application of 1.0 kg HA ha^{-1} gave mean additional monitory return of Rs.5028, 2405, 2044 and 4720 ha^{-1} for wheat, cotton, maize and groundnut,

respectively as compared with control. When combined with NPK the same levels of HA gave additional return of Rs.5724, 3305, 2408, 3400 ha^{-1}, respectively as compared with NPK alone.

Methods of HA acid applications also revealed encouraging results. Application of HA through soil spray was found more efficient than banding or broadcast. HA applied through soil spray was superior by 11.77 and 9.83% over broadcast and banding, respectively when applied alone. Higher grain yield with soil spray might be associated with uniform mixing of HA with soil which promoted it respectively.

Series of laboratory experiments on the mechanism of beneficial effects of HA have been completed. The results suggested positive effects of HA on the activities of acid phosphatase, alkaline phosphatase and urease under laboratory conditions both in normal soil and as well as saline soils. The activities of alkaline phosphatase were higher than acid phosphatase. The activities of enzymes phosphatase decreased with time of incubation (2 weeks). The microbial activities measured as rate of CO_2 production increased with HA addition up to 1.0 kg ha^{-1} but decreased with highest dose of 2.0 kg ha^{-1}. The cation exchange capacity and moisture retention capacity of soil showed consistent improvement with higher doses of HA. Humic acid was extracted successfully from the coal collected from Hangu, Kohat.

Name of Project: **Determination of Growth, Wood Properties and Water Table Control Following Afforestation of Proven Provenances/Species Under Saline and Waterlogged Conditions in Pakistan**

Name of PI/ Institute: **Mr. Muhammad Khan**,
Forest Geneticist/SRO,
Pakistan Forest Institute, Peshawar

Duration 28. 12. 2004 to 27. 12. 2007

Financial Status:

Total Cost:	Rs.2.998 million
Funds Released:	Rs.1606450/-
Funds Utilized:	Rs.1051931/- (up to 31. 12. 2006)

Objectives:

- To establish species cum demonstration plots on farm lands over 5 acres area at two sites in two districts in NWFP under water logged and saline condition.
- To monitor water table and to recommend suitable salt tolerant species for the specific sites in NWFP.
- To develop agro forestry models for problematic area through community participation to overcome environmental issues.
- To determine wood properties of the species established on marginal lands for farmer's use.

Achievements:

The project envisages lay-out of two trials one each in 2005 and 2006 for testing various salt tolerant species on saline farmland. The study planned for 2005 was laid out at Tooro village in Mardan district. Twelve species were planted in replicated experiment. The initial year survival and height data indicate suitability of *Acacia ampliceps, A. nilotica, Casuarina glauca* and *Tamarix aphyla* for planting on saline farmlands. Soil samples data showed that the area is saline, saline sodic and sodic. 36 piezometers have been installed to monitor the level of the ground water table. The depth of ground water table ranges from 60 cm to 110 cm in the initial year of the experiment. The data on soil analysis and depth of ground water table was recorded on sixth month interval in order to establish their correlation with the tree species planted in the trial. The site for laying out the second field trial was selected at village Nazar of Swabi district. The trial for testing salt tolerant species was laid out planting various species viz. *Eugenia jambulana, Tamarix aphylla, Casuarina gluaca, Casuarina obesa, Eucalyptus camaldulensis, Albizzia procera, Acacia albida, Terminalia arjuna, Acacia nilotica, Acacia ampliceps, Salix viminalis,* and *Phoenix dectylefera* in March 2006.

The initial two years survival and height data indicated suitability of *Albizzia procera, Casuarina glauca, Casuarina obesa, Tamarix aphylla, Terminalia arjuna, Eugenia jambulana, Acacia ampliceps, Acacia albida, and Eucalyptus camaldulensis* for planting on saline farm land. Soil samples data showed that the experimental area is saline, sodic and saline sodic. The depth of ground water table ranged from 110 cm to 165 cm in June 2006 and 60 to 120 cm in December 2006 at Mardan site. The water table depth at Swabi site ranged from 240 cm to 262 cm in June and 238 cm to 262 cm in December, 2006. Both soil analysis and monitoring depth of ground water table is being done at six months interval in order to determine the effects of tree plantation on salinity and water logging in the area.

Name of Project: **Nutrient Indexing and Integrated Nutrient Management for Sustaining Sugarcane Yields**

Name of PI/ Institute: **Dr. Sagheer Ahmad,**
Scientific Officer,
Sugar Crops Research Program, Institute of Field & Horticultural Crops (IFHC), NARC, Islamabad

Duration: 25. 03. 2004 to 24. 03. 2008

Financial Status:

Total Cost:	Rs.5.800 million
Funds Released:	Rs.4550800/-
Funds Utilized:	Rs.4450001/-

Objectives:

- Soil fertility mapping by diagnosing the nature, extent and severity of nutritional disorders in sugarcane and sugarcane soils of the project area.
- Use / recycle press mud / filter cake, produced in quantities of 200,000 tonnes in the project area, as organic fertilizer for improving soil fertility, soil physical conditions, and sugarcane yields.
- Develop a package of technology for on-site integrated, balanced nutrient management, including micronutrients, for an expected yield increase of 20 to 35% and improve quality by 1 to 1.5%.
- Reduce environmental pollution by recycling press mud/ filter cake in agriculture.

Achievements:

Conducted field experiments in the districts of Sargodha and Jhang for determining nutritional needs of sugarcane during 2005-06. The experiments were conducted at 10 sites in Sargodha and Jhang districts measuring one acre at each site. At six sites, press mud along with chemical fertilizers including deficient micronutrients were tested. The treatments included farmer's practice (FP), recommended rate of NPK with and without zinc and boron (Zn & B), and half and/or quarter rate of NPK along with various doses of press mud (10, 20 & 30 t ha^{-1}) made by mixing industrial press mud and ash or press mud at 5, 10 & 15 t ha^{-1}.

In autumn-2005 planted experiments application of Zn + B along with recommended rate of N, P and K fertilizers increased can yield in all the experiment sites followed by 10 t compost ha^{-1} and recommended NPK fertilizers. Increase in yield was 19.1 and 16.8% respectively over that of farmer's practice (FP).

In spring 2006 press mud (PM) experiments, introduction of press mud in the treatments increased can yield invariably at all the sites. Increase in number of canes per hectare was also recorded with the application of press mud over that of farmer's practice. Cane length and brix were also increased over that of FP. Maximum average cane yield was recorded with recommended NPK + 10 t PM ha^{-1}

followed by half NPK + 10 t PM ha^{-1}. Increase in yield was 49.8 and 49.2% respectively over that of farmer's practice (FP) at two sites.

Nutrient status of cane plants and nutrient uptake is being monitored in all fertilizer treatments through plant tissue analysis.

Newly plated field experiments/Ratoon crop of previously conducted experiments are being managed in Sargodha and Jhang.

From the studies conducted so far, it is concluded that quality, quantity and method of application of press mud had varying effect on cane yield and quality under different soil and environmental conditions. Application of press mud as compost had little effect on sugarcane yield. Pure press mud application enhanced cane yield in different experiments with and without the use of Zn + B, and at half and full rate of recommended NP & K fertilizer over farmers' practice.

Micronutrients (Zn + B) application also had beneficial effect on cane crop. An increase in sugarcane yield of 15.7 to 38.5% over that of farmer's practice has been recorded with the application of Zn (7.5 kg ha^{-1}) + B (1.5 kg ha^{-1}) along with recommended rates of N, P and K fertilizers. Integrated use of press mud and micronutrients further aggravated this effect.

Name of Project: **Field Evaluation of Arbuscular Mycorrhizal Fungi and Their Significance in Wheat-Maize Cropping System Under Different Soil Series of NWFP**

Name of PI/ Institute: **Dr. M. Sarirullah Sarir,**
Professor,
Department of Soil and Environmental Sciences, NWFP Agricultural University, Peshawar

Duration: 20. 12. 2004 to 19. 12. 2007

Financial Status:
Total Cost: Rs.1.411 million
Funds Released: Rs.1035971/-
Funds Utilized: Rs.994193/-

Objectives:

- Selection of important soil series commonly use for wheat-maize cropping system in different agro-ecological zones of NWFP.
- Soil and roots sampling from different soil series of NWFP for spores isolation and their identification and estimation of the status of Vesicular Arbuscular Mycorrhizal (VAM) fungal infections.
- Determination of soil physicochemical characteristics of the survey sites.
- To conduct pot experiments for investigation of the scope of inoculating the non-mycorrhizal wheat and maize crops identifies during the field survey.

Achievements:

Soil and plant root samples collected from different important crop growing agro-ecological zones (series wise) of NWFP were analyzed for *Arbuscular mycorrhizal* (AM) fungal species and their root infection status. Physicochemical properties of these soils were also determined. Pot experiments were conducted in both salt-affected soil (Charsadda) and eroded soil (Mardan) on the effect of inoculation of AM fungi on the growth and nutrient accumulation of both wheat and maize crop in different treatments utilizing both organic and inorganic fertilizer applied alone and in different combinations. The crop was harvested and showed prominent effect of inoculation. Data was recorded and analyzed.

Three research papers have been published from project work in national agricultural journal, while two have been submitted for publication.

Seven students have completed their M. Sc. (Hons.) degree on the basis of their research work conducted under the project. In addition, three students completed their special problems, review paper and seminar for their B. Sc (Hons.) degree program.

Name of Project: **Increasing and Sustaining Crop Productivity of Water Eroded Lands through Rainwater and Soil Fertility Management**

Name of PI/ Institute: **Dr. M. Shafiq,**
Principal Scientific Officer,
Water Resources Research Program, INRES, NARC, Islamabad

Duration: 01. 07. 2004 to 30. 06. 2007

Financial Status:

Total Cost:	Rs.7.490 million
Funds Released:	Rs.4434000/-
Funds Utilized:	Rs.3266743/-

Objectives:

The overall objective is to develop and disseminate rainwater and nutrient management technologies for increasing and sustaining productivity in eroded lands. The specific objectives are:

- Participatory diagnosis of constraints and opportunities (PDCO) related to rainwater, soil, and nutrient management
- Identify factors of soil physico-chemical degradation due to water erosion.
- Determine water-nutrient interactions and nutrient imbalances under rainfed agriculture in eroded lands.
- Develop integrated nutrient and water management strategies for increasing and sustaining crop productivity.
- Promote proven and cost-effective available/developed technologies for water conservation and soil fertility restoration by means of innovative extension approaches.
- Assess the potential of soil carbon sequestration through restoration of eroded and nutrient depleted soils.

Achievements:

The rainfed areas commonly known as the *Barani* tract account about 25 percent of the total cropped area in Punjab. Pothwar plateau comprising of 1.82 million hectare is the largest contiguous block of rainfed areas of Punjab. Low and erratic rainfall, erosion hazard, inadequate soil depth and poor soil fertility etc. are the main limitation affecting the production potential of these areas. To achieve the overall and main objectives of the project, five studies given below were carried out:

i. Soil and Agricultural Development Potential of Pothwar
ii. Nutrient Status of Water Eroded Soils in Pothwar Plateau
iii. Diagnostic Analysis for Rainwater and Soil Fertility Management Practices in Fatehjang and Gujar Khan Tehsils of Pothwar Plateau
iv. Effect of Water Conservation and Fertilization on Maize and Wheat Crop Yields

v. Effect of Fertilization and Supplemental Irrigation (Nutrient-water interaction) on Yield of Wheat

The summarized results are given as under:

- The available information was compiled and field survey was carried out. Prepared a generalized geomorphic soil map of Pothwar, a generalized agricultural development potential map of Pothwar and a generalized soil erosion map of Pothwar. Selected two target areas i.e. Fatehjang and Gujar Khan for detailed experimentation. The selected experimental fields (eight at each target area) keeping in view the major soils, degree of soil erosion were characterized.

- The soils of both the target areas indicated widespread deficiency of major plant nutrient. Nearly 100% soil samples collected from Fatehjang and Gujar Khan, target areas were deficient in Nitrate-Nitrogen and Phosphorus. As regard Potassium only 15% top soils and 38% of sub-soils collected from Fatehjang were deficient. However, 35% of top soils and 53% of sub-soils in Gujar Khan were deficient.

- The extent and severity of the deficiency of some micro nutrient was alarming. For example, 95% top soils and 100% sub-soils of both target areas were deficient in Zinc and 85% and 90% in Boron. However, 17% of top soils and 24% sub-soils were deficient in Iron. None of the top soils and sub-soils was deficient in Copper and Manganese.

- Soil erosion and fertility degradation problems were very severe which were badly affecting crop productivities. Farming had become a part time job. The maintenance of land was poor and getting further poor due to increasing cost of fuel/energy. The use of fertilizer was sub-optimal and un-scientific. Rainwater conservation was not properly done. Nearly 70% of respondent had reported that loss of rainwater as surface flow had increased over the last 20 years. The increased surface runoff had enhanced soil erosion and fertility degradation.

- The wheat total bio-mass and grain yield was higher under Guliana and Missa soil series than respective Rajar soil series. The treatment affect was significant. It was observed that conservation coupled with improved fertilization produced significantly higher yield than simple water conservation control. The increase in grain yield due to fertilization and fertilization plus water conservation ranged from 20 to 54 percent.

- On the average Missa soil series gave 29% higher maize fresh biomass than Rajar soil series at Fatehjang. The maize grain yield was significantly different. The trend amongst treatment was: T4 - water conservation + fertilization > T2 – fertilization > T3 – water conservation > T1 – control.

- The water use efficiency for wheat and maize was increased due to improved fertilization. It was highest where water conservation coupled with improved fertilization. For maize it was 172 percent and 159 higher than control at Fatehjang and Gujar Khan. Whereas, for wheat the increase was 35 percent and 34 percent, respectively.

- The wheat straw and grain yield was affected by supplemental irrigation and fertilization especially during dry years. The increase in wheat grain yield due to fertilization was 34 percent. The wheat grain yield doubled than control where supplemental irrigation was coupled with fertilization. From the results it is evident that under nutrient deficient soil simple supplemental irrigation can not produce the potential yield. Fertilization also improved the water use efficiency.

Four research papers published in national journals from the project work. Three technical reports compiled/prepared on research and studies conducted during 2004 and 2005. Two papers presented and published in the proceedings of international symposium and congress held at Huazhong Agricultural University, Wahan, China during September 9-13, 2005 and NARC, Islamabad, Pakistan during March 28-31, 2006 respectively on the basis of research findings of the project.

Two students one each for Ph.D. and one for M. Sc worked for their degree program in the project.

Name of Project: **Improving Root-Association of Diazotrophs (*Azorhizobium* spp. *Azospirillum* spp.) in Rainfed Wheat**

Name of PI/ Institute: **Mrs. Shahida Nasreen Khokhar,**
Senior Scientific Officer,
Soil Biology & Biochemistry, Land Resources Research Program, INRES, NARC, Islamabad

Duration: 01. 07. 2004 to 30. 06. 2007

Financial Status:

Total Cost:	Rs. 2.233 million
Funds Released:	Rs.1953225/-
Funds Utilized:	Rs.1934000/-

Objectives:

- To select microbial genetic resource of efficient diazotrophs which can perform well with rainfed wheat.
- To improve rainfed wheat productivity through increased endo-symbiotic root colonization with diazotrophic microorganisms under dry as well as irrigated conditions.

Achievements:

During the project period 246 samples of wheat roots were collected from 82 farmers' field from Potowar, D. I. Khan and Quetta. Two hundred and fifty endophytic diazotrophic isolates (*Azospirillum*-like) were recovered on N-free medium from surface sterilized wheat roots. Seven *Azorhizobium* isolates, two from NARC and five from Kala Shah Kaku, were obtained from stem and root nodules of *Sesbania rostrata.* No *Azorhizobium* could be found in soils from Potowar and Quetta.

All isolates were characterized for their cultural and microscopic characters. Frequency of occurrence of *Azospirillum*-like from the three ecologies, was in the order of Potowar > D. I. Khan > Quetta.

One hundred and fifteen isolates (115) were subjected to green house evaluation in sterilized sand culture conditions, for their ability to fix nitrogen, with wheat (var. MH97), in terms of their total nitrogen content of shoot/seedling and their effect on plant growth in terms of shoot dry weight (mg) and root dry weight (mg)/seedling. Twelve (12) *Azospirillum*-like isolates (11 from D. I. Khan and one from Quetta) brought more than 75% increase while thirty nine (39) *Azospirillum*-like isolates (28 from D. I. Khan, 4 from Potowar, 7 from Quetta) and one *Azorhizobium* (from Kala Shah Kaku) brought more than 50% increase in shoot N-content (mg)/seedling.

Out of ten *Azospirillum*-like isolates and six *Azorhizobium* isolates tested for low temperature (15^0C) tolerance on N-free agar medium, two *Azospirilla* from D. I. Khan and three *Azorhizobia* from Kala Shah Kaku grew equally well at 15^0C and 30^0C. Selected ten isolates were characterized for their cell osmotic potential. *Azorhizobium* 3.2ksk and *Azospirillum* A4 had an osmotic potential above - 26.6 bars. These isolates were also characterized for their ability to

utilize malate, lactate and glucose as C-source.

Root Colonization Ability of nine selected isolates (five *Azospirillum* and four *Azorhizobium*), marked for their antibiotic resistance, studied in sterilized sand culture conditions. Three *Azospirillum* isolates (A2, A4, B3) and two *Azorhizobium* isolates (A-2 and 3.6ksk) were found capable of endophytic colonization on re-inoculation of wheat. Grain yield, dry root weight and total above ground biomass showed good correlation (0.83, 0.67, 0.63 respectively) with root endophytic colonization of the diazotroph. Highest increase over control (50%) in grain yield was recorded when inoculated with *Azorhizobium* (A-2), and it did not differ significantly from when inoculated with any of the test *Azospirillum.* However, highest amount of nitrogen in grain (22.6 mg/plant) was found when inoculated with A4. In a growth medium where only 10mg N was available per plant, this is a sure indicator of occurrence of nitrogen fixation by the inoculated diazotrophs.

Root Colonization Ability of nine selected isolates was also studied in potted field soil (having 1.2%N). All isolates colonized roots endophytically in the presence of other soil microorganisms. An increase of 25% in shoot nitrogen content at 8 week age was recorded, in the presence of N @60 kg ha^{-1} (half of recommended dose) in unsterilized potted soil. Inoculation induced head setting one week earlier than uninoculated fertilized control. All test microorganisms (in the presence of half dose) produced grain yield equal to that of fertilized control. Diazotrophs differed in their abilities to accumulate nitrogen in different parts of the wheat plant at maturity.

In the field, all the test microorganisms in presence of half dose of nitrogen, performed better or equal to fertilized control (receiving nitrogen @ 120 kg h^{-1}). An increase in grain yield ranging from 11% to 45% and from 14% to 38% under soil moisture levels (at sowing) of 14% respectively was recorded due to different diazotrophs, when compared to un-inoculated control.

Inoculation affected root dry biomass, number of tillers, thousand grain weight yield, %N of grain and total N of grains significantly. Highest grain yield (10% higher than fertilized control) was obtained when *Azospirillum* B3 or *Azorhizobium* 3.4ksk was used as inoculants. Highest amount of nitrogen (53kg h^{-1}) accumulated in grain was when *Azorhizobium* 3.4ksk was inoculated, which equaled fertilized control while *Azospirillum* B3 followed it.

The research studies concludes that Diazotrophs (including *Azospirillum*) occur as natural endophyte in wheat roots in Pakistan while *Azorhizobium* in stem and root nodules of *Sesbania rostrat*a. Though *Azorhizobium* could not be found from any of the rainfed areas surveyed, the isolates evaluated proved to associate with roots of wheat GA2002 in rhizoplane as well as endophytically and increased grain yield from 11% to 45%. Though the relationship between endophytic colonization and growth parameters seem to be altered under field conditions, yet they brought increase in yield comparable to fertilized control. The existence of some good nitrogen fixing strains in the natural gene pool, which are low temperature insensitive, have high osmotic potential and can colonize rhizoplane of wheat or roots endophytically can bear the promise of good inoculants for wheat crop in Pakistan under dry land as well as irrigated conditions.

Two papers evolved from project work were presented at International Conference and Symposium held at Lahore on July 29, 2006 and Faisalabad on March 28, 2007 respectively.

Name of Project: **Modeling Leaching Losses of Fertilizer Nutrients from Root Zone and Environmental Implications**

Name of PI/ Institute: **Dr. M. Mahmood-ul-Hassan,**
Senior Scientific Officer,
Land Resources Research Program, INRES, NARC, Islamabad

Duration: 01. 07. 2004 to 30. 06. 2007

Financial Status:
Total Cost: Rs.2.4095 million
Funds Released: Rs.1878250/-
Funds Utilized: Rs.1738438/-

Objectives:

- Study possible occurrence and quantum of nitrogen and phosphorus leaching in soils under high input cropping systems.
- Develop relationships between preferential nutrient transport and soil type.
- Validate models' simulated results.

Achievements:

Boron (B) and zinc leaching experiments were completed using intact columns of Sultanpur and Lyallpur soil series. Boron and Zn sorption capacity of Sultanpur and Lyallpur soils was determined by constructing multi-point isotherms and equilibrating the soils with B and Zn solution of different concentrations. Independent break through curve (BTC) for each soil and solute was constructed by plotting average percolate concentration against cumulative percolates. Solute flow parameters, for example mean pore solute velocity, dispersion and regression etc. were calculated from the breakthrough curves (BTCs). The flow parameters were calculated using convection-dispersion equation (CDE) executed using CXTFIT and the preferential models. The flow paths were marked by applying blue dye to explain the breakthrough curves.

Maize was sown on two selected soils on permanent experimental layout. Sequential soil samplings of experimental plots were done during growth season of maize. Maize field experiments were harvested, agronomic yield data was recorded and soil and plant samples were collected.

Potato was sown (after harvesting of maize) at same sites on permanent experimental lay out. Sequential soil samplings of experimental plots were done during growth season of potato. Soil samples, collected during maize and potato growth season, dried, ground, stored and analyzed for nitrate-nitrogen and phosphate.

Blue dye application indicated the existence of finger flow in Shahdara and Sultanpur soil. In the Lyallpur soils, the blue dye moved through macropores and indicated macropores preferential flow. The Lyallpur soil due to its greater clay content sorbed greater B and Zn compared to the Sultanpur but macropores flow it had early breakthrough of B. The B-adsorption partition

coefficient was in the range of 1.17 (in case of Lyallpur) to 1.1 (in case of Sultanpur). Both the Lyallpur and Shahdara soils had similar Zn sorption trend in low concentration (≤ 0.1 $\mu g\ mL^{-1}$), while at greater concentrations, the Lyallpur sorbed relatively greater Zn than the Sultanpur. The Lyallpur had greater maximum Zn sorption capacity and the binding strength than the Sultanpur. The Zn-adsorption partition coefficient was 21 in case of Layllpur and 18 in case of Sultanpur. Therefore, the Lyallpur soil had slightly greater Zn adsorption capacity than the Sultanpur and appeared it may be related to clay content.

Boron breakthrough in Sultanpur soil columns occurred after 10 cm of cumulative drainage and relative concentration (C/Co) peaked to 0.9 after 32 cm of cumulative drainage. In both the soils B breakthrough occurred earlier than one pore volume. In the Lyallpur columns the breakthrough was immediate due to high preferential flow. The two-domain CDE fitted well to the boron and nitrogen breakthrough data for Shahdara and Sultanpur soils were r^2 was 96 to 99 and relative lower r^2 was observed for Lyallpur and Pacca ranging from 66 to 84.

Average macro-pore velocity (Vm) was higher (3.53 – 4.03 cm per cm of drainage) in relatively better structured soils, i.e., Layallpur and Pacca, as compared to relatively les structured, i.e. Sultanpur and Shahdara where Vm was 1.18 – 2.28 cm per cm of drainage. Water partitioning coefficient ($\theta m/\theta$) in Lyallpur and Pacca was higher (0.60 to 0.97) compared to 0.13 to 0.34 for Lyallpur.

Recommended dose for hybrid maize significantly increased maize grain yield over farmer practice in both Shahdara and Lyallpur soils. Although, boron application, in addition to recommend dose, increased (4%) yield, the increase was non-significant. However, in Lyallpur soil, boron application significantly increased maize grain yield.

Potato tuber yield increase was 18 and 21% with recommended fertilizer doses in Shahdara and Lyallpur soils over farmer fertilizer use practice, respectively. Potato tuber yield increase with boron application was about 5% higher in both soils than recommended fertilizer doses but the increased was non-significant.

Maize and potato response to fertilizers application was relatively higher in Lyallpur soil than Shahdara soil. Increase in soil nitrate and phosphorus concentration was observed at lower depth (up to 80 cm) after 5^{th} crop under field conditions.

A research paper has been published in national journal from research and studies conducted under the project while one has been accepted for publishing. A paper presented in 11^{th} Congress of Soil Science at NARC from 28-31 March 2006 has been printed in the abstracts. A paper was presented in National Seminar on Soil Care for Sustainable Environment held at Faisalabad during May, 2006. Prepared two annual progress reports of the project work. Four students completed internship under the project.

Name of Project: **Testing and Evaluation of Low-cost Lining Materials for Watercourse in Drought Endangered Areas of Balochistan**

Name of PI/ Institute: **Mr. Nadeem Sadiq,**
Scientific Officer,
Arid Zone Research Center, PARC, Quetta

Duration: 01. 09. 2004 to 31. 08. 2007

Financial Status:

Total Cost:	Rs.2.776million
Funds Released:	Rs.1510200/-
Funds Utilized:	Rs.1359000/-

Objectives:

- Devise mechanism to minimize the water course losses.
- To analyze financial and economic feasibility of various lining materials.

Achievements:

Topographic survey of Quetta, Pishin and Mastung sites was carried out showing slop gradient, farm size and topography for experiments. Three treatments; PE sheet, Bitumen and control (farmers practice) were included in the study to carry out water management research in these areas.

In Mastung site, the discharge loss (cusec) per meter recorded in PE sheet treatment was less than the two treatments which was 0.001 as compared to Bitumen and control treatments of 0.002 and 0.005 respectively. The discharge loss (ft^3/day) per 100 m recorded in the three treatment comes to be 8640, 17280 and 43200 respectively. In Pishin the discharge loss (cusec) per meter recorded in PE sheet treatment was 0.0005 cusecs as compared to Bitumen and control treatments of 0.001 and 0.003 cusecs respectively. The discharge loss (ft^3/day) per 100 m recorded in the three treatments comes to be 4320, 8640 and 25920 respectively. It was observed that in PE sheet treatment, only one point was found ruptured where as in Bitumen treatment, grasses emerged form 3-5 point in Pishin site. The cost of PE treatment (182 meter) and Bitumen treatment (110 meter) in Pishin was Rs.8500/- and Rs.10500/- respectively where as in Mastung, the cost of PE treatment (190 meter) and Bitumen treatment (90 meter) was Rs.9500/- and Rs.11900/- respectively. The cost of PE treatment and Bitumen treatment per meter comes to be Rs.46.7 and Rs.95/- respectively for Pishin site where as the cost of PE treatment and Bitumen treatment per meter was Rs.50/- and Rs.97/- respectively for Mastung site.

Name of Project: **Refinement of Skimming Well Design and Operational Strategies for Sustainable Groundwater Development**

Name of PI/ Institute: **Dr. Muhammad Ashraf,**
Director,
Pakistan Council of Research in Water Resources, M/o Science & Technology, Govt. of Pakistan, Khayaban-e-Johar, H-8/1, Islamabad

Duration: 05. 05. 2004 to 15. 10. 2007

Financial Status:
Total Cost: Rs.2.100 million
Funds Released: Rs.1509600/-
Funds Utilized: Rs.1509000/-

Objectives:

The overall objective of the project is to refine the skimming well design and develop operational strategies based on thickness of freshwater layer. The specific objectives are to:

- Determine depth to interface of the fresh and brackish groundwater in the target area.
- Conduct surveys and characterize design of skimming wells installed by farmers and their operational strategies.
- Fine-tuning of the design and development of operational strategies for sustainable groundwater management using skimming wells.

Achievements:

A three years study (2005-07) was conducted in Chaj Doab (the area between the rivers Chenab and Jhelum to: (i) determine the depth of fresh-saline water interface (ii) conduct surveys and characterize design of skimming wells installed by farmers and their operational strategies and (iii) fine-tuning of the design and development of operational strategies for sustainable ground water management using skimming wells. Collected information regarding skimming wells, such as numbers of strainers, size of strainers, depth of strainers, inter-strainer spacing, discharge of skimming wells and quality of pumped water etc. Electrical conductivity (EC) of ground water was determined by measuring resistivity with Terrameter SAS 4000 on an approximate grid interval of 10 km x 10 km. Ten multilevel observation wells were installed in the area to measure the spatial and temporal hydro-salinity at different depths. Out of these sites, 3 sites were selected to conduct pumping tests where farmers have installed skimming wells. These tests were conducted to determine the suitability of designs, radial influence of drawdown, variation in the ground water and pumped water quality for different pumping duration of 4, 6, 8 and 12 hours. Impact of local groundwater recharge on the hydro-salinity was also studies.

There was a drastic increase in the number of skimming wells installed in the area during the drought period i.e. from 2000 to 2002 and there is high concentration of skimming wells along the northern branch of Lower Jhelum Canal. A large number of skimming wells (36%) are pumping water with an EC greater than 2.0 dS/m, reflecting some problems either in the design of the wells or with operational strategies.

There are no set design criteria for the installation of skimming wells. The design of skimming wells absolutely depends on the advice of the drillers and the wishes of the farmers. The numbers of strainers varies from 2-20 and the size of the strainers from 5-20 cm. The distance of the strainers from the pump is also arbitrary. Six strainers of 7.5 cm diameter are commonly used by the farmers. Total depth of the well most commonly adopted is 18 m from the soil surface.

The maximum radial drawdown effect, during pumping test, extended up to 145, 187 and 150 m at Site 1, Site 2 and Site 3 respectively. It continues to extend further if the pumping is continued. The maximum drawdown at Site 1, Site 2 and Site 3 were 4.68, 3.98 and 2.86 m respectively which increase with an increase in the pumping time, indicating that steady state conditions could not be achieved even after 12 hrs of pumping. The maximum drawdown took place with a radius of 5-10 m only, which reduced down to 30-50 cm at the edges of the cone of depression. Therefore, two skimming wells of 28 lps discharge each, should not be installed within a radial distance of 350 m (3.5 ha).

Six strainers of 7.5 cm size or 8 strainers of 5 cm diameter may be installed up to 20 m depth with 10 m well screen to pump about 28 lps water. The distance of strainers from the well should be 3 m and a pumping time of 4 to 12 hrs/day may be adopted for skimming wells without having an adverse effect on pumped water quality.

The prevailing water table in the area ranges from 2-10 m. The water table is shallow near the upper reaches of river and lower Jhelum canal and is as deep as 10 m towards the lower parts of the doab due to less recharge available. The ground water quality shows high spatial and temporal variability and ranges from 0.6-4.0 dS/m. At shallow depth (2 to 10 m), groundwater quality is relatively good (0.4-1.0 dS/m) near the river banks. Freshwater pocket exist at some scattered places particularly near recharge source. At deeper depth (10 to 30 m), the salinity is very high (2.4-4.0 dS/m) particularly at the centre of the doab. However, in the areas near river, the water quality is relatively good (<2.4 dS/m). At 40 m depth or beyond, the water quality the worst (>4.0 dS/m) in area with a few freshwater pockets along lower reaches of the river Jhelum and upper reach of river Chenab. Fresh-saline water interface in the target area is 30 m from the soil surface in the centre of the doabs and along banks of the Jhelum River and 40 m near the banks of River Chenab.

The spatial and temporal variability of ground water is very high. Therefore, site specific information regarding ground water quality is necessary for proper installation and operation of wells. Moreover, regular monitoring of hydro-salinity is also important for sustainable management of groundwater resources. The groundwater quality can be improved when recharged locally with rainwater.

Name of Project: **Use of Low Quality Groundwater for Sustainable Crop Production**

Name of PI/ Institute: **Dr. Ashfaq Ahmad Sheikh,**
Deputy Director,
Pakistan Council of Research in Water Resources, M/o Science & Technology, Khayaban-e-Johar, H-8/1, Islamabad

Duration: 05. 05. 2004 to 15. 10. 2007

Financial Status: Total Cost: Rs.1.700 million
Funds Released: Rs.1449800/-
Funds Utilized: Rs.1284545/-

Objectives:

The overall objective of the project is to develop and test strategies for conjunctive use of surface and low quality groundwater using cyclic and mixing modes at the farm level. The specific objectives are:

- Estimate quality and status of groundwater use in the selected target area.
- Design and test strategies for cyclic and mixing modes for saline and sodic ground waters respectively.
- Estimate the potential cropped area and cropping intensity under both strategies and water availability at the farm level.

Achievements:

The main theme of the study was to design and test strategies for conjunctive use of low quality groundwater and estimate the potential cropped area and cropping intensity under evolved strategies and water availability at the farm level. A detailed survey of the study area (Sargodha District, Chaj Doab) was carried out to assess the status of ground water quality and utilization using participatory appraisal survey. Groundwater and soil samples from surveyed tube well were also collected for detail quality analysis.

The findings of baseline survey showed that the canal supplies are limited in the area with average supply of 4-6 hours/week and the farmers are forced to use marginal to unfit groundwater to meet irrigation requirements regardless of the hazardous effects on crop and soil health which were observed in the fields. Mainly due to this, installation of deep tube wells is at increase in the area regardless of the quality of groundwater and maximum installations were made during the drought period from 1998-2000. The depth of groundwater generally varies from 20 to 30 ft whereas the tube wells are largely drilled up to depth of 75 to 125 with average of 100 ft and are generally driven by diesel engine. The quality of groundwater varies from usable to unfit for irrigation. The quality of about 32% surveyed tube well was found fit, 34% of marginal quality and 34% unfit for irrigation. The locations near river and canal have fresh ground water and quality deteriorates from marginal to highly saline/sodic as move away from the river and canal.

The testing of developed strategies for use of low quality ground water at four selected farmers' fields (i. one site with saline groundwater, ii. one with sodic, and iii) two sites with saline-sodic ground water) showed working of developed strategies at the farmers' field. In almost all the cases, the developed strategies provided yield higher than the farmer plot. The reduction/stability in soil properties (ECe, SAR, infiltration rate) has been observed in most of the treatments tested.
It has been evaluated that saline ground water, leaching of salt at the end of cropping season is reasonable strategy. Similarly for sodic water, maximum ratio of 25:75 (canal:ground water) is more appropriate. For saline-sodic ground water, a hybrid combination of mixing-cum-cyclic or cyclic-cum-mixing mode proved reasonable.

On an average, the farmers may increase the use of low quality ground water about 25-30% relative to existing ground water use. Therefore, about 25-30% more cropped area may be brought under irrigation using the above suitable strategies.

A case study "Status of Groundnut Utilization in Indus Basin" presented and published in the Proceeding of International Conference on Agricultural Engineering: Issues and strategies held at Faisalabad during February 16-18, 2006.

Name of Project: **Sustainable Rice-Wheat Farming System on Salt-Affected Soils using Brackish Water and Amendments**

Name of PI/ Institute: **Dr. Ghulam Murtaza,**
Assistant Professor,
Institute of Soil & Environmental Sciences, University of Agriculture, Faisalabad

Duration: 01. 07. 2004 to 30. 06. 2007

Financial Status:
Total Cost: Rs.2.923 million
Funds Released: Rs.2113300/-
Funds Utilized: Rs.2131076/-

Objectives:

- Screening of existing salt tolerant rice and wheat varieties (3-4 each) against ambient soil salinity and sodicity levels.
- Growth response of saline-sodic soils to the rice and wheat varieties (proved tolerant from lab. study) in rice-wheat cropping zone to amelioration strategies.
- Farmer's education to utilize salt-problem soils and brackish irrigation waters.
- Economic viability of the strategies under investigations.

Achievements:

Evaluated some salt tolerant cultivars of rice and wheat for growth and yield at different salinity and sodicity levels i.e. different ratios of EC and SAR in a sandy clay loam soil. Among the cultivars tested, rice SSRI-8 produced the highest productive tillers and paddy yield while cultivars SIS-32 produced the highest tillers, grain and straw yields. Irrespective of the varieties, the highest level of EC to SAR (T_5 and T_6) caused significant reduction in paddy yield while at the lowest levels of EC and SAR (T_1 and T_2) paddy yield was not affected compared to that with the control. But in case of wheat crop, all the levels, i.e. the lowest (T_1 and T_2), medium (T_3 and T_4) and the highest (T_5 and T_6) of EC and SAR, affected the wheat yield adversely with significant difference among treatment. For both the crops, there were non-significant differences in yield at the two ratios tested (i.e 0.50 and 0.25) at all the levels of EC and SAR.

Salt tolerant cultivars of rice (SSRI-8) and wheat (SIS-32) crops selected from first year experiments were cultivated in farmers saline-sodic fields near Dijkot, Faisalabad (site 1) and Gojra, Toba Tek Singh (site 2) with the treatments: Brackish water alone (T1); Canal water alone (T2); Gypsum @ 100% soil gypsum requirement (SGR) + brackish water (T3); Gypsum @ 100% (SGR) + one irrigation with brackish and one with canal water (T4); Gypsum @ 100% (SGR) + two irrigation with brackish and one with canal water (T5); FYM @ 25 Mg ha^{-1} + one irrigation with brackish and one with canal water (T6); FYM @ 25 Mg ha^{-1} + two irrigation with brackish and one with canal water (T7).

After harvest of wheat 2006-07, bulk density decreased significantly with the applied treatments at

both sites. Maximum percent decrease in bulk density at 10-15 cm soil depth was recorded where one irrigation with BW + one with CW + gypsum @ 100% SGR was applied at both sites. While at 20-25 cm soil depth, maximum percent decrease in bulk density was with canal water at site 1 and at site 2 where two irrigations with BW and one with CW + FYM @ 25 Mg ha^{-1} was applied. After the harvest of final wheat crop in May 2007, farm manure caused the highest reduction in pH_s and EC_e of soil at 0-15 cm soil depth while at 15-30 cm soil depth one irrigation with CW and one with BW along with gypsum @ 100% SGR remained better.

At site 1, significant decrease in SAR occurred at both sites which was natural since a decrease in SAR or ESP needs external source of Ca^{2+} which was made available through gypsum and farm yard manure application. Decrease in SAR was more in gypsum/organic matter treated plots at 0-15 cm soil layer than that at 15-30 cm depth. Soil improvement with respect to SAR was higher at site 1 than at site 2 mostly due to the fact that the initial SAR was higher with the lowest infiltration rate at site 1 than at site 2. At site 1, maximum productive tillers and straw and paddy yields of rice were observed with gypsum @ 100% SGR + one irrigation with BW and one with CW followed by FYM @ 25 Mg ha^{-1} + one irrigation with BW and with CW. Regarding the wheat, same sequence of treatment was found.

At site 2, the first crop of rice (2005) failed. Regarding rice (2006), maximum productive tillers and straw and paddy yields were observed with FYM @ 25 Mg ha^{-1} + one irrigation with BW and one with CW. Gypsum + cyclic irrigation of BW and CW produced the highest straw and grain yields of wheat 2006-07.

Economic of treatments was calculated on the basis of four crops (Rice 2005, 2006 and Wheat 2005-06, 2006-07) for both sites. At site 1, total expenditure (Rs.84595 ha^{-1}), gross income (Rs.141897 ha^{-1}) as well as net benefit (Rs.57302 ha^{-1}) was the highest with FYM @ 25 Mg ha^{-1} + one irrigation with BW and one with CW. At site 2, total expenditure (Rs.69861 ha^{-1}) was the highest where farm manure + one irrigation with BW and one with CW was applied. Maximum gross (Rs.101173 ha^{-1}) and net benefit (Rs.35871 ha^{-1}) were obtained with gypsum + one irrigation with BW and one with CW.

The research results concluded that among the rice cultivars tested SSRI 8 gave maximum paddy yield, maximum productive tillers and minimum non-productive tillers. The increase in EC: SAR ratios proved more hazardous for rice even at lower EC and SAR values. Wheat cultivars, SIS-32 gave maximum plant height, productive tillers, straw and grain yields at different EC:SAR ratios. Data could be important for soils where sodicity over rides salinity and irrigation water are brackish.

From fields studies it is concluded that saline sodic ground water could successfully reclaims saline-sodic soils provided agricultural grade gypsum passed through 30 mesh sieve is applied @ 100% SGR. Addition of farm manure or gypsum proved pre-requisite and economical for calcarious saline-sodic soils and brackish water under the agro-climatic conditions of Pakistan for sustainable utilization of low quality soil and water resources. Rice proved better crop for soil reclamation while wheat yielded better and thus contributed more for net benefit than rice. Saline sodic water could be used without adverse effects on soil quality or crop yields if it is used in cyclic fashion, i.e. alternate use of canal and brackish water plus appropriate soil amendments.

Six M. Sc (Hons.) students have completed their research work for thesis writing during report period. A paper has been published in national journal from project research work.

Name of Project: **Evaluation and Formulation of Calcium Carbide Based Soil Amendment for Improving Crop Production**

Name of PI/ Institute: **Dr. Muhammad Arshad, (T. I),**
Professor,
Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad

Duration: 17. 05. 2004 to 16. 05. 2007

Financial Status: Total Cost: Rs.2.993million
Funds Released: Rs.2031900/-
Funds Utilized: Rs.1781682/- (up to 31. 12. 2006)

Objectives:

- Evaluation of concentration dependent release of C_2H_2 and subsequently C_2H_4 from added CaC_2.
- Formulation of cost effective CaC_2 - based formulation for improving growth and yield of cereals.
- Effectiveness of CaC_2 formulation under different soil conditions for C_2H_2/C_2H_4 production.
- Development of technology transfer package for the farmers for general use.

Achievements:

Field experiment was conducted to evaluate the effect of different application rates of calcium carbide (CaC_2) on growth and yield of wheat. Recommended dose of N, P and K fertilizer were applied @ 120-90-60 kg ha^{-1} as urea, single super phosphate (SSP) and sulphate of potash (SOP) respectively. P & K fertilizers were applied in all treatments. Wax-coated CaC_2 was applied @ 10, 20 and 30 kg ha^{-1} in the presence and absence of recommended dose of nitrogen. Application of CaC_2 along with NPK fertilizers significantly increa sed growth and grain yield of wheat compared to recommended dose of NPK fertilizer alone.

Effectiveness of encapsulated CaC_2 was compared with wax-coated CaC_2 for improving growth and yield of wheat by conducting a field experiment. Phosphorus and potash fertilizers were applied @ 90 and 60 kg ha^{-1} as SSP and SOP in all treatments. Urea (N) was applied @120 kg ha^{-1}. Encapsulated and wax-coated CaC_2 were applied @ 30 kg ha^{-1} with and without nitrogen fertilizer. Comparison between encapsulated and wax coated CaC_2 showed that coated application of CaC_2 was better than encapsulated CaC_2.

Experiments were carried out to evaluate the effect of wax coated CaC_2 on wheat growth at different plant spaces. In one experiment, plant to plant distance of 10 cm and row to row distance of 15 cm was maintained while in other plant to plant distance of 20 cm and row to row distance 25 cm was maintained. Coated CaC_2 was applied @ 30 kg ha^{-1}. Recommended dose of NPK were included for comparison. Seeds of wheat (cv. Inqlab 91) were sown in drenches (three seeds per drench). The data regarding growth and yield of wheat revealed that the effects of coated CaC_2 were more

promising at wider spacing.

Three experiments to evaluate the effect of different application rates and coatings of CaC_2 on growth and yield of rice (cv. Super basmati) at farmer's field was conducted. CaC_2 was coated either with paint, wax or lakh and applied @ 30 kg ha^{-1}. Encapsulated CaC_2 was also used for comparison. In another experiment, wax and lakh coated CaC_2 were also applied @ 15, 30, 45 and 60 kg ha^{-1}. CaC_2 was tested both in the presence and absence of N fertilizer. The P and K fertilizers were applied in the treatments. CaC_2 was applied after two weeks of transplanting of rice seedlings. The growth and yield parameters were recorded at maturity.

The observation and data recorded from research studies revealed that wax coated CaC_2 @ 30 kg ha^{-1} significantly increased growth and yield of wheat compared with recommended dose of NPK fertilizer alone. Wax- coated CaC_2 is easy to apply in the field and its application @ 30 kg ha^{-1} is quite economical and feasible for the farmers.

Name of Project: **Management Aspect of Surface and Groundwater Resources of Irrigated Areas**

Name of PI/ Institute: **Dr. Rai Niaz Ahmad,**
Director,
Water Management Research Centre, University of Agriculture, Faisalabad

Duration: 29. 05. 2004 to 28. 05. 2007

Financial Status:
Total Cost: Rs.2.534 million
Funds Released: Rs.1915500/-
Funds Utilized: Rs.1892000/-

Objectives:

- To determine the variability in the available surface water supplies, demands, and potential of safe use of groundwater resources in Bari Doab.
- To apply the MODFLOW computer model in Bari Doab for developing practical guidelines and water quality maps for the safe development and use of groundwater to avoid secondary salinization.

Achievements:

The study was conducted at micro and macro level. The micro level study was to address safe use of groundwater on the basis of surface water supply and demand in selected experimental area and macro level study was to address application of "MODFLOW" in Bari Doab. At micro level study, experimental sites were selected in Bari Doab across the Lower Bari Doab Canal (LBDC), near Renala Khurd, District Okara, with sites in command areas of Bairwali minor and 1-R distributary's, off taking from LBDC and irrigating the area of a number of villages. Eighteen piezometers were installed; ten across the LBDC leading towards the fields and eight across the 1-R distributary.

Surface water supplies data were obtained from the Irrigation and Power Department. Data of cropping pattern at the experimental sites were collected on village basis for the Rabi 2004-05, Kharif 2005 and Kharif 2006. The data of crop and cropped area were used to determine demand of surface water supplies.

Results obtained so far revealed that surface water supplies in the area were irregular and below than the designed water supplies and more than that even supplies on designed discharge basis of irrigation network are unable to meet the crop water requirements of the existing cropping pattern in both of the study areas. Surface water shortage was observed in both the Rabi and Kharif cropping season, which was about 63% in the study area. Within cropping seasons (Kharif), maximum water shortage of 72.5% was observed during the month of July, followed by August (70%). The average maximum shortage in surface water supplies for the experimental area during Rabi season was about 51% whereas, surface water shortage within the Rabi seasons, on monthly basis, was maximum in the months of January due to closure, followed by March (59%) and

April (57%). The shortage in irrigation water supplies at one experimental site was different than the water shortage on the other experimental site because of different cropping intensity (131.34%) and high delta crops in the study area. To meet the water shortage in the area, there is increasing trend of using the ground water without knowing the consequence of using low quality water. The groundwater quantity analysis showed that the area is under the risk of secondary salinity, which will increase with the increase of ground water use. Thus it is imperative to reduce the use of ground water, which is possible by improving the surface water use efficiency and changing cropping pattern in the study area.

The second part of study was to develop, apply, calibrate and test model for different future scenarios for Bari Doab. The US geological survey model MODFLOW coupled with the MT3D solute transport simulator under a PMWIN environment was used as the modeling framework. The spatial domain represented in the model consists of four layers (0-7 m, 7-30 m, 30-90 m and 90 to bed rock) and 2500m x 2500 m cell size. A 6 monthly stress period was used to represent the Kharif (summer) and Rabi (winter) periods. The main purpose of developing hydrological model was to determine "Water Balance" in Bari Doab. MT3D solute translator was used to simulate the water quality scenarios. It is important to mention that extensive data regarding water supplies, channel hydraulic parameters and aquifer characteristic, rainfall and water table fluctuations are pre-requisites to develop and apply the model. The data were collected at the level of Irrigation Administrative Divisions (11 numbers). The work consolidated a large amount of database in various formats to a single database to develop a model for the Doab. The required work proposed under the project to develop model for the Bari Doab has been successfully completed. The calibrated flow and quality model is capable to simulate future scenarios at each Division and whole Bari Doab level. The developed model and the available data can be readily used to carry out range of future environmental studies for area of Bari Doab.

The results suggested that there is need to manage surface and ground water to promote environmental sustainability in Bari Doab. There is high risk of ground water salinization due to over pumpage in area of good quality water and zero pumpage in area of saline water. As the areas of good quality and bad quality water are located closely under open boundaries, there would be a chance of saline water intrusion in sweet water zones. The utmost requirement is to make the beneficiaries aware of risk attached with the use of low ground water qualities. The micro level studies concluded that there is increasing trend of ground water use in Bari Doab to meet crop water requirements of increasing cropping intensity. The water balance studies indicated a decline in ground water level at the rate of 2 to 3 meter every year depending upon the ground water pumpage. There is dire need at the government level to devise ground water legislation for limiting ground water share in agriculture use which may otherwise put this precious resource under a big threat. Farmers need to change flood irrigation/conventional methods with High Efficiency Irrigation System (HEIS) or approved irrigation methods i.e. furrow and bed-furrow irrigation.

Three M.Sc. (Hons.) Agri. Engg. Degrees were awarded to students under the project on completion of their research work under the project. Two proceeding papers and several other papers are under preparation for publication.

Name of Project: **Testing and Evaluation of Lining and Control Structure Alternatives for Irrigation Channel**

Name of PI/ Institute: **Dr. Muhammad Rafiq Choudhry,**
Professor,
Department of Irrigation & Drainage, University of Agriculture, Faisalabad

Duration: 28. 05. 2004 to 27. 05. 2007

Financial Status:

Total Cost:	Rs.4.128 million
Funds Released:	Rs.2047600/-
Funds Utilized:	Rs.1999999/-

Objectives:

- To identify nationwide problems of existing control structures adopted for watercourse improvement.
- To develop economical and efficient control structure at tertiary level to overcome chipping, leakage and durability problems for sustainable watercourse improvement.
- To test the hydraulic and economic performance of the developed control structures for improving watercourse conveyance efficiency leading towards water productivity enhancement in agriculture on sustainable basis.

Achievements:

About six prototype control structures comprising concrete, plastic, steel materials were produced. Four more designs of control structures prepared were given to the manufacturer for fabrication. Two manufacturers, namely City Construction Co. Lahore and Hussnain RCC Sargodha were engaged to manufacture the control structure. A total of 10 designs including those previously fabricated and top wall were produced for demonstration and testing.

In addition following activities were also conducted:

a. Professionals from on farm water management (OFWM) (Dept. of Agriculture Punjab) were associated to participate in technical aspects of improvements of control structures. A number of meetings in this regard were held to discus the alternative designs of control structures manufactured in cooperation with the manufacturers. Their suggestions were incorporated.

b. Test site was developed with 4 panel installation and water availability from a tubewell of the Department of Irrigation and Drainage. A number of lids of 20 inches and 18 inches diameter were tested for possible leakage.

c. One water course at the university campus was selected to test the designed control structures. The selected watercourse was surveyed and 6 control structures were installed for testing. Another watercourse selected at Sheikhupura, where 12 control structures were installed and tested.

d. A national seminar entitled “Water Control in Tertiary Irrigation Channels – Issues and Remedies” was held on May 19, 2007, where more than 150 participants attended from the provinces. A number of Professionals in water management, professors of the universities, administrators and farmers participated in the seminar. Five technical papers including presentation of the project activities were presented. The control structure products produced under the ALP/PARC project were displayed to the participants.

Name of Project: **Silicon Nutrition for Enhancing Crop Productivity**

Name of PI/ Institute: **Dr. Rahmatullah,**
Associate Professor,
Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad

Duration: 01. 07. 2004 to 30. 06. 2007

Financial Status:
Total Cost: Rs.3.431 million
Funds Released: Rs.2235052/-
Funds Utilized: Rs.2042540/- (up to 30.04. 2007)

Objectives:

- Evaluate effects of Si fertilization on growth performance of rice, wheat and sugarcane.
- Study role of Si nutrition in controlling fungal disease of these crops.
- Identification of Si-accumulator genotypes/cultivars of these crops and their relationship with tolerance to diseases (especially fungal) and other abiotic stresses such as salt tolerance

Achievements:

During the reporting period various soil and solution culture experiments carried out were:

- ♦ Role of Si to combat toxic effect of Cd in maize and spinach grown in a contaminated soil.
- ♦ Response of indigenous and improved varieties of wheat to Si in hydroponics.
- ♦ Behavior of salt sensitive and salt tolerant genotypes of sugarcane to either Si or K and or both under saline condition.
- ♦ Role of Si to ameliorate toxic effects of salinity in wheat.

Results of these studies are summarized below:

Growth performance of two wheat genotypes, (Auqab-2000 & SARC-5) differing in salinity tolerance, to applied silicon under normal and saline conditions was investigated. Plants were grown in pots filled with normal (EC = 1.16 dSm^{-1}) and saline soil (developed EC = 10 dSm^{-1}). Silicon was applied @ 0, 50 and 130 µg Si/g soil using calcium silicate. Silicon application in growth medium significantly ($p<0.01$) improved dry matter and grain yield of both genotypes. Silicon application significantly reduced Na uptake and increased K concentration, resulting in a significant increase in K:Na ratio in shoots.

A solution culture experiment was conducted for the evaluation of Si fertilization on a group of wheat genotypes. The group plants were subjected to 4 Si levels viz; 0, 25, 75 and 150 ppm Si. Addition of Si in the cultural solution improved the growth of plants as compared with control. All genotypes showed better growth response at treatment Si @ 75 ppm level. The wheat genotypes were categorized into Poor (C-591, Blue Silver), Medium (Dirk, SA-42) and Better (Inqlab-91,

Maxi-Pak and Uqab-2002) responsive to Si application.

A hydroponic experiment was conducted to study the comparative role of silicon and potassium to combat the toxic effects of salinity in sugarcane genotypes differing in salinity tolerance; two salt sensitive (CPF 243 and SPF 213) and two salt tolerant (HSF 240 and CP 77-400). The nutrient solution was salinized by two salinity levels (Nil and 100 mM NaC1) and/or enriched with two Si levels (Nil and 2 mM) and/or two K levels (Nil and 3 mM). Application of 100 mM NaCl in the root medium significantly ($P<0.05$) reduced biomass accumulation in four sugarcane genotypes. The adverse effects of salinity were more pronounced in salt sensitive genotypes than salt tolerant. Addition of K and Si either alone or in combination with each other strongly inhibited the uptake of Na+ and significantly ($P<0.05$) improved biomass accumulation. Potassium uptake, K+/Na+ ratio, Ca2+ uptake and Si uptake were also significantly ($P<0.05$) increased by supplementary Si and K. The ameliorative effects of added K and Si were more prominent in salt-sensitive genotypes than to salt tolerant.

A pot experiment was conducted to investigate the effect of exogenously supplied Si on yield and Cd uptake in maize (*Zea mays*, cv. Anguri) and spinach (*Spinacia oleracea*. cv. Desi I). The soil was artificially contaminated with Cd. Four treatments investigated were; TI (Control), T2 (+CD @ 25 mg kg^{-1}), T3 (+Si @75 mg kg^{-1}) and T4 (+Cd @ 25 mg kg^{-1} +Si @75mg kg^{-1}) in both species. Addition of Si in the growth medium significantly ($p<0.05$) increased shot and root dry matter production. Cadmium contamination negatively affected shoot and root biomass in both species. Silicon concentration in shoot increased with additional Si in both species. The presence of Cd in growth medium also resulted in higher shoot Cd as well as more shoot Si concentration. The results indicate that Cd toxicity effects were more in spinach than maize. The results also revealed that application of Si proved to be beneficial in both species but ameliorative effects of Si were more in maize than spinach.

The overall results of the experiments revealed that application of active Si in growth medium enhancing soil fertility, increasing quantity and quality of crops and also reduces the negative impact of adverse environmental condition especially salinity, drought, lodging and metal toxicity. Major conclusion drawn from project activities are:

a. Enhancement of growth and yield of wheat in soil and solution culture
b. Promotion of upright stature and resistance to lodging in rice
c. Resistance to disease organism in wheat
d. Resistance of metal toxicity in maize
e. Reduction of drought stress in wheat
f. Effect on quality and quantity in sugarcane
g. Change in mineral composition of wheat under salt stress
h. Combating salt stress in rice
i. Rice Husk is best source of Si fertilizer

However all these studies are conducted on shoot dry matter and yield basis, but the role of Si on physiological and molecular levels still poorly understood.

Three papers, one in international and two in national journals were published from project work. Six persons completed M. Sc degrees program and two students conducted their research for Ph.D program.

Name of Project: **Improving Yield and Nitrogen Use Efficiency in Cereal Based Cropping System**

Name of PI/ Institute: **Dr. M. Tariq Jan,**
Professor,
Department of Agronomy, NWFP Agricultural University, Peshawar

Duration: 17. 05. 2004 to 16. 05. 2007

Financial Status:
Total Cost: Rs.1.234 million
Funds Released: Rs.1005300/-
Funds Utilized: Rs.819973/- (up to 31. 12. 2006)

Objectives:

- The major objective of this investigation is to develop a sustainable nitrogen management system for cereals (maize and wheat) to utilize the N from crop residues and chemical fertilizers in the year of application and years to follow after application.

Achievements:

Experiments on maize and wheat to understand the fertility contribution from inorganic & organic source of N and determine the KCl impact on urea efficiency in cereal, were conducted. First experiments consists two types of N-fertilizer (NH_4 & NO_3) and three application time at sowing, 2^{nd} node appearance and boot stage. Second experiment was integrated management of crop residue (cereal and legume), type of N-fertilizer (NH_4 and NO_3) and its application time. Third experiment was consisted of crop residue and muriate of potash (MOP) application with urea. All the agronomic data on maize and wheat was collected and statistically analyzed. Statistical analysis of the agronomic data shows that fertilized plots had higher grain yield and other parameter as compared to control plots both in wheat and maize crops. The performance of Nitrate form of nitrogen was greater than Ammonium form in both crops. The cereal, legume residues and muriate of potash had improved the urea utilization in both wheat and maize.

Practical results are obtained from the study, which can significantly improve maize and wheat production i.e type of N fertilizer (NH_4 & NO_3) had no significant effect on yield and yield components of maize and wheat. It is the time (crop growth stage) and method of N application which determines its utilization efficiency resulting in higher yield. Cereal residue must be supplemented in split dose of N fertilizer (particularly NH_4), half at sowing and rest at lower growth stage, preferably at pre tasseling stage in maize and boot stage in wheat. Legume residues can perform equally well if applied alone and later supplemented with N fertilizer. Muriate of Potash (MOP) increased urea N efficiency but addition of crop residue proven better than MOP in terms of urea efficiency.

Two students worked in the project and obtained data for completion of their special problem and review papers for B. Sc (Hons.) degree program.

Name of Project: **Improvement of Groundnut Production through Rhizobial Inoculation in NWFP**

Name of PI/ Institute: **Dr. Syed Sabir Hussain Shah,**
Director,
Soil and Plant Nutrition Directorate, Agricultural Research Institute, Tarnab, Peshawar

Duration: 22. 05. 2004 to 25. 04. 2007

Financial Status:

Total Cost:	Rs. 1.701 million
Funds Released:	Rs.1662200/-
Funds Utilized:	Rs.1662114/-

Objectives:

- To determine the nodulation status of groundnut crop on the farmers' fields in different parts of NWFP.
- To popularize groundnut Rhizobial inoculation technology among the farmers.
- To prepare and distribute groundnut Rhizobial inoculant, free of cost among the farmers for about 5000 acres.
- To supplement the use of N fertilizer through biological N fixation and thereby reduce cost on chemical fertilizers and minimize environmental pollution.

Achievements:

A detail survey to determine the nodulation status of groundnut crop on farmers' fields was carried out at Karak, Swabi, Kohat, Kurram, Haripur and Nowshera. Samples of healthy nodules were collected for isolation of groundnut *Rhizobia* in the laboratory. Four local strains of groundnut were isolated as $GNK_{1,}$ $GNK_{2,}$ $GNL_{1,}$ and $GNL_{2.}$ Two Rhizobial strains of groundnut viz, CIAT 3101 and NC 92 were acquired from Australian Legume Inoculants Research Unit NSW Agriculture and three strains viz, IC 7001, IC 7017 and 7114 were acquired from International Crop Research Institute for Semi Arid Tropics (ICRISAT), India. More than 5500 packets of *Rhizobial* inoculants for groundnut crop were locally prepared and distributed free of cost among the groundnut growers in different parts of province.

Experiments to see the effect of different strains of *Rhizobia* on the performance of groundnuts crop were conducted at ARI, Tarnab, Peshawar and recorded nodulation data. Two field experiments on *Rhizobial* inoculation of groundnut crop were conducted at Parachinar and Mingora and recorded physic-chemical characteristic of test soil. Inoculation trials were conducted on farmers' field in Kohat, Karak, Parachinar, Swabi, Mingora and Nowshera and recorded pod yield data for comparison of pod yield with un-inoculated groundnut crops.

The activities and studies conducted under the project revealed that most of groundnut crops on farmers' field were lacking sufficient nodulation due to low number of effective *Rhizobia*. About

70% farmers' field in NWFP need artificial seed inoculation with its effective *Rhizobia*. At Parachinar 60% fields showed good nodulation due to favorable climatic condition and presence of effective native groundnut *Rhizobia*. Main reasons for low yielding of groundnut crop are poor agronomic practices including imbalance fertilizer, sowing low yield local varieties, lack of *Rhizobium* inoculum, disease and pest control and uncertain climatic condition. The Rhizobial Inoculation improved the nodulation and pod yield. Crops performed well when seed inoculated with local strain of *Rhizobia* compared with those acquired from abroad. Demonstration trials showed that *Rhizobium* inoculation improved pod yield ranging from 7 to 40%. Gypsum application @ 500-1000 kg ha^{-1} also improved the nodulation and pod yield of groundnut crop.

Two bulletin one in Pushto language *"-Da zamakey zarkhezi auo phallidar pasloona"* and one in national language Urdu *"Mung pali ki Ahmeit aur Kasht"* has been printed for guidance of farmers and extension workers in order to popularize the *Rhizobium* Inoculation Technology. The Agriculture Minster, Dean, Faculty of Agriculture, Kabul University and Agricultural Scientists from Afghanistan showed keen interest in the Pushto booklet and Rhizobial inoculation technology of food legumes during their visit to ARI, Tarnab, Peshawar in 2005 and 2006 under USAID program.

Three post graduate students of Department of Soil and Environmental Sciences, NWFP Agricultural University, Peshawar successfully completed internship in the field of *Rhizobial Inoculation* of legumes (Biofertilizer Technology) under the project in Soil Microbiology Section of Soil and Plant Nutrition Directorate, ARI, Tarnab, Peshawar.

Social Sciences

Name of Project: **Analysis of Technology Transfer for Sustained Growth in Agriculture as used by Extension in Sindh, Pakistan**

Name of PI/ Institute: **Dr. S. S. Bukhari,**
Associate Professor,
Department of Agri. Education, Extn. & Short Cources, Sindh Agriculture University Tandojam, Sindh.

Duration: 01. 01. 2003 to 30. 09. 2006

Financial Status:
Total Cost: Rs.0.500 million
Total Releases: Rs.276000/-
Total Expenditure: Rs.80000/-

Objectives:

- Assess the technology transfer process/package for sustained growth as used by the Extension Department in Sindh.
- Assess the impact of various sources of information employed in dissemination of information.
- Identify and determine the technology transfer gaps/ constraints between research generators and users as faced by Extension Department.
- Develop a technology transfer model based on information gathered through the project for Extension in Sindh.
- Suggest recommendations that help address the problems/ constraints of the farming community and their solutions at various levels for their consideration and application.

Achievements:

The study sought to identify and analysis of technology transfer for sustained growth in agriculture. The study employed survey method and 400 farmers, 100 extension personnel and 70 research personnel were determine as sample. Three questionnaires were developed; one for farmers, one for extension and one for research personnel.

The study showed that sugar cane, wheat cotton and mango were the major contributing source of farm economic of the farmers. Majority of the farmers received less than one visit by the field assistant. Insect pests and diseases and water shortage were the major problem of the studied area. Radio, neighboring farmers and agricultural suppliers were the sources of information as used by the farmers for obtaining new information regarding technology transfer. Group approaches to technology transfer were perceived "effective". Farmers perceived on average agricultural extension and research services as fair to good on various aspects. Farmers were of the opinion that farmers' field schools, demonstration, farm visit are effective in diffusing new technology.

Name of Project: **The Impact of Domestic Support to Punjab's Agriculture Under WTO Regime**

Name of PI/ Institute: **Mr. Qamar Mohy-ud-Din,**
Associate Professor,
Department of Agricultural Marketing, University of Agriculture, Faisalabad

Duration: 28. 10. 2004 to 11. 08. 2006

Financial Status:
Total Cost: Rs.1.565 million
Total Releases: Rs.988000/-
Total Expenditure: Rs.870730/-

Objectives:

- To estimate the aggregate measure of support (AMS) being provided including:
  a) Market Price Support (MPS)
  b) Input-output subsidies
  c) Other non exempt measures like direct payments etc.
- To estimate the impact of AMS on production, trade and welfare of farmers of the Punjab.
- To determine the extent of domestic support to be provided to the agriculture sector and rural development in the Punjab province.
- To estimate future projection level of domestic support on various sectors and its impact on rural development in Punjab.
- To suggest guidelines for providing domestic support for general development of agriculture and rural development in the Punjab Province.

Achievements:

To achieve the objectives, relevant information and data were acquired both from primary and secondary sources. The data relating to Pakistan's domestic support to agriculture sector including Aggregate Measures of Support (AMS) and green box outlays as notified by Govt. of Pakistan to World Trade Organization (WTO) were acquired from online data base available on WTO website http;//docsoline.wto.org and Ministry of Food, Agricultural and Livestock (MINFAL), and Ministry of Commerce, Govt. of Pakistan. Punjab province being the leading province in agriculture constituted the universe of the study. The AMS as provided by the Govt. of Punjab was estimated by using the information at Pakistan level. Budgetary outlays for various green box type supports over the years were used in order to describe the extent of various items of domestic support provided by Govt. of Punjab. For this purpose, relevant information was obtained from Planning and Development (P&D) Department, Govt. of Punjab and various issues of Economic Survey of Pakistan, Agricultural Statistics of Pakistan, Punjab Development Statistics and Punjab Economic Report 2005.

Various agricultural related institutes were also surveyed where domestic support is being

provided in Punjab province in order to find out the extent of support being received by these institutes, their contributions towards agricultural and rural development of the province, problems faced by these institutes and explore the avenue for future provision of domestic support in the province of Punjab without contravening the provisions of WTO. Cobb-Douglas type of production function was employed for studying the impact of domestic support on total agricultural production of Punjab. For future projections, Auto Regressive Integrated Moving Average (ARIMA) model was used.

According to the findings of study, Pakistan at present is in full conformity with WTO regime on agriculture and has already fulfilled all the obligations of Agreement on Agriculture (AoA) vis-a-vis market access, domestic support and export competition.

Regarding domestic support, agricultural producers in Pakistan are provided a notional type of minimum support price for few commodities. The implementation of the support price policy has been restricted to wheat, rice, cotton and sugarcane. Crops such as gram, onion, potato, and non-traditional oilseeds, i.e. sunflower, canola, soybean and safflower have been excluded from the programme and now these are traded in private sector. This is a component of Aggregate Measure of Support, which is negative since the emergence of WTO in 1995. In case of non-product specific support, budgetary and hidden subsidies on fertilizer and credit have also been phased out.

Under the green Box, Pakistan has been giving domestic support under the categories of general services on research, storage facilities, marketing services, extension services, general services, infrastructural services, flood protection services, and water supply facilities etc.

The estimates of Aggregate Measure of Support (AMS) in Punjab depict the same trend as AMS at Pakistan level exhibits. The AMS in the base period and through out the implementation period up to 2003-04 remained negative. In case of product specific (AMS) in the base year 1986-88, in Punjab eight crops were having negative AMS. The AMS was extended to the agriculture sector in Punjab only under price support programme of the government. All the crops except sugarcane received negative subsidy i.e. crops were rather taxed instead of receiving support.

In case of non product specific AMS, the share of Punjab in the base period was 70.284 million US dollars. This is the only period for which Pakistan notified fertilizer and agricultural credit subsidies besides electricity subsidy to WTO. In the later years, only in the first year of implementation period non product support was extended in the Punjab province in the form of fertilizer subsidy. In the subsequent years the figure for non product specific AMS for Punjab remained zero.

Presently in Punjab, domestic support falling under the green box is being provided under various categories like agricultural research and extension, pest and disease control, rural development, regional assistance, infrastructural services, public stockholding for food security purposes, state trading in food grains, agricultural marketing and information services, environmental protection, expenditure on natural calamities and disasters. In order to explore the scope of future provision of domestic support, a survey of various institutions in Punjab related to above heads were carried out. During the survey, almost all the institutions reported many types of problems and

particularly the funding problems severely constrained the performance of these institutions.

Cobb-Douglas type of agricultural production model was used to study the impact of domestic support on Punjab's total agricultural production. The estimate model established that the cropped area, agricultural labour, distribution of seed, budgetary expenditure on agricultural research and extension, land reclamation, and wheat price support contributed positively towards agricultural production where as the contribution of fertilizer and expenditure on food trading services was found negative. As majority of the farmers in Punjab are illiterate and are not sufficiently equipped to meet the challenges posed by WTO. Therefore, if the objective is to increase the welfare, government must provide domestic support to farmers.

On domestic support, there is very little by way of constraint on policy. Total Aggregate Measure of Support (AMS) in case of Pakistan is negative implying that agriculture sector in Pakistan and Punjab instead of receiving support under the amber box were rather taxed. Pakistan has no reduction commitments in case of AMS. Therefore Pakistan can utilize this cushion by increasing its support falling with in the preview of AMS so that first it attains positive sign and then further it can use the minimum provision i.e. 10 percent of the production value of each crop.

Further more, governments both at national and provincial level should explore the green box items and extend maximum possible domestic support to the farmers in Punjab. Domestic support for agricultural research and extension, infrastructural services, rural and regional development, pest and disease control, and marketing and promotion services would boost not only total agricultural production but also it would be quite instrumental in enhancing the overall welfare of the farmers.

Recommendations:

Pakistan is economically an agrarian country largely drawing its economic strength from agriculture sector. In spite of its major role in the economic development of the country, the agriculture sector in the recent past has initiated its journey towards commercialization and this sector has not yet become self supportive. Farming community lacks proper knowledge and is not properly quipped to meet the challenges of modem agriculture. Majority of the farmers are illiterate and are unable to make rational decisions on their own and need institutional support. Moreover market mechanism is not well established and not capable enough to provide proper economic signals to all the stakeholders. All these factors justify that domestic support to our agriculture should be continued rather enhanced. The agreement on agriculture of WTO sets various rules and regulations regarding the provision and prohibition of domestic support to agriculture. In the following, various suggestions have been extended for the provision of domestic support in the Punjab province within the framework of various WTO rules:

1. On domestic support, there is very little by way of constraint on policy. Total Aggregate Measure of Support (AMS) throughout the implementation period as notified by Pakistan is negative, implying that agriculture sector in Pakistan and Punjab instead of receiving support under the Amber Box was rather taxed. Pakistan has no reduction commitments in case of AMS. Therefore Pakistan can utilize this cushion by increasing its support falling with in the preview of AMS so that first it

attains positive sign and then it may use the minimum provision i.e. 10 percent of the production value of each crop.

2. Pakistan's Gross Domestic Product (GDP) is Rs 4480 billion. The share of agriculture in total GDP is 23 percent i.e. Rs. 1030 bullion (Govt. of Pakistan, 2005). Ten percent of total agricultural output i.e. Rs. 103 billion can be given as non-product specific support to agricultural sector or rural development, without contravening the provisions of AOA of WTO.

3. The results of the study indicate that wheat price support have contributed significantly in increasing agricultural output of the Punjab province. Wheat crop is very important from food security point of view; the price support programme for wheat should be continued. This support can be extended because current total AMS in Punjab is negative and there are as such no reduction commitments in this regard.

4. In the province of Punjab the contribution of food trading services towards agricultural output is not positive according to the findings of the study. Therefore, government should gradually disengage itself from food trading, services and let the private sector extend these services for handling the output.

5. Although Amber Box type of domestic support bars provision of certain types of support but Green Box type domestic support has no limit. Therefore, the government of Punjab should explore possibilities to provide domestic support under Green Box measures. This will enable the needy sectors to get their due share.

6. In the WTO regime, agricultural producers of Punjab are confronted with many challenges that call for an increased investment in rural public domain such as agricultural research to further improve agricultural technology and to provide producers with better production conditions that are comparable with their foreign competitors. With increased productivity either in terms of higher yield or lower cost of inputs, farmer's production cost could be brought down to render their products more competitive. The results of the study report negligible contribution of investment in research in Punjab which is because of meager budgetary allocation for operational research. In this direction following steps are recommended:
    a. The Government of Punjab should accord high priority to agricultural research and investment spending on agricultural research should be increased manifolds immediately.
    b. It should be ensured that major proportion of budget of the various research organizations is incurred on the operational research.
    c. There is a need to bring drastic institutional changes in the provincial research organizations in order to stern the current outflow of competent agricultural researchers. Human resource base needs to be strengthened. Agricultural research scientists should be given competitive salaries and all types of research facilities. On the job training facilities particularly foreign trainings should be arranged for the researchers and educationists for acquisition of latest technical knowledge as well as the foreign exposure.

d. All the vacant positions in the research organizations of the province should be immediately filled. Fresh recruitment, promotions and appointment against administrative posts should be on merit and should be tied up with performance.
e. The agricultural research should be problem solving and target oriented. Goals and targets should be set in consultation with various stakeholders. In this regard, there is an urgent need to establish a coordination mechanism among various stakeholders like research and extension organizations, private and public sector organizations and educational institutions.

7. Agricultural extension plays a key role in improving agricultural productivity. Presently the budgetary allocation for agricultural extension is also far less than the current needs of the province. Government should lay special emphasis on improving extension services in the province and funding in this area should be increased. According to Davidson et al (2001) urgent attention is required for rethinking extension strategies for Punjab so as to narrow down the growing information gap between the rich and the poor farmers. The advance programming principles should be adopted by the extension department of Punjab to bridge the information gap between the farmers, are suggested below:
   a. Use of surveys, village visits, and discussion methods can provide a means of assessing needs of the people of village by the extension staff.
   b. Extension workers and the school teachers in the villages could be used as contact people to initiate projects and identify key leadership for helping in various projects.
   c. Field work for extension workers should consist of farm-to-farm visits or house-to-house visits in villages. A personal link between the villagers and the extension office could be established and maintained through these visits.
   d. Integrated farm projects should be set up with farmers to show methods that were practical for them.
   e. Practical training for extension staff should be arranged by working directly in the fields with the farmers, discovering their needs and helping them to improve farm practices.
   f. The literate villagers should be provided the extension publications.
   g. This will create a link between the universities and the villagers, and will improve farm practices of village people.
   h. To increase family income and to make available a higher quality of product for the market, the trainers should be selected to attend training on developing a marketable product and sharing this information with other villagers.

8. The results of the study establish a significant relationship between the distribution of improved seed and agricultural output in the province of Punjab. Therefore, efforts should be made to further enhance the distribution of seed in the province. In this regard, the cost of transporting seeds can be subsidized in the province with the objective of ensuring universal and timely access to this vital input. Seeds should also be made available in case of natural calamity and seed storage infrastructure should be developed. Grants should be provided to both public and private seed corporations for the maintenance of certified and foundation seeds. The core poor should be given

improved seed at cheaper rates and in small packs.

9. Fertilizer constitutes a major component of cost of production of the crops. The government should ensure timely and proper availability of all types of nitrogenous, phosphate and potash fertilizers at affordable rates to farming community. The government is already giving gas subsidy to the fertilizer sector which should be continued and additionally the government should give subsidy on the import of fertilizers. Besides this, technical and advisory services should be arranged for to the farmers so that they may utilize the fertilizers effectively.

10. High priority in the budgetary allocations should be accorded for the development of infrastructure by the Punjab government. Public expenditure on the irrigation, and land reclamation should be further enhanced and spending on lining of canals and water courses for overcoming water losses during conveyance of water should be increased. In water deficient areas, water conservation techniques should be introduced and promoted among the farmers. Where installation of tube wells is feasible, farmers should be provided incentives and technical expertise for tube well installation. In this connection, electricity should be provided at subsidized rates. In our neighbouring country India, power to agriculture sector is offered at a very low price; in a few cases it is even free. Like many Indian states, the government of Punjab can also adopt the policy of providing irrigation subsidies to facilitate the resource poor farmers.

11. Under the commodity loan programs the producers of designated crops should be allowed to receive a loan from the government by pledging production as loan collateral. Following harvest of the crop, a farmer may obtain a loan for all or part of the new crop. The government can adopt such policies to issue commodity loans to the farmers to facilitate production and to render them free from the exploitation by the middlemen and wholesalers. Furthermore, loans for marketing, storage and transportation purposes of agricultural commodities should also be liberally arranged.

12. Expenditure on public stockholding of food for food security under green box expenditures of Punjab has been quite low in the past. The provincial food department receives no allocation from the provincial budget; rather it finances its expenditure by taking loans from the banks. Whereas, India's green box payments during 1995-1997 were dominated by expenditures on public stockholding for food security and totaled to US$2,872.9 million in 1997. Government has the cushion to increase spending on stockholding of food to ensure timely availability of food to the poor on concessional rates. This area of domestic support should be vigorously explored.

13. To encourage the farmers for setting up of scientific storage systems for vegetables; The Directorate of Economics and Marketing, Government of Punjab should provide not only the financial assistance to farmers to erect storage structures but should also be given technical guideline for the process. As much as 25-50 percent of the construction cost of the storage structure could be offered to farmers. The scientific drawing on modem lines and cost estimates for storage structures should be made available free of cost by the district agriculture offices.

14. Huge demand exists for cut flowers in the international market. Cooling is one of the important steps in bringing fresh cut flowers from the grower to the marketplace. To ensure the quality of these flowers, government should provide financial incentives to the private sector to construct and maintain cold storage facilities at market and farm levels.

15. The general and product specific disease control measures such as early warming systems, quarantine and eradication has assumed high importance because of Sanitary and Phyto-Sanitary Agreement of WTO. Since the province of Punjab is the major producer and exporter of fruits and vegetables, the government should ensure proper pest and disease control mechanism in the province in lines with the international standards if is to increase the exports from the Punjab. A strict system of inspection including general inspection service and the inspection of particular products for health, safety, grading and standardization purposes should be enforced and inquiry points at various places should be set up.

16. Agricultural marketing in the past in Pakistan and the province of Punjab has largely remained ignored but the disposal of occasional surpluses of some of agricultural commodities; emergence of agribusiness sector and challenges posed to agrarian economy by WTO has increased its importance. The farmers of Punjab in general and small farmers in particular lack modem marketing techniques that result in high post-harvest losses. Although a separate Ministry of Agricultural Marketing has been established but there is a need to make it vibrant and functionally working for the provision of various marketing related services to the farmers. The farmers should be facilitated in the product preparation, handling, storage, bargaining, grading, standardization, packing and disposal of their produce. Market information system should be strengthened in order to provide information to all stake holders and bring coordination in agricultural markets.

17. The findings of the study indicate that contribution of agriculture labour in increasing agricultural production of the province of Punjab has been quite significant in spite of the fact that labour in our country is not equipped with modem techniques used in Agriculture sector. It is therefore, urgent need of the time to arrange training programmes for not only the farmers but other stakeholders as well. The Govt. should chalk out comprehensive training programmes in collaboration with various research and training institutes and agricultural Universities.

All the above suggested sectors, sections, stakeholders need domestic support of the provincial government. The suggested provisions can help directly or indirectly, the agricultural and rural development in the province. The government can extend domestic support to the above suggested areas without contravening the provisions of AOA of the WTO.

Name of Project: **Economic analysis of agroforestry plantations in Sindh province of Pakistan**

Name of PI/ Institute: **Dr. Heman Das Lohano,**
Assistant Professor,
Department of Agri. Economics, Sindh Agriculture University, Tandojam

Duration: 28. 10. 2004 to 27. 10. 2007

Financial Status:
Total Cost: Rs.1.328 million
Total Releases: Rs.386791/-
Total Expenditure: Rs.339208/-

Objectives:

- To assess the current status of forestry development in Sindh and Pakistan.
- To conduct a benchmark survey of agro forestry plantations in selected districts of Sindh.
- To undertake economic analysis of major tree species grown in agroforestry plantations.
- To study the needs, availability, marketing, and export aspects of forestry with special reference to Sindh province.
- To recommend policy measures and program initiatives for the development of agro forestry in Sindh on a sustainable basis.

Achievements:

The study aimed at assessing the current status of agroforestry in Sindh and Pakistan, conducting economic analysis of agroforestry plantation on private farmland, and exploring the marketing of agroforestry products in the selected districts of Sindh. Primary as well as secondary data were collected for accomplishing the objectives of the study. Primary data were collected from producers and middlemen by conducting surveys in four districts of Sindh, namely Sanghar, Badin, Matiari and Hyderabad. Cluster sampling method was used for primary data collection. Sample size of the farmers was 210, and that of the middlemen was 105 from the study area. For data collection, the survey was conducted from March to June 2006. The randomly selected respondents were personally interviewed with the help of questionnaires. Secondary data were collected from the government and other publications.

In terms of area, the farmland trees account for 11 percent of the total forest area in Pakistan. In Sindh, farmland trees account for 14 percent of the total forest area. However, farmland trees are very productive in terms of growth per year, as they account for 53 percent in the total forest growth per year in Pakistan, and 55 percent in Sindh (FSMP, 1992a). It has been estimated that 90 percent of fuel-wood and 46 percent of timber requirements in Pakistan are being met from tree plantations at private farmlands through agroforestry practices (Government of Pakistan, 2005a).
In the province of Sindh, the most common practices of agroforestry on private farmland are block plantations of *Acacia nilotica* (BabuT), shelterbelts and scattered trees with common tree species of *Acacia nilotica* (BabuT), *Eucalyptus camaldulensis* (Sufaida) and *Azadirachta indica* (Neem). Block plantation of *Acacia nilotica* is locally referred to as Hurrie. Results from the survey of the

selected districts of Sindh indicate that the block plantation of Acacia nilotica provided 34 percent internal rate of return to the farmers. The internal rate of return was 27 percent from Acacia nilotica, and 23 percent from *Eucalyptus camaldulensis*, grown as shelterbelts and/or scattered trees.

Results of the study showed that the highest net marketing margin per 40 kilograms received by the middlemen was from the block plantation of Acacia nilotica (Hurries). The net margin received by various middlemen ranges from 5 to 16 percent in the marketing of wood products. It was observed in the survey that there were relatively few middlemen in wood marketing at each location, as compared to the middlemen involved in marketing of agricultural crops. These few middlemen in wood marketing purchase and sell a large quantity of wood. Thus, their total returns are much higher than they might seem on per unit basis.

Results of this study indicate that there is a need of promoting agroforestry plantations for meeting the rising demand for wood products and other numerous economy-wide benefits. For promoting agroforestry on private farmlands, the government needs to make efforts on providing technical assistance, extension services, awareness, and availability of seed and seedlings. The government should promote research on agroforestry for exploring suitable tree-crop combination for different types of soil. Based on the research outcomes, the government should disseminate the information to farmers about trees species suitable for a particular area and tree-crops mix that can be used in agroforestry system.

Conclusion and Suggestions:

Agroforestry at private farmlands provides numerous economy-wide benefits. Agroforestry plantation produces many goods and services, some of them are sold in the market and have a market value, while others are not sold in the market but are valuable. Market goods from agroforestry include timber, firewood, and non-wood forest products such as pods, leaves, gum, lac, and other indigenous products. Nonmarket services include windbreak, soil improvement, shade for farmers, beauty, and many other aesthetic services. About 90 percent of fuel-wood and 46 percent of timber requirements are being met from tree plantations at private farmlands (Government of Pakistan, 2005a). Tree plantations also provide many ecological and environmental benefits to the economy. Where these all benefits are significant, the socially optimal level of trees plantations would be higher than the existing level. In this case, the government will need to intervene for increasing tree plantations, as tree plantation will benefit the whole economy.

In the province of Sindh, the most common practices of agroforestry on private farmland are block plantation of *Acacia nilotica* (Hurrie), and shelterbelt and scattered tree plantations with common tree species of *Acacia nilotica* (Babul), *Eucalyptus camaldulensis* (Sufaida) and *Azadirachta indica* (Neem). Results from the survey of Sanghar, Badin, Matiari and Hyderabad districts of Sindh indicate that the block plantation of *Acacia nilotica* provided 34 percent internal rate of return to the farmers. The internal rate of return was 27 percent from *Acacia nilotica,* and 23 percent from Eucalyptus camaldulensis, grown as shelterbelts and/or scattered trees.

Currently, Pakistan is facing timber and firewood shortage of about 29 million cubic meters (Government of Pakistan, 2006a). Due to shortage in local supply and rising demand for forest products, Pakistan imports various wood products and other forest products each year.

Agroforestry on private farmlands is contributing significantly in supplying the various forest products, these lands have more potential. There is a lot of uncultivated land that can potentially be used for agroforestry plantations. For promoting agroforestry on private farmlands, the government needs to make strong efforts. Following measures are suggested in promoting agro-forestry on private farmlands:

- Government should establish a separate division for the agroforestry in the forestry department for coordinating with agriculture and extension departments. There is a need of raising funds for agroforestry on private farmlands. The government should provide seedlings, technical assistance, and extension service. Furthermore, the government needs to initiate programs for awareness and motivation to farmers regarding agroforestry.

- The government should promote research on agroforestry for exploring suitable tree-crop combination for different types of soil and disseminate the research outcomes and information to farmers about trees species suitable for a particular area and tree-crops mix that can be used in agroforestry system.

- Update and transfer information regarding farmers' perception, soil conditions, and other social as well as economic factors in promoting the tree species and in designing their plantation scheme.

- Explore and introduce suitable tree species for farmlands to reduce tree crop competition and provide high profit in Sindh such as Sesbania grandiflora (Manijhandri) which is fast growing and short rotation tree.

- Installation of wood seasoning, preservation and processing units in forest area for enhancing the production of quality wood. It will also reduce import of wood and wood products and will increase utilization of locally produced processed wood.

- Marketing efficiency also plays an important role in promoting the overall efficiency of agroforestry from farms to end-users. Farmers also lack the comprehensive information about products market orientation. The government should initiate programs for awareness on marketing aspects of the agroforestry products.

Name of Project: **Poverty Alleviation Through Enhancing Agricultural Productivity by Implementing Priority Interventions in the Selected Areas of NWFP.**

Name of PI/ Institute: **Mr. Muhammad Ishaq,**
Scientific Officer,
Technology Transfer Institute(PARC), Tarnab, Peshawar

Duration: 18. 08. 2004 to 17. 08. 2007

Financial Status:
Total Cost: Rs.5.029 million
Total Releases: Rs.4251600/-
Total Expenditure: Rs.4094373/-

Objectives:

- To find out the current status of agricultural productivity and its potential for enhancement in the project area.
- To identify and prioritized the major constraints through transfer of tested technologies and capacity building programms.
- To remove the identified constraints through transfer of tested technologies and capacity building programs.
- To create Information Exchange Forum (IEF) through existing Community Based Organizations (CBOs) and to create functional linkages with line departments to make IEF operational.
- To assess the impact of the tested technologies on the productivity level of farmers in the selected villages.

Achievements:

During the initial survey of project it was observed that cereal yields (wheat and maize) are low in the core project area. The major reasons identified for these low yields were the cultivation of disease susceptible varieties and lack of awareness about the improved management techniques. Keeping in view the above scenario an intervention in collaboration with Departments of Agriculture Extension and Research, NWFP on wheat and maize was developed and organized eight training programs on wheat management practices one each in the four villages of both the Charsadda and Kohat districts of NWFP while six training programs on maize management practices organized in four villages of Charsadda and two of Kohat districts. In addition to the above activities, brochures developed on wheat and maize covering the improved management techniques, were also distributed among the farmers in order to sustain the activity.

Off-season vegetables in Charsadda area can be produced, however the area farmers are not aware of the cultivation techniques, especially nursery raising. During the first half of the current year, capacity and four training programs one each in Gulabad, Kanriwar, Mirwali Kalay and Tangibarazai villages of Charsadda were conducted to make the farmers aware of off-season

vegetable cultivation. A brochure developed on off-season vegetable cultivation was also distributed among the farmers.

In the study area almost every household keep livestock, however, the livestock breed is of low quality and prone to diseases. Keeping in view this, interventions in livestock management practices were also developed with special emphasis on disease prevention and treatment and breed improvement through artificial insemination. Eight training programs on livestock disease, livestock management and artificial insemination were organized in collaboration with the Livestock department of NWFP at Akhonkalay and Dagai villages of Swat, Kot and Kharmatu villages of Kohat and Mirwalikalay, Gulabad, Tangi Barazai and Kanriwar villages of Charsadda. Brochure developed on livestock diseases and their treatment was developed and distributed among the livestock holders in the project area.

The results of need assessment survey show that pre and post harvest losses in fruits/ vegetables are high due to improper handling and insect/pest attack. In this connection four training programs were organized on insect and pest control on garlic (one each in four villages of core project area of Kohat district).

Name of Project: **Impact of Sanitary and Phytosanitary Agreement (SPS) on Agricultural Exports from Pakistan**

Name of PI/ Institute: **Dr. Khalid Mustafa,**
Associate Professor,
Department of Agricultural Marketing, University of Agriculture, Faisalabad

Duration: 17. 03. 2005 to 16. 03. 2007

Financial Status: Total Cost: Rs.1.438 million
Total Releases: Rs.911750/-
Total Expenditure: Rs.498247/-

Objectives:

- To identify the problems that limit effective participation of Pakistan in the SPS arrangements.
- To delineate the impact of Sanitary and Phytosanitary Agreement (SPS) on the export of agricultural and food products from Pakistan to the markets of developed countries.
- To find out the adverse implications of SPS agreement, if any, on agricultural exports from Pakistan and suggest ways to minimize such effects.
- To recommend policy prescriptions in line with the WTO trade liberalization move, based on the research findings.

Achievements:

Data collected is being analyzed. Summary of the preliminary findings of research is presented below:

- Apparently exporter's education, age and experience seem to have positive relationship with the quantity of products (mango and kinnow) exported from the country.

- Majority of the exporters purchased more than ninety percent of products (in case of kinnow) directly from farmers whereas most of the mango exporters purchased almost seventy percent of the commodity directly from farmers. 30 percent of the mango exporters purchased mango from the wholesale market.

- The exporters generally exported kinnow and mango in the Gulf and Middle Eastern countries. Export to other countries was almost nominal.

- Most of the exporters work on Consignment Auction Basis in the Gulf and Middle Eastern countries. However, fixed price method was found to be a common practice in the European countries.

- Majority of the exporters were aware of the requirements of importing countries. As such,

they compelled to these requirements to greater extent.

- Majority of the exporters used cartoons for the expert of mango and kinnow, especially to the European countries, whereas some of the exporters still used wooden crates to export fruits (mango and kinnow) in the Gulf and Middle Eastern countries.
- Majority of the exporters were found to have general awareness about the WTO but they had very little knowledge about SPS measures.
- Majority of the respondent were aware about the fruit fly infestation. They reported that the issue is not so serious as export of mango and kinnow is not restricted due to this particular factor.
- The facility of Hot Water Treatment was insufficient and restricted most of the exporters to explore new markets especially in the EU.
- Majority of the exporters complained that high fuel prices has increased cost of consignment preparation and squeezed their profit margins.
- On an average, 10 percent losses were received in the movement of commodity from farmers fields to the processing units. Almost 3 percent of the total export volume was rejected for not adhering to various quality parameters.
- Importers generally rejected mango and kinnow export consignments due to issues like presence of premature fruits in the cartoons, damaged cartoon, poor grading and standardization.
- The role of Export Promotion Bureau and Pakistan Horticulture Development and Export Board was found good but exporters were not generally satisfied with the performance of Department of Plant Protection and the handling of fruits by airlines.
- Most of the exporters underlined the need to develop export culture and in this respect; they remarked that Government may chalk out a plan for proper orchard management, suitable transportation, better storage facilities and availability of packaging material at fair prices. An improvement in the working of different institutions involved in the export process was also emphasized by exporters.

Name of Project: **Strengthening of Design and Analysis Capabilities in the National Agricultural Research System (NARS)**

Name of PI/ Institute: **Dr. Muhammad Inayat Khan,**
Professor/ Chairman,
Department of Mathematics & Statistics, University of Agriculture, Faisalabad

Duration: 28. 08. 2004 to 27. 08. 2007

Financial Status:
Total Cost: Rs.02.833 million
Total Releases: Rs.1777400/-
Total Expenditure: Rs.1107702/-

Objectives:

- To conduct experiments on improved experimental designs at PARS (university agricultural field experiments station), NARC Islamabad and at AARI to test the efficiency of the designs.
- To disseminate and introduce novel statistical methods and advance but statistically efficient experimental designs for agricultural experimentation, through trainings and workshops.
- To tutor statistical softwares (GENSTAT and SPSS) for the scientists of NARS to improve their data handling and analysis capabilities.

Achievements:

Activities:
To meet the objectives, six experiments of wheat (two at each research station, AARI, Faisalabad, BARI Chakwal and one at PARS, Faisalabad and one at PARS (Faisalabad) and NARC, two experiments of rice at RRI, Kala Shah Kaku and three experiments of maize at MMRI, Yousafwala were conducted.

A training program on the "Applied Multivariate Techniques using Different Statistical Packages" was organized according to the work plan at University of Agriculture, Faisalabad. Twenty participants who already attend the first year course from different research institutes participated in workshop.

The results of the experiments on different research stations under alpha design layout were demonstrated. Special attention was given to the analysis of alpha design on different statistical packages especially on Mintab.

Output/ Results:
Gain in the efficiency of wheat experiments as compare to the previous year is comparatively high, especially in BARI (Chakwal) and PARS (Faisalabad). However, on some locations

(NARC, AARI) gain inefficiency is not much high which indicates that more efficient analysis is needed for these experiments. Data on rice crop was collected and prepare for the final analysis while data on maize crop is still under process. Data collection on different agronomic parameters on their relevant time is continuing.

It is hoped that the scientists on different research institutes verified the latest design techniques and transferred the resulting knowledge to other scientists.

Name of Project: **Enhancing Agricultural Productivity through Transfer of Demand Driven Technologies to the Farmers in the Selected Districts of Sindh**

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

Duration: 18. 08. 2004 to 17. 08. 2007

Financial Status:
Total Cost: Rs.4.36 million
Total Releases: Rs.3996800/-
Total Expenditure: Rs.3297405/-

Objectives:

- To identify issues, constraints, and opportunities and prioritize farmer's needs of improved interventions through PRAs & other informal & multi-disciplinary approaches.
- To create Information Exchange Forum (IEF) at the village/community level through already formatted Community Based Organizations (CBOs).
- Establishment of database of research-based tested and proven technologies/interventions available with ARS located in the province.
- Creation of functional linkages with Extension, Research and other line departments to make IEF operational through two-way flow of information developing effect mechanisms of technology transfer to the end users.
- Organize and undertake capacity building programmes for farmers, activists, and extension workers of all cadres as well as district government functionaries on sustainable basis.
- To transfer the demand driven technologies to the farmers according.
- Institutionalize Participatory Monitoring & Evaluation (PME) system at CBO level for performance assessment and on-going monitoring and Evaluation.

Achievements:

The agriculture development depends on capabilities in the generation of appropriate agricultural technologies most suitable to the agro-climatic conditions of the farmers. Technology generation, transfer and adaptation are interrelated processes of an integrated and dynamic system and are very instrumental for increasing agriculture production. The wide gap 'between technological production possibilities and the persistent low level of agricultural production in Pakistan has been an issue of concern in the agricultural development literature for decades. For dissemination of agricultural innovation, many different agricultural development models ranging from the classical technology diffusion, community development, green revolution and integrated rural development approaches have been adopted over the past decades with little success. Agricultural production in the country is still largely dominated by subsistence, low technology utilizing traditional procedures.

The major thrust of the project was the transformation of traditional agriculture into science based agriculture by enhancing interface of research scientists with agricultural extensionists and farmers.

A comprehensive plan consisting of sustainable transfer of improved tested Agricultural technologies in respect of crop, livestock, poultry, fishery and value added activities such as, fruits and vegetables processing, packaging, shelf improvement activities has been carried out in the selected district of Sindh. Also training for rural women on various income generating activities such as, poultry farming and preparation of value added products such as tomato ketchup, lemon squash and apple jam has been arranged on farmers field to disseminate the technologies.

This project was the "Demand Driven Approach" rather than "Supply Driven Approach". Farmers of .the selected districts were the focal point, they were organized through Information Exchange Forum (IEF and existing CBOs). The tested technologies have been made available to them at the door step with the help of IEF, other institutions and organizations, making it participatory. The active involvement of farmers (through IEF and existing CBOs) during the entire process of identification, selection and transfer of technologies about crop, livestock, poultry, and other income generating activities has been carried out. This make them trained enough to carry out such activities after termination of project, making the whole process a sustainable source of development.

Four districts i.e. Thatta, Hyderabad, Mirpurkhas and Shikarpur were selected based on the agro-ecological zones or major cropping system in the province. From each district one taluka selected as project area. From Thatta taluka Kot Ghulam Muhammad; from Shikarpur taluka Tando Allahyar has been selected. After that, a cluster of five villages in each selected site is selected for project activities. From each villages number of CBOs and VOs and their members has been listed to provide them support through the project for capacity building. Under this project following activities was carried out in the target area.

*Seminars/Workshops***:** Five seminars/workshops were organized for the training of extension personnel and local leaders who participated in local programmes. Persons who are well qualified in the field under consideration provide leadership through introductory lectures, discussions and consultations. Participants bring with them official data of their respective situations together with professional problems connected with them. Reference materials like books, manuals and reports are made available by the organizers for the participants. The effectiveness of the seminar/workshop depends upon a highly qualified pool of resource persons, careful planning of subjects, resources, schedules, food accommodation etc. as well as active participants of the trainees.

Field days: Field days generally held in places where large crowds can gather to see field trails, machinery demonstrations and other improved farm practices. Subject specialists invited to discuss problems of the farming people and, workout solutions. Field days give farmers an opportunity to discuss matters of common interest with each other. Under the project 90 field days were organized at selected villages on different aspects.

Training: Fourteen (14) training were organized for farmers, rural women and extension field staff in the target area for transmission of knowledge, skills, attitudes, motivations, etc. concerning the safety requirements of operations, processes, environments, etc. to workers, supervisors, managers and others.

Printed Material: The printed matters are more expedient, more manageable and better suited to meet the needs of the farming community given the increasing yearly increments to the knowledge of ever changing technology. There is evidence that money spent on publications changed 40% more practices than the average of all expenditure on extension teaching. Under this project 28 brochures/booklets were printed on various aspects on agriculture and same is distributed in meetings, fairs, exhibitions, shows and farmer's days.

Radio Talks: Radio is an immensely powerful technology for the delivery of education with enormous global potential reach. Under the project 31 radio talks on crop production technology of major crops, fruits and vegetables in local language were recorded. These are broadcasted from radio station Hyderabad.

Name of Project: **Poverty Alleviation through Introducing Improved and Tested Technologies for Rural Agricultural Farming Communitiesi in the Selected Districts of Balochistan**

Name of PI/ Institute: **Mr. Muhammad Afzal,**
Director,
Technology Transfer Institute (PARC), Siriab Road, Quetta, Balochistan.

Duration: 28. 08. 2004 to 27. 08. 2007

Financial Status:
Total Cost: Rs.4.822 million
Total Releases: Rs.3253200/-
Total Expenditure: Rs.2354739-

Objectives:

- Identification of issues, constraints, opportunities and prioritize farmers' needs of improved technologies.
- To establish information exchange forum (IEF) at the village and community level through existing CBOs;
- To enlist research based tested and proven technologies/ interventions available with NARS located in the province;
- Arrangement of capacity building programs for farmers, activist, and extension workers, of all cadres as well as district government functionaries on sustainable basis;
- To create the functional linkages with extension, research and all line departments to make IEF operational through two way flow of information. Developing mechanisms of technology transfer to the end users.
- Disseminate the demand driven technologies to the farmers;
- Establishment of a participatory, monitoring and evaluation (PME) system at CBOs level for performance assessment and ongoing monitoring and evaluation.

Achievements:

During the current year 2006-07, field days on technology dissemination (BM, vegetable and crops) as well as mobile veterinary camps were organized in all the project sites. Brochures on rice production technologies and production of small ruminants were also printed and distributed among the farmers.

Fields Days/ Seminars: Fields days on wheat varietals adoption and production technology in Mastung, Pishin, Loralai and Manguchar were organized.

Fields days on tomato, cotton, BM and Livestock were organized in Muslakh, District Bolan, Pishin, Jaffarabad and Mastung.

Survey on Soil and Water Sampling: To assess the ingredients proportion in the sub or surface

soil as per crop requirement, soil and water sample collection survey was initiated in September 2006 in Pishin district. It was extended to Jaffarabad, Bolan, Mastung and Loralai districts. pH, $CaCl_2$, Texture, ECe, mS/cm, organic mater%, total nitrogen%, available phosphors ppm, available potassium ppm and $CaCO_3$% parameters were considered. The data analyzed and prepared report. The services of soil scientist were hired and delivered lecture on usage of chemical fertilizer, FYM as per soil result to the farmers.

Name of Project: **Human Resource Development (HRD) in the Changing Environment of Globalization – Collaboration with APO**

Name of PI/ Institute: **Dr. Abdul Hayee Qureshi,**
Senior Scientific Officer
(WTO) Social Sciences Division, PARC, Islamabad

Duration: 27. 04. 2005 to 26. 04. 2008

Financial Status:
Total Cost: Rs.4.735 million
Total Releases: Rs.3732100/-
Total Expenditure: Rs.2486183/-

Objectives:

- To provide an opportunity to the participants from the APO member countries to share their views and experiences on the issues confronting to agriculture sector;
- To learn methods and procedures to assess and analyse policies and issues pertaining to the chosen areas of agriculture;
- To suggest policy recommendations and solutions for higher agricultural productivity and production.

Achievements:

A five days seminar on 'Best Practices of Agricultural Technology Transfer and Commercialization' was held from 4 to 8 December 2006 in Islamabad, Pakistan, organized by the Asian Productivity Organization (APO) and implemented by the Pakistan Agricultural Research Council (PARC) and the National Productivity Organization (NPO). Nineteen participants from 7 member countries and six resource speakers from Asian Vegetable Research Institute (AVRDC), India, Pakistan, Philippines, and USA attended.

The objectives of the seminar were: 1) to review the current status of the development, transfer, and commercialization of agricultural technologies in member countries, 2) to discuss best practices and approaches for agricultural technology transfer and commercialization; and 3) to formulate strategic actions for the effective transfer and commercialization of agricultural technologies.

In the seminar resource papers were presented by selected experts focused on the topics: 1) Management, transfer, and commercialization of agricultural technologies in the Asia-Pacific region; 2) Creating an enabling environment for agricultural technology transfer in developing countries: issues, challenges and strategies; 3) Innovative Approaches in Disseminating Agricultural Technologies Considering the Viewpoint of Asian Farmers; 4) Managing intellectual property rights (IPRs) for better transfer and commercialization of agricultural technologies; 5) Technology Development for Value Addition of Various Food Materials of Agricultural Origin; and 6) Adaptation and Commercialization of Thro N-Type Rice Thresher: a success story. The lead presentations were followed by the presentation of country papers wherein the participants

discussed the current status of Agricultural Technology Transfer and Commercialization in their respective countries. For field studies, the participants visited: a) Amjad Brothers Zarai Industries, Faisalabad; and b) Institute of Food Science and Technology of the University of Agriculture, Faisalabad. This was followed by group discussions wherein the participants identified issues and problems in agricultural technology transfer and commercialization and formulated action plans to address them.

Workshop Outputs: A workshop was organized to discuss salient issues and impediments in effective transfer and commercialization of agricultural technology in respective member countries; and to formulate national strategic action plan needed for effective transfer and commercialization. For in-depth discussion on the subject, participants were divided into two groups. The Group-I included Bangladesh, Mongolia, Nepal and Sri Lanka while Group-II consisted of Iran, Pakistan and India. The output of group discussions is summarized below:

Recommendations: Based on resource paper and country paper presentations, group discussion, and other sources of information, seminar participants forwarded the following recommendations:

Adjustment to paradigm shift:

1. A lot more emphasis should be placed on marketing, commercialization and export of the agricultural produce and products rather than continue traditional emphasis only on increasing agricultural production.

2. In order to meaningfully enter into the domain of agricultural innovation, the technology generation and technology transfer institutions should broaden their vision beyond traditional agricultural norms for comprehension of developments like emerging food and health concerns, changes in consumers' food habits, changes in market competition pattern, and recent applications of information technology to agricultural research and extension.

Policy support:

i. In view of increasing trend towards privatization, the government should ensure that the small and marginal farmers should not be deprived from receiving cost free extension advice from public extension services.
ii. Various types of government incentives, including financial ones, should be given to farmers.
iii. Provide policy incentives for the private companies for their extension services for the farming communities.
iv. Need-based facilities should be provided to all R & D institutions involved in farm-market-consumer value chain.
v. More attention should be given to strengthen research and especially extension institutions where devolution or decentralization has occurred due to the fact that these institutions seem to have been marginalized in the process.
vi. Consideration should be given to the creation of one-stop farmers' service centers and public-private partnership houses at an administrative level with convenient access by farmers.
vii. Although agro-ecological zone mapping has been done in several countries, it should be done as a matter of policy in those countries also which have not yet benefited from this

very useful activity.

Intellectual Property Rights (IPR):

1. Knowledge-based economy should be encouraged in all countries in the region to effectively manage IPRs under the TRIPS (Trade-related Aspects of Intellectual Property Rights) regulations of the WTO.
2. Identify protected and non-protected agricultural technologies on regular basis.
3. The countries should make the educational investments required to establish the domestic capacity so as to withstand the challenges of knowledge economy.
4. Capacity building on IPR management for different stakeholders [academic institutions, R&D institutions, industries (goods and services), government departments and ministries (law making, regulating, providing funds and incentives for research, etc) and other agencies such as attorney firms, judiciary, farmers and NGOs and different aspects vis-a.-vis IPR awareness, information and documentation, patent search and analysis, techno-legal drafting of patent applications, patent litigation, licensing, valuation and negotiating IP (Intellectual Property) licensing deals.
5. Capacity-building should be multi-faceted at the national level, regional level and at multi-country level, which are in the same stage of development so as to remain ahead or at par in the knowledge race.
6. The development of skills and competence to manage IPR and efforts should be made for synergism between industry and scientific research by creating Autonomous Technology Transfer Units as associate units of universities and national laboratories to facilitate the transfer of know-how generated to industry.
7. Asian countries should file joint application of appropriate geographic indications, wherever possible to protect their IP from exploitation by unscrupulous organizations (e.g., Basmati rice by India and Pakistan).
8. Non-exclusive licensing should be given for agricultural technologies. However exclusive license should be given only in situations where (i) commercialization in foreign countries, (ii) difficult areas offering low incentives; (iii) commercialization requiring high development cost, iv) exclusive license should cover only one territory while it is non-exclusive in another, etc.
9. Asian countries should form an alliance for cooperation regarding Distinctness, Uniformity and Stability (DUS) testing, sharing of data, buying/borrowing of test reports, use of reference varieties from other countries for effectively protecting the plant varieties to save time and expenditure and more so utilize intellectual capital at the earliest for their population.
10. Incentives should be given to researchers and enterprises by government funding agencies for promoting the culture of innovation and intellectual protection in industries, and academic as well as R&D institutions. The following incentives, for example, would be extremely useful:
    i. Excise duty waiver on patented products for a certain period of time from the date of commencement of commercial production.
    ii. Financial government support for commercialization of indigenous technologies.
    iii. Creation of technology development boards by government funding agencies for financing of indigenous technologies for setting up of commercial plants. (In India, for example, 50% of the cost of setting up of industrial unit is given on easy loan

repayment basis).

iv. Exemption from drug price control order - Bulk drugs produced based on indigenous R&D may be exempted from drug price control for a certain period of time from the date of commencement of commercial production.
v. Weighted tax deduction on R&D expenditure - Weighted tax deduction (e.g. @ 150%) on R&D expenditure should be available to companies engaged in the business of biotechnology, agricultural technologies, manufacture of agrochemicals, etc. The expenditure on scientific research shall include expenditure incurred on clinical trials, field trials, obtaining approvals from the regulatory authority of state/province and central governments and for filing a patent application.
vi. Accelerated depreciation allowance - Depreciation allowance at a higher rate should be made available to the industries, which are involved in the manufacture of goods or products based on indigenous technologies.
vii. Tax holiday to R&D companies for some years which are involved in the development of agri-technologies.
viii. Income tax relief on R&D expenditure
ix. Tax deduction for sponsoring research

Coordination among stakeholders:
The interaction, collaboration and coordination among agricultural research, extension, producers, civil society institutions and private sector should be enhanced in the matters of choice, introduction and commercialization of technologies.

Support for SMEs:
Techno-based entrepreneurial ventures in the agriculture sector should be supported incorporating incubation mechanisms such as agricultural technology transfer, legal and marketing orientation and training.

Capacity-building:
There should be a well planned and detailed re-orientation of agricultural research and extension staff to global marketing changes in relation to their present mandates and country conditions.

In all activities on capacity-building for research and extension, relevant public and civil society institutions and the private companies should be included in the exercise for more comprehensive and meaningful capacity development of the institutions which serve farmers in various capacities.

Training programs should not only focus on training of extension workers in crop sector but also in livestock, fisheries and any other major subjects which are of interest to the farmers.

In view of the fact that, unlike for agricultural research, very few international flora exist for agricultural extension, extension workers should be encouraged to join professional national and/or international networks in order to keep themselves abreast of the latest developments in their professional fields.

Institutional reforms:

i. The number of subject-matter specialists in different technical subjects, which is presently scant in many countries' extension services, should be increased and their placement in various locations should be determined by the dominating technical advice needs of farming communities in that particular location.
ii. Institutional and operational reforms should be initiated both in research and extension organizations in order to bring their functions and practices in line with recent global socio-economic developments.
iii. The number of adaptive agricultural research units should be increased with revised terms of reference asking for more active involvement of men and women farmers in field trials to ensure research which addresses farmers' field problems.

Field operations reforms:

i. More gender-sensitive and grassroots approaches should be used in order to encourage rural community-level planning and decision-making by men and women in research and extension programming.
ii. Local conditions should be kept in view while developing agricultural machinery designs so that they could be quickly accepted and used by the producers in a smooth way.
iii. Objective assessment should be undertaken for specific technologies, prior to their release, for their agricultural enterprise potential covering technical feasibility, social acceptability, environmental soundness, financial viability, and possible government policy and political support.
iv. Technically sound surveys should be conducted for assessing the socioeconomic impact of technology dissemination and agricultural extension approaches and programs, against pre-intervention baseline surveys data.

Finally, the participants recommended that International Organizations such as FAO, APO, ADB, World Bank should enhance their support for their member countries in strengthening their national systems for effective transfer and commercialization of agricultural technologies. Further APO should continue to organize this type of workshops for creating awareness of the emerging trends in agricultural sector especially technology generation, assessment, transfer and commercialization to change the mind set of all stakeholders.

Monitoring and Evaluation of Projects – Salient Findings

Monitoring and Evaluation of Projects – Salient Findings

Monitoring and evaluation of projects play an important role in successful implementation and provide better means for learning and improving planning and allocating resources. The Planning Directorate working as ALP Secretariat for the Agricultural Linkages Program funded under Agriculture Research Endowment Fund (AREF), beside project identification, appraisal and approval, is actively involved in monitoring, review and evaluation of ongoing projects. The progress of projects are monitored at various levels using different means i.e. evaluation of mid year and annual technical progress reports, in-house review on completion of one year and onsite evaluation through experts by visiting field and lab. activities.

During the year 2006-07, 20 projects of Animal Sciences were evaluated. In crop sciences 23 projects were evaluated while 15 projects of natural resources were evaluated during March/April, 2007 as most of projects activities were visible in field in form of standing crops. Similarly in social sciences 5 projects were evaluated. The findings of the reports have been provided to the concerned PIs for taking necessary action on the recommendations.

The performance and rating of the projects according to the evaluation reports is summarized as under:

1. **Animal Sciences**

S #	Title of Project	Salient Findings and Rating
1	Production of Breeding Bulls to Improve Milk Production of Nili Ravi Buffaloes in Rural Areas, LPRI, Bahadurnagar, Okara	• Progress found satisfactory • Selected bulls produced to improve milk production in Nili Ravi Buffaloes
2	Enhancing Milk Yield of Kundi Bufaloes through Production of Performance Tested Bulls, Animal Husbandary Deptt, Hyderabad Sindh	• Progress is partially satisfactory • No outstanding finding is available, the project itself had a great scope due to community involvement and strategic breeding plans initiated towards the genetic improvement of Kundi Buffaloe for the first time
3	Studies on the Effect of Bovine Somatotropins on Productive and Reproductive Parameters of Kundi Buffaloes in Sindh, SAU Tandojam	• The progress found satisfactory • Use of rbST seems to enhance milk production without significant negative effect, yet its propagation would require extra care. Longterm response to rbST treatment and its impact on human health needs to be documentd. There could be a possibility of trade restrictions as well.
4	A Comparison of Concentrate and Fodder Based Finishing Diets on the Performance, Carcass Composition and Meat	• The progress was rated as satisfactory • Findings of the study will be useful and identification of the breeds suited to different systems of production i.e. concentrate or forage based

	Quality of Lohi and Sipli Lambs, University of Agriculture, Faisalabad	
5	Effect of Long Term Use of Bovine Somatotropin (Bst) Hormone on Milk Productionl Reproductionl Health and Various Physiological Parameters in Nili – Ravi, LPRI, Bahadurnagar, Okara	• The progress was found satisfactory • No significant affects of long term use of bST found. • Project should produced information leaflet giving project results with economics of the long term as well as short term use of bST harmones. There is also strong need to study the effects of bST use in animals on human health etc.
6	Genetic Characterization of Native Cattle and Buffalo Breeds of Pakistan, University of Agriculture, Faisalabad	• Progress was satisfactory • Techniques for DNA extraction established in optimaization of PCR conducted. On completion of study researcher will be able to identify breed specific markers which will help in patenting our indeginous cattle & bufaloe breeds internationally.
7	Development of Milk Recording and Genetic Evaluation Models in Sahiwal Cattle, University of Agriculture, Faisalabad	• Progress rated as Good • Developed the Genetic Evaluation Models
8	Influence of Altering Dietary Cation Anion Difference on Productive and Reproductive Efficiency of Buffaloes, University of Agriculture, Faisalabad	• Progress found as Satisfactory • The findings of the studies indicate role of balancing dietary cation & anion to enhance milk production, reproductive efficiency and management of buffaloes during summer conditions. Finding of the studies has been produce in leaflets and in "Urdu"
9	Application of Molecular Techniques for Differential Diagnosis of Rinderpest and Related Diseases, NIBGE, Faisalabad	• Progress was rated as Satisfactory • Primers developed shall be useful for differential diagnosis of vesicular diseases in animals. These primars shall not be used for typing or subtyping of FMD virus isolation in Pakistan
10	Aquaculture of Fin Fishes (Snappers and groupers) in Ponds along Hub River Estuary/Gharo Creek, University of Karachi	• Progress found satisfactory
11	The status of Shrimp's Fisheries in Sonmiani Bay Lagoon, Baluchistan, Pakistan, University of Karachi.	• Progress is Satisfactory • PI is suggested to include a concise chapter with analytical approach on the problems of the shrimps industry in the studied regions
12	Studies on Mineral Imbalances in the Livestock of Canal Irrigated Districts of	• Progress rated as Good • Useful information is expected for preparation of feed supplements and ration

	the Punjab, UVAS, Lahore.	
13	Epidemiology of Helminthiasis in Sheep, UVAS, Lahore.	• Project rated as Partially Satisfactory
14	Mott grass as a Potential Source of Dietary Forage for Lactating Sahiwal Cows, University of Agriculture, Faisalabad.	• Progress found as Satisfactory
15	Immuno-prophylaxis of Foot and Mouth Disease (FMD) in bovines, UVAS, Lahore.	• Progress rated as Satisfactory • Developed the inexpensive FMD Vaccine
16	Molecular Characterization and Pathogenicity of Avian Adenovirus Causing Hydropericardium, UVAS, Lahore.	• Progress found Partially Satisfactory
17	Studies on the Reproductive Physiology of one Humped Camel (*Camelus dromedaries*) in the Natural Ecology of Pakistan, University of Agriculture, Faisalabad.	• Progress found Partially Satisfactory
18	Clinical & Biochemical Studies on Genital Prolapse in the Buffalo, University of Agriculture, Faisalabad.	• Progress rated as Satisfactory
19	Development of Supplementary Feed Based on Apparent Nutrient Digestibility of Different Feed Ingredients for Laboe rohita Fingerlings.	• Progress found Satisfactory • Improved fish feeds will be available for supplementary feed
20	Evaluation of Indigenous Medicinal Plants for the Steroid Hormonal Activities for Veterinary and Medicinal Use, University of Agriculture Faisalabad.	• Progress rated as Satisfactory • Heat stable herbal hormones inducers have been investigated

2. Crop Sciences

S #	Title of Project	Salient Findings and Rating
1	Introduction and Yield Improvement of Moth-bean in NWFP, ARI D.I. Khan	• Satisfactory • Selection of YMV resistant Mothbean lines is very important aspect for introducing this crop among the farmers for getting seed yield and growing as fodder for animals.
2	Better Utilization of Food for Healthy and Productive Life in Agriculture Sector, NWFP Agricultural University, Peshawar	• Partially Satisfactory • Data was analyzed for nutrients intake which may not necessarily be the nutrients absorbed like in case of protein Biological value (BV) should be considered. • According to the personal history table of the farmer with reference to table 1, weight and height of different farmers of different villages do not show their status as UNDER-WEIGHT • All the research activities were according to their approved work plan.
3	Quality Characterization of Oilseed Crops through NIRS, NIFA, Peshawar	• Satisfactory • The calibration equations developed at the end of the project will be useful and valuable for the breeders and researchers in the country for prediction of quality characteristics (oil content, protein content, fatty acid profile, uric acid and total glucosinolate content) of major oilseed crops like rapeseed/mustard, canola, sunflower, sesame, soybean and groundnut through NIR spectroscopy technique.
4	Development of Heat Tolerant, Early Maturing and High Yielding Mungbean (Vigna radiata (L.) Wilczek) Genotypes, NIFA, Peshawar	• Satisfactory • One variety i.e. Ramzan has been released through this project
5	DNA-based genetic characterization of cotton germplasm (Component-I), NIBGE, Faisalabad	• Satisfactory • Total 95 genotypes of *G. hirsutum* and 33 *G. arboreum* were utilized for this study. Genomic DNA of all these genotypes was isolated and amplified using PCR analysis. • Information of each polymorphic locus for structural genomic markers was gathered and mass scale DNA characterization of cotton germplasm was carried out using different SSR series
6	Use of RNA Interference for Genetically-Engineered Male Sterile Tomato Plants for Production of	• Satisfactory • For developing male sterility in tomato two genes namely Lat 51 and Ta 29 were targeted using RNA technology • TA 29 gene was amplified and cloned from the genomic DNA of tomato and was sequenced by di-deoxy method

	Hybrid Tomato, NIBGE, Faisalabad	• Sequencing of TA-29SN1 clone from tomato showed maximum homology with tobacco TA-29 gene. In the same way a pollen specific gene Lat 51was isolated and successfully cloned in a vector and is being transformed
	Application of DNA Finger Printing for Drought Tolerance in Wheat, NIBGE, Faisalabad	• Satisfactory • Analysis of cell membrane stability of 95 genotypes and synthetic population was completed. The other characters recorded were seed size, coleoptile length, photosynthesis, relative water content. Kohistan 97, Chakwal 86, Barani 83 and Rawal 87 were found drought tolerant lines as compared to others whereas MH-97 was sensitive to drought. • The F1 generation was raised to F2 from the crosses made last year between drought tolerant (Kohistan 97) and sensitive genotypes (MH-97). A population of a cross between Opata and genotype-257 was raised in the field.
8	Molecular Characterization of Available Germplasm of Wheat in Pakistan (Component-II), University of Agriculture Faisalabad	• Satisfactory • 350 accessions of wheat germplasm have been acquired from Plant Genetic Resources Program and other sources. The material acquired is being characterized using Random Amplified Polymorphic DNA (RAPD) and Simple Sequence Repeats (SSR). • The data generated form the experiments reveal that medium to low genetic diversity exist in the germplasm. So there is need to broaden the genetic base through acquisition/collection from diverse ecologies.
9	Development and Testing of a Resource Conservation Tillage implement, University of Agriculture Faisalabad	• Report is in Pipeline
10	Development of Integrated Pest Management of Subterranean Termits in Agro-Ecosystem, University of Agriculture Faisalabad	• Satisfactory • Sufficient work has been undertaken and data collection in properly laid out trial. • PI has been collected the sufficient data regarding the behavior of termites using standard monitoring techniques
11	Studies on Resistance Monitoring and Insecticide Effects on Chrysopid Predators (Neuroptera)	• Satisfactory • Collection of the *Chrysoperla carnea* had been made from Multan, Bahawalpur, D. I. Khan, D. G. Khan and Rahim Yar Khan. The results given in the report are in line with the objective of the project as per approved work plan • Interpretation of the results is reasonably good and results are nicely presented in tabulated forms. A good synthesis of the overall results is presented analytically

12	Molecular Characterization of Rice Germplasm Using RAPD Analysis	• Satisfactory • The accomplishments are quite well according to the approved work plan. • P.I. taking a very cautious approach has ensured the purity of varietal material form reliable sources. This would eliminate any later confusion due to any past error in labeling/indexing of the collection in germplasm resource.
13	Characterization of Pakistani Isolates of Chili Veinal Mottle Potyvirus (ChiVMV) and Cucumber Mosaic Cucumovirus (CMV) Infecting Chili Crop	• Satisfactory • The project Scientists studied 44 different plant species as probable host of ChiVMV virus and found that out of these six were susceptible to this virus. However, the project Scientists have not made similar studies on CMV • The target of screening Capsicum germplasm against ChiVMV virus under controlled condition was achieved for Sindh and Punjab isolates of ChiVMV virus
14	Development and Evaluation of a Mobile Flat-Bed Dryer for Sunflower and Canola	• Satisfactory • A complete operational model of the Mobile Flat Bed Dryer for Sunflower and Canola has been manufactured
15	Studies on Breeding Biology and Post-Natal Development and Control Trails against Rodent Damaging Date-Palm Orchards of Tehsil Nok Kundi Distt: Chagai-Balochistan	• Partially Satisfactory • Collection of 10 live rodent specimens has been carried out who damage the Palm Trees and the taxonomic and morphometric data gleaned from these specimens confirm the genus Nesokia and suggest the species as short-tailed mole rat (Nesokia indica) • The economic analysis has showed a loss of Rs. 5.33 million per crop season and it is has been estimated on the basis of prevailing market rates and estimated production of dates per tree per season.
16	Integrated Weed Control for Major Crops (Wheat & Rapeseed) and Fallow Land in Pothwar (Component-II)	• Performance of the project rated as satisfactory • P.I. may use these experiments for the training of graduate students of his university to equip them in proper use and handling of chemicals. This lot of students will be asset in future to extend the knowledge of weed management to the end users. • P.I. was asked to do the economical analysis of all the treatments or their combinations for evaluation of the best possible recommendation that is economically viable.
17	Integrated Weed Management in Wheat, Cotton, Rice and Pulses in Punjab	• Performance of the project rated as satisfactory • This project is a part of the umbrella project which is in progress through out the country. Some components of this project have not progressed as desired / planned. In the present scenario I may recommend that since the target crops of both the Faisalabad & Tandojam components are almost same therefore Faisalabad may help ARI, Tandojam

		in consolidating the recommendations for weed management of the target crops
18	Development of High Yielding, Long Grain Varieties of Rice for Par Boiling Purpose.	• Performance rated as partially satisfactory • The P.I. mentioned that he is yet to record some physical grain parameters. As well as he wishes to transfer the long grain parameter to existing Basmati varieties through conventional breeding if he is allowed to utilize unspent budget of the project for another two years. Although, it is not possible to transfer the trait from the mutants to the existing Basmati varieties just in two years through conventional approach but he may be allowed to initiate this work in this direction. Otherwise the P.I. may go on with this test in his routine departmental research programmes at NIAB.
19	Enhancement And Evolution of Germplasm For Stressed Environment Through The Use of Agro-Biodiversity.	• Performance rated as satisfactory • The PI claims to have produced a new wheat species informally named as "DURUGEN" having drought and salt tolerant abilities. This species has produced by crossing two tetraploid wheat species followed by natural doubling of chromosomes. • It was suggested that the drought and salt tolerant material developed by the PI may be utilized for further wheat breeding programme at NIAB and any other wheat research stations of the country as the material seems to be an excellent source for these important biotic stress traits as claim by the PI.
20	Developing forage-plus-grain winter wheat production system for the Northern areas.	• The progress of the project found "Excellent" • P.I. has done a very appreciable job to develop a base for the research work on the winter wheat cultivars and generated basic information regarding the adoptability of the germplasm in Pakistan. He may share this information with the other groups of scientists working on the issue and may initiate a collaborative project with Coordinated Research Programme on Wheat at NARC, Islamabad. • Economic analyses for using these varieties as forage or for grain or in combination will be helpful for the farmers.
21	Integrated Weed Control in Cereals (Wheat and Maize), Peshawar (Component-IV)	• Performance rated as satisfactory • Field experiments are in progress using all available options. Different weed control methods including use of pre and post emergence herbicides have been almost finalized for the crops under investigation. Hopefully project will be able to deliver some recommendations on the basis of one year data.
22	Identification of superior Soybean Cultivars for different	• Performance rated as satisfactory • The data may be analyzed statistically by using appropriate

	Agro-ecologies of Pakistan	statistical method after consultation of scientific literature. • The analysis of oil content of all the lines of soybean selected for different areas may also be carried out. • The area where this crop is economical and fit in the rotation may also be identified and soybean lines suited to that particular area may be specified. • In new areas where soybean is intended to be grown, its economics in relation to already grown crops/ cropping pattern may be calculated.
23	Transgenic Tomato with Resistance to Bacterial Wilt	• Performance rated as partially satisfactory • The PI was suggested to multiply the transgenic material as soon as possible, so that the testing can be performed within the project duration. • Try to avoid horizontal expansion to the maximum possible extent, so that more efforts are utilized in vertical accomplishment. • The green house/ laboratory work should strictly be supervised by the P.I.

3. Natural Resources

S. No	*Name of Project*	*Project Performance and Rating*
Pakistan Council of Research in Water Resources (PCRWR), Islamabad		
1	Refinement of Skimming Well Design and Operational Strategies for Sustainable Groundwater Development	The project is rated good. The findings are of practical nature and are useful. The knowledge generated/information may be disseminated and demonstrated in other areas for the use of fresh ground water.
2	Use of Low Quality Groundwater for Sustainable Crop Production	The experiments were not looked after properly. The whole field was infested with weed. The progress is unsatisfactory.
University of Agriculture, Faisalabad		
3	Testing and Evaluation of Lining and Control Structure Alternatives for Irrigation Channel	Overall the project rated partially satisfactory and works needs to be improved.
4	Management Aspect of Surface and Groundwater Resources of Irrigated Areas	The project made some good findings; water table especially sweet water is falling deeper due to increasing pumping and reduction in recharge and causing of mining. The situation demands either to shift from high crops to low delta crops or maintain equilibrium between water pumping and recharge. The progress of the project is satisfactory and can be rated as good project.
5	Sustainable Rice-Wheat Farming System on Salt-Affected Soils Using Brackish Water and Amendments	Progress of project found partially satisfactory and work needs to be improved
6	Silicon Nutrition for Enhancing Crop Productivity	Addition of silicon under saline and toxic soil cadmium condition improved yield of rice and wheat. Keeping in mind the beneficial effects, use of silicon as fertilizer for sustainable agriculture is recommended by PI in the report. Three scientific papers published from project research work are very informative and contained lot of useful information.

		The progress of the project found and rated satisfactory and recommended for continuation.
7	Management Strategies for Metal Contaminated Soil Receiving City Waste Effluent for Sustainable Crop Production and Food Security	Progress of the project found partially satisfactory and work needs to be improved.

National Institute for Biotechnology and Genetic Engineering (NIBGE), Faisalabad

8	Use of Nitrogen Fixing, Plant Growth Promoting Rhizobacteria (PGPR) for Development of Bio-Fertilizer for Crops on Economic Importance Umbrella Project (NIBGE, Faisalabad - Component-II)	Progress of the project found partially satisfactory and work needs to be improved.

National Agricultural Research Centre (NARC), Islamabad

9	Modeling Leaching Losses of Fertilizer Nutrients from Root Zone and Environmental Implications	Field Soil nutrient leaching experiments under saturated conditions depicted that presence of N and P contents in leachate shortly after application indicate the nutrient losses from surface soil to subsurface soils. Particularly, the presence of a reactive nutrient - P in leachate of all the soils depict phosphorus movement despite the soil P sorption capacity. The progress of the project rated satisfactory and recommended for continuation.
10	Increasing and Sustaining Crop Productivity of Water Eroded Lands through Rainwater and Soil Fertility Management	Water conservation and fertilizer application have tremendous scope for increasing crop production. Water use efficiency is affected by number of factors such as available water, crop, soil fertility status, weed control etc. Fertilization improved yield components and resultantly the grain yield. Water use efficiency increased appreciably under fertilization over control. Under nutrient deficient soil, simple water conservation practices can not increase crop yield and water use efficiencies, significantly. The progress of the project rated

		satisfactory and recommended for continuation.
11	Improving Root-Association of Diazotrophs (Azorhizobium spp. Azospirillum spp.) in Rainfed Wheat	Initial data shows the prospects of some N-fixing bacterial isolates to contribute about ¼ of wheat crops N-requirement viz. 30 kg ha^{-1}. This could be an appreciable contribution through BNF and would save farmer's money if provided the inoculums of these bacterial isolates. It is a useful study for developing a bio-fertilizer. The progress of the project rated satisfactory and recommended for continuation.
12	Use of Nitrogen Fixing, Plant Growth Promoting Rhizobacteria (PGPR) for Development of Bio-Fertilizer for Crops on Economic Importance(Coordinated Project- NARC Component-I)	The up to date progress of the project found satisfactory and recommended for continuation
13	Assessment of Productivity Potential and Utilization of Rangelands and Sown Pastures in Pothowar Plateau	. The project will produce useful data/information with respect to range assessment and potential species for Pothowar region. *Panicum maximum* has great potential to provide the fodder during lean winter season. *Panicum antidotale* with moisture content of 65.92 % has been found as quite succulent and need to be encouraged. The crude protein contents in *Bothriochola pertusa* (Palwan) and *Panicum antidotale* has been observed as high as 20.12% and6.12% respectively on the matter basis, hence need to be propagated. The progress of the project rated satisfactory and recommended for continuation.

NWFP Agricultural University, Peshawar

14	Increasing Crop Production Through Humic Acid in Rainfed and Salt Affected Soils in Kohat Division (NWFP)	The application of humic acid (HA) for different crops improved the productivity. Among the methods applied for use of HA, application of HA through soil spray was found more efficient than banding or

		broadcast. Progress reports were organized and written in explicit manner. The progress of project found and rated satisfactory and recommended for continuation.

Pakistan Forest Institute (PFI), Peshawar

15	Determination of Growth, Wood Properties and Water Table Control Following Afforestation of Proven Provenances/Species Under Saline and Waterlogged Conditions in Pakistan	The progress found and rated satisfactory and recommended for continuation.

The major contributions of the projects are:

i. The institutes has been are strengthened in form of research and lab. equipments, machinery and computers etc.

ii. The host institutes provided with operational funds has contributed in research and development and made functional to some extent.

iii. New knowledge and information has been generated in forms of progress reports, research papers, brochures etc. and shared with scientists through circulation, field days and seminars, workshops etc.

iv. Supported students especially in agricultural universities in conducting research for their degree program. As a result numbers of students have been awarded B. Sc (Hons.), M. Sc (Hons.) and Ph. D degrees on successful completion of their thesis.

v. Provided job and better training facilities to the graduate students on recruitment in projects as Research Assistants/Fellows/Associates

vi. Being the 1st competitive grant in field of agricultural research, enhanced the capabilities and skills of scientists to develop and win research proposals for funding

vii. Established national and international linkages and coordination among various research scientists and institutes.

4. Social Sciences

Project Title: **Strengthening of Design and Analysis Capabilities in the NARS, University of Agriculture, Faisalabad**

Findings:

Overall progress presented by PI seems satisfactory. Project has almost completed its life and has achieved the targets as per work plan. However, the expenditure of the project is proportionately on the lower side which may be utilized efficiently in the remaining life of the project. Final project report due in near future is expected to be a comprehensive one and findings with certain recommendations for adoption of biological and social scientists. Project termination date is August 2007.

Project Title: **Impact of Sanitary and Phytosanitary Agreement (SPS) on Agricultural Exports from Pakistan**, **University of Agriculture, Faisalabad.**

Findings:

The project has already completed its duration on March 16, 2007 but it is still at the stage of data collection and a lot of work has to be done for accomplishment of the project objectives and planned activities. PI in his letter No./DMAB 238-40 dated April 17, 2007 mentioned the major setbacks in execution of project research activities. Delay in releases from PARC was claimed the main reason, which is incorrect. The reason for delay in releases from PARC is actually due to late submission of financial and physical progress reports by the PI to the ALP Secretariat. The physical and financial progress of the project is far behind the schedule and not much satisfactory. The expenditures of the project are proportionately on the lower side which may be utilized efficiently. PI raised the issue of the availability of research fellow, retaining at wage rate of Rs. 8000/- per month and the lengthy process of recruitment are the main reasons of behind the schedule progress of the project. Extra efforts are required to accomplish project objectives and targets. During the project review, PI requested for extension in project life from March 17, 2007 to December 31, 2007. Member (SS) advised him to submit draft research report first on the citrus and mango by mid-August, 2007. Based on the quality of the research report and overall physical and financial progress, extension request in project duration up to December 2007 may be considered and recommended for the approval of ALP BOD. PI promised to submit the draft report by mid-August 2007.

Project Title: **Socioeconomic and Health Implications of Female Unpaid Work in Agriculture and Livestock Sector**

Findings:

Project is behind the schedule and performance may be rated unsatisfactory. Informal survey and annual progress reports to gauge scientific outputs against targets/planned activities are not furnished; and progress claimed in reports is not supported by any tangible technical/physical outputs. Project file is totally empty and silence. The use of financial resources of the project is

proportionately on the lower side which may be utilized efficiently. Project will terminate in September 2008. There is a need to speed up the project activities for timely completion of project planned activities. However, PI vowed to accomplish all project objectives and targets within project life.

Project Title: **Bridging the Gender Gap in Agri. Extension through Designing and Testing an Innovative and Holistic Outreach Program of the UAF Strengthening of Design and Analysis Capabilities in the NARS, University of Agriculture, Faisalabad**

Findings:

Progress seems not very much satisfactory. Overall performance of the project is behind the schedule. Some of the planned activities are still required to achieve the project objectives. Field survey has to be undertaken to identify and prioritize future needs for capacity building of rural community for both male and females in the project areas; to assess the gender gap regarding information need related to agriculture and home economics; and to analyze the obstacles to gender and development. Progress reported to ALP Secretariat does not match to the accomplishments of the project. The expenditures of the project are proportionately on the lower side which may be utilized efficiently. So there is a need to speed up the project activities for timely completion of project planned activities. Project will terminate in March 2008.

Project Title: **Comparative Advantage and Competitiveness of Major Crops in Pakistan – Price Risk Analysis, University of Agriculture, Faisalabad**

Findings:

Project is far behind the schedule. Financial and technical performance is extremely poor. Project is still at primary data collection stage while the project is going to terminate in November 2007. The expenditures of the project are also proportionately on the lower side which may be utilized efficiently. Project Incharge must realize his responsibilities and take project seriously to honor his commitments for timely achieving its objectives, targets and planned research activities. During review, the PI requested for extension in its life.