Final Report

Ex-post Evaluation of PTTC Project
Genetic Resources Preservation and Research Laboratory (GRP & RL)

in

Plant Genetics Resources Institute (PGRI),
National Agricultural Research Center, Islamabad.


Plant Genetic Resources Institute, Islamabad. Pakistan

JICA Pakistan Office

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PREFACE

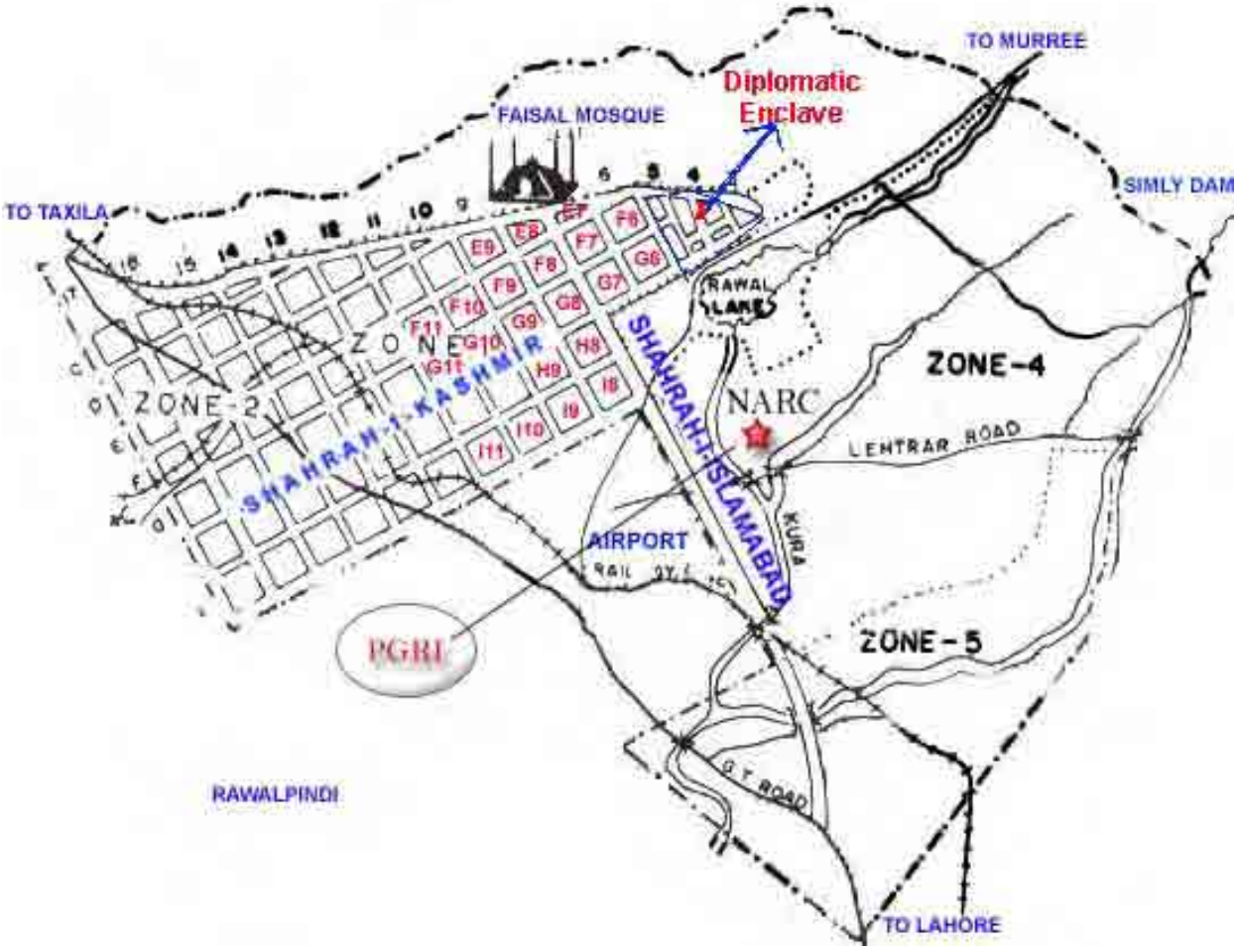
A consistent evaluation system from the preliminary stage to ex-post is considered as an important yardstick to judge the results of the technical cooperation projects as objectively as possible. These results are expected to be utilized for improving the effectiveness and efficiency in the future projects. Therefore, JICA has been implementing full-fledged ex-ante evaluations for each technical cooperation project (TCP) since fiscal year 2001. Terminal evaluation has been conducted for all technical cooperation projects, in the past. However, the effects arising at a certain period after the end of the cooperation in shape of impact and sustainability at that time have not necessarily been verified or analyzed. In order to implement projects more efficiently and effectively, it is important to conduct ex-post evaluation for each project and to also give feedback of the evaluation results to the recipient countries. The lessons learned and recommendations highlighted in the evaluations give a significant direction to the planners and policy makers for implementation of future projects.

This report is based on the results of ex-post evaluation for technical cooperation project, after four years of project termination.

I wish to express my sincere appreciation to the staff of Plant Genetic Resources Institute and the neighboring national institutes/organizations for their close cooperation extended to the team to complete the study successfully.

Takao Kaibara
JICA PAKISTAN OFFICE
RESIDENT REPRESENTATIV

LOCATION MAP



Pakistan Map

ABBREVIATIONS

A/C	After Care Project
AARI	Ayub Agricultural Research Institute, Faisalabad.
ASO	Assistance Scientific Officer
BBTV	Banana Bunchy Top Virus
C/Ps	Counterpart
CLCV	Cotton Leaf Curl Virus
GRI	Genetic Resources Information
GRPRL	Genetic Resources Preservation and Research Laboratory
IAB&GR	Institute of Agricultural Biotechnology and Genetic Resources (Islamabad)
IBGE	Institute of Biotechnology & Genetic Engineering, Peshawar
IPGRI	International Plant Genetic Resources Institute
JICA	Japan International Cooperation Agency
MINFAL	Ministry of Food, Agriculture and Livestock, Pakistan
NARC	National Agricultural Research Center
NCP	National Commodity Program
NIAB	Nuclear Institute for Agriculture and Biology, Faisalabad.
NIFA	Nuclear Institute for Food and Agriculture, Peshawar
ODA	Official Development Assistance
PARC	Pakistan Agricultural Research Council
PDMe	Project Design Matrix for Evaluation
PGR	Plant Genetic Resources
PGRI	Plant Genetic Resources Institute
PGRP	Plant Genetic Resources Program
SDS-PAGE	Sodium Dodecyl Sulfate-Polyacrylamyde Gel Electrophoresis
SO	Scientific Officer
SSO	Senior Scientific Officer
UAF	University of Agriculture, Faisalabad
UPOV	Union for the Protection of New Varieties

PHOTOGRAPHS

Equipment Received Under Project Type Technical Cooperation (PTTC)

Centrifugal Machine at PGRI, Islamabad

Microscope at PGRI, Islamabad

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Screening against Powdery Mildew Disease in Peas
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国名：パキスタン・イスラム共和国		**案件名**：植物遺伝子資源研保存究所計画
分野：農業一般		**協力形態**：プロジェクト方式技術協力（現：技術協力プロジェクト）及びアフターケア協力
所轄部署：農業開発協力部（当時）		**協力金額**：2.16 億円 （プロジェクト方式技術協力 1.79 億円、 アフターケア 0.37 億円）
協力期間	プロジェクト方式技術協力 1993 年 6 月～1998 年 5 月 アフターケア協力 2001 年 8 月～2003 年 8 月	**先方関係機関**：パキスタン農業研究協議会
		日本側協力機関：農林水産省 (独)農業生物資源研究所
他の関連協力： 無償資金協力「植物遺伝子資源保存研究所設立計画」（1991 年/15.67 億円）		

１-１　協力の背景と概要

パキスタン国は地理的にも気候的にも変化に富み、遺伝的多様性中心のひとつである中央アジアセンターに位置し、植物遺伝資源研究にとって世界的に重要な国のひとつである。
一方で、同国経済の柱である農業の生産性向上の推進に伴い、経済性の高い作物や改良品種の普及により潜在的な優良種を含む在来植物遺伝資源が急激に消滅しつつある。
こうした背景のもとパキスタン政府は第 7 次 5 カ年計画（1988～1993 年）において植物遺伝子資源研究の強化を挙げ、高収量種の導入により 4.7%の農業生産性の向上を目指し、我国に対し協力の要請を行った。我国は作物改良に寄与する植物遺伝子資源研究のため、1991 年に無償資金協力を通して研究施設の建設及び主要設備の調達を行い、研究基盤の整備を行った後、同無償資金協力に引き続き、特に穀物、豆類を中心とした作物遺伝資源の収集、評価、保存、記録及び配布等の研究活動を強化することを目的として技術協力プロジェクトを 5 年間(1993-1998)実施した。その後、更なる研究活動の向上および組織体制の強化を目指しアフターケアを 2 年間(2001-2003)実施した。

１－２　協力内容

本プロジェクトでは無償資金協力にて整備された研究所を対象に、同施設の能力強化のため、本邦研修やパキスタンへの専門家派遣をとおして植物遺伝子資源の収集、評価、保存、記録及び配布等に関する総合的な技術支援を実施した。

（1）上位目標

パキスタンの作物生産性向上を図るため、病虫害及びストレス耐性新高収量品種育成に貢献する

（2）プロジェクト目標

パキスタンの育種家及び研究者に貢献するため、植物遺伝資源保存研究所の活動が強化される

（3）アウトプット（成果）

・ジーンバンクにより多くの遺伝資源の収集がなされ、保存される
・農学的、生化学的分析で有用特性が評価される
・保存及び配布に備え、より多くの遺伝資源が増殖される
・データ管理能力が向上する
・植物遺伝子管理マニュアルが公開される
・育種家と研究者の連携が強化される
・植物遺伝子資源保存研究所の活動が強化される

（4）投入（プロジェクト終了時）

日本側：

投入要素	プロジェクト方式技術協力	アフターケア
長期専門家派遣	6 名	1 名
短期専門家派遣	22 名	4 名
研修員	16 名	5 名
機材供与	1.4 億円	0.2 億円
ローカルコスト	0.39 億円	0.17 億円
総額	1.79 億円	0.37 億円

相手国側：

投入要素	プロジェクト方式技術協力	アフターケア
カウンターパート	23 名	22 名
機材購入	無し	無し
土地施設提供	土地提供は先方政府、施設は我国無償資金協力により建設	

２． 評価調査団の概要

調査者	（担当分野：氏名、所属先、職位） 総括：JICA パキスタン事務所長　貝原孝雄 評価分析：Mr.Abdul Razzaq Saleemi 情報収集/現地調査：Mr. Nisar Ali Khan 評価管理：JICA パキスタン事務所員 Mr. Sohail Ahmed JICA パキスタン事務所員 深澤 晋作	
調査期間	2007 年 12 月 1 日ー2008 年 3 月 14 日	評価種類：事後評価

３．実績の確認

３-１　プロジェクト目標の状況

パキスタン国内の関係研究機関 10 機関からの聞き取り調査の結果、各施設における研究活動の基礎となる遺伝子資源の提供という面で、植物遺伝資源保存研究所の活動に関する高評価が得られるとともに、農家からも優良品種の提供による増収が報告されており、本プロジェクトの目標である、パキスタンの育種家及び研究者に対する貢献が認められた。これは植物遺伝資源保存研究所がパキスタン国内の研究施設を対象として提供した遺伝子資源数がプロジェクト開始時には 140 であったものが、プロジェクト方式技術協力期間中には平均 838 と上昇、アフターケア期間中は 551 と多少減少したもののアフターケア終了後 2007 年までの平均が 1,260 と大幅に上昇していることからも裏付けられる。

３-２　上位目標の達成状況

植物遺伝資源保存研究所は新品種の開発を担当する研究施設に対し遺伝子資源を提供することにより病虫害及びストレス耐性新高収量品種育成に寄与し、ひいてはパキスタンの作物生産性の向上に貢献することを目的としている。このことはアフターケア事業実施後も年間平均 1,260 回の試料提供が同研究施設から他の農業研究施設へ行われるようになり、これまでにパキスタンで開発された主要作物の新品種 248 種のうち 50%以上 131 種が植物遺伝資源保存研究所の設立以降に開発されるという結果につながったと考えられ、上位目標は達成したと考察される。

３-３　終了時評価での提言の活用状況

アフターケア時の終了時評価では主に情報提供の拡充とそれに伴う技術者の継続勤務が提言されているが、情報提供についてはパキスタン農業研究評議会全体としてのインターネットでの情報提供の拡充を行い対応している。

４.評価結果の概要

４-１　評価結果の要約

（1）インパクト

アフターケア事業実施後も年間平均 1,260 回の試料提供が同研究施設から他の農業研究施設へ行われ、新品種の開発に利用されるとともに、パキスタンにおける唯一の植物遺伝子資源保存研究施設として関係研究施設や大学などに対する指導を行っている。
また、表 1 に示すとおり、これまでにパキスタンで開発された主要作物新品種のうち 50%以上が植物遺伝子資源保存研究所の設立以降に開発されており、表 2 の各種作物収量の伸びに係るデータを重ねると、上位目標“パキスタンの作物生産性向上を図るため、病虫害及びストレス耐性新高収量品種育成に貢献する”に対して同施設の設立・強化が寄与しているものと考察される。

表 1: パキスタンにおける作物新品種開発数

	小麦	トウモロコシ	米	植物油用種子	豆類
1933 年から 1993 年（植物遺伝子資源保存研究所開設）	51	14	27	15	10
1993 年（植物遺伝子資源保存研究所開設）以降	56	7	13	18	37

Source: Seed certification and registration department, GOP.

表 2: パキスタンにおける主要作物収穫量推移 (kg/ha)

作物	1993-94	2004-05	増収率(%)
小麦	1894	2586	36
トウモロコシ	1380	2849	106
米	1626	1994	23
ヒヨコマメ	393	794	102

Source: Agric. Statistics GOP, 2004-05

当初予想されなかった正のインパクトとして、国際間の食料及び農業に関する植物遺伝子資源条約に加盟し、パキスタン国内にとどまらず、他国への遺伝子資源の配布を行うことによる国際社会への貢献が上げられる。
本プロジェクトによる負のインパクトは見受けられない。

（2）自立発展性

増加を続けるパキスタン国の人口を支えるために、食糧の増産は国家的な重要事項となっており、限られた水資源や塩害化、病害虫への対策の観点から遺伝子資源の管理の一層の重要性が認識されてきている。この様な状況の下、パキスタン唯一の植物遺伝子資源に関する専門の研究施設として同施設の重要性は増し、その分、財政的、組織的に見ても政府から優先的な処遇を受けるとともに農業関連の研究施設でも重要視されている。このことから今後の自立発展性が認められると判断される。

【組織面】

植物遺伝子資源保存研究所はパキスタンにおける唯一の植物遺伝子資源に関する専門の研究施設であり、遺伝子資源の重要性が広く認識されてゆく中、同施設の重要性への認識も増している。
また、植物遺伝子資源の配布や分析機材の外部利用についても外部の研究者からの評価を得ており、無償資金協力及び技術プロジェクトにて調達された機材や施設について適切に維持管理及び運用する能力が持続されているものと思われる。但し、機材調達後既に 15 年以上経過しており、設備機器も含め根本的な改修や入れ替え等が求められる。
アフターケア終了時に 20 名雇用されていた同研究施設研究者は現在 16 名と減少しているが、日本を含む海外での研修を受けた職員も多く、各人への負担が大きいものの職務への熱意は高い。職員の不足については、個別プロジェクトに対する 3-5 年の臨時雇用という形で補っており、現在 8 名の職員が臨時雇用されている。このうちの数名については現在実施されている個別プロジェクト終了後常時雇用職員として雇用することとなっている。
以上から組織運営面での問題は認められない。

【技術面】
プロジェクト時に日本での研修を受けた 17 名の研究者のうち 5 名は定年等で職場を離れ、残る 12 名が引き続き勤務している。日本で直接研修を受けた高い技術力を有した職員から現在勤務している研究者に技術や知識が引き継がれており技術面での持続性は確保されている。同施設では関係分野において農業大学等からの学生の受入や各大学での関連分野カリキュラムに於ける助言を行うなど、将来の研究者の育成を行っており、現在 13 名のインターンの受入を行っている。このように将来を見越した技術面での強化を行っており、自立発展性が認められる。
【財政面】
プロジェクト開始時 1994 年度に 1.179 百万ルピー（2.36 百万円）だった年間予算が 2006 年度においては 14.666 百万ルピー（29.23 百万円）へと増加している。この間のインフレ率が 7%であったことを考慮すると、優先的に予算配分が行われていることが伺える。
　また、別途個別プロジェクトごとに予算が配分されており、これらの予算を合計すると人件費や機材等の維持管理費もカバーできており、財政面での自立的発展性が認められる。

4-2　プロジェクトの促進要因

（1）インパクト発現を促進した要因
パキスタン国の人口増加率は年間 2.8%（1975 年から 2005 年/UNDP）と高い伸びを示しており、この高い人口の伸びを支えるために作物生産性の向上は同国の重要な政策となっている。作物生産量を安定的に向上させるため、新たな病虫害及びストレス耐性新高収量品種の開発が強く望まれ、パキスタン国内において新品種開発を手がける各種研究機関及び農業大学等からの遺伝子資源の提供の要請が増加、このことがインパクト発現を促進する要因となった。

（2）自立発展性強化を促進した要因
プロジェクト実施の対象となった植物遺伝子資源保存研究所は植物遺伝子資源の保存に係る専門の施設としてはパキスタン国における唯一の研究施設であり、遺伝子資源の重要性が認識される中、同施設の重要性も広く認識される事となった。
また、同施設において学生の研究へのサポートや、大学教育との連携が同施設の国内における地位を固めることとなっている。

4-3　プロジェクトの阻害要因
本プロジェクトにおける阻害要因は特に認められない。

4-4　結論
パキスタン国唯一の植物遺伝子資源保存研究施設として育種家や研究者へ年間平均 1,260 回の試料提供を実施しており、これまでに同国で開発された新品種のうち 50%以上が同施設の設立後に開発されていることからも、上位目標に対し本プロジェクトが寄与していることが考察される。自立的発展性についてもプロジェクト後も引き続き活発な研究活動が実施されていることからも明らかである。また育種家や研究者間でも同施設の重要性が認識され、又、国際的にも遺伝子資源の交換等の連携を行い、このことが予算額の増加として同国政府からも重要性が認識されていることは明らかである。

4-5　提言
パキスタン側への提言
・修復が困難となっている老朽化した機材については、交換が必要である。（遺伝子保存室空調機器）
・継続的な能力強化のためには、定期的な情報交換が必要であり、技術を高めた職員を引き続き雇用するためには何らかの報奨制度の導入が必要である。
・作物収量の向上及び持続的農業のための植物遺伝子資源の重要性を政府は引き続き認識することが必要であり、パキスタン政府はこの重要な分野への経済的、人的な投資に最重要度を与えるべきである。

4-6　教訓 ・遺伝子資源の活用に係るプロジェクトの持続性を保つためには、関係者間の認識の共有とともに研究員の能力、十分な財源、優れた施設及び機材が不可欠である。 ・短期専門家の派遣や本邦研修により継続的にパキスタン側研究者の技術更新を図ったことは、対象研究施設の基礎を築く上で効果的な支援方法となった。
4-7　フォローアップ状況 同施設は竣工後既に 15 年が経過しており、同施設の心臓部である植物資源保管冷蔵施設の空調設備の故障が課題となっている。このため同研究施設より我国へのフォロアップの要請がなされたが、先方実施機関による実施を促すこととし、設備機器の代理店など必要な情報提供を行った。

EXECUTIVE SUMMARY

<table>
<tr><td colspan="3">I. OUTLINE OF THE PROJECT</td></tr>
<tr><td colspan="2">Country: Islamic Republic of Pakistan</td><td>Project Title: Genetic Resource Preservation and Research Laboratory</td></tr>
<tr><td colspan="2">Issue/Sector: Agriculture</td><td>Cooperation scheme: Technical Cooperation</td></tr>
<tr><td colspan="2">Division in charge:</td><td>Total cost: 216.4 million yen (PTTC 179 + A/C 37.4 million yen)</td></tr>
<tr><td rowspan="3">Period of Cooperation</td><td rowspan="3">June 1993- May 1998 &
August 2001-August 2003</td><td>Partner Country's Implementing Organization: Pakistan Agricultural Research Council, Islamabad. Pakistan.</td></tr>
<tr><td>Supporting Organization in Japan:</td></tr>
<tr><td>Related Cooperation: Grant Aid Project "Establishment of Genetic Resource Preservation and Research Laboratory" (1,567 million yen).</td></tr>
</table>

1.1. Background of the Project

Pakistan is located in Central Asian Region, which is one of the centers of biodiversity. The climate and topography of this country is ideal for a variety of crop spieces that need to be preserved and that is why germplasm conservation is of critical importance.. Therefore Pakistan is well known as one of the most important country for research of genetic resources.

On the other hand, under the dynamic agricultural growth policy of Government of Pakistan, high yield crops and improved varieties have been given a priority as indigenous species including potential high value varieties that are extinguishing rapidly.

Based on such situation, in 1989 the Government of Pakistan requested the Government of Japan to support the facilities and technologies for collection, preservation and evaluation of plant genetic resources to be used as material in breeding improved varieties. In 1993, the facility for Genetic Resource Preservation and Research Laboratory that is now called "Plant Genetic Resources Institute (PGRI)" was established by the Government of Japan in collaboration with the Government of Pakistan. This was followed by a 5 year (1993 to 1998) project-type technical cooperation that was later on by implementation of as aftercare technical cooperation to (August 2001 to August 2003) in order to transfer technologies for the management of genetic resources of food crops. Government of Pakistan aims to increase agricultural growth rate to 4.7% by use of high yielding varieties and strengthening the research organization and facilities of the NARC including conservation of Plant genetic resources on priority basis.

1.2. Project Overview

JICA carried out a comprehensive technical assistance programme for the project and provided technical training to Pakistani counterparts in Japan and on the job in Pakistan also through JICA experts. All equipment required for six laboratories and experts to build the in house capacity of staff of the project (PGRI) were supplied by Government of Japan under the Grant Aid scheme. The key activities carried out included germplasm collection, preservation and evaluation, multiplication, documentation and distribution to national research institutes/ organizations as breeding and research material for development of improved varieties.

Overall Goal

・To develop new high yielding varieties with insect and/or disease resistance and stress tolerance in order to increase crop production in Pakistan

Project Purpose

・Activities of PGRI are strengthened in order to serve crop breeders and researchers in Pakistan

Outputs

1. More plant genetic resources are allocated and conserved in the gene bank.
2. More useful characters are evaluated by agronomical and bio-chemical analysis.
3. More genetic resources are multiplied for conservation and distribution.
4. Data management system is improved.
5. Plant Genetic Resources Management Manual is published.
6. Coordination with national breeders and researchers is strengthened.
7. PGRI activities are improved.

Inputs

Japanese side

Input	PTTC Period	After care Period
Long term Experts	6	1
Short Term Experts	22	4
Trainees (in Japan)	16	5
Equipment	140 million yen	20 million yen
Local cost	39 million yen	17.4 million yen
Total Cost	179 million	37.4 million

Pakistani Side

Counterparts	23	22
Equipment	NA	NA
Land and facilities	Land was provided by Government of Pakistan and facilities were established under Japanese Grant Aid Scheme.	

II. EX-POST EVALUATION TEAM

Members of the Evaluation Team	Mr. Takao Kaibara / Team Leader Mr. Abdul Razzaq Saleemi / Consultant Team Leader, Evaluation & Analysis Mr. Nisar Ali Khan / Consultant Expert Mr. Sohail Ahmed / Management of the evaluation Mr. Shinsaku Fukazawa / Management of the evaluation	
Period of Evaluation	December 1, 2007 to February 5, 2008	

III. PROJECT PERFORMANCE

3.1 Performance of Project Purpose

As a result of fact-finding analysis of farmers and 10 releavant organizations, it was found that the project achieved the purpose to strengthen activities of PGRI in order to serve crop breeders and researchers in Pakistan at all levels in the project area with satisfaction of such crop breeders and researchers. The evaluation team also observed its high relevancy, prospect of positive impacts, efficiency, and sustainability of the project based on the discussions with concerned officials, counterparts, and crop breeding research institutions.

3.2 Achievement related to Overall Goal

PGRI distributed 1,286 germplasm per year for breeders and researchers to contribute developing new varieties.

More than 50% of crop varieties (131 varieties) have been developed after the establishment of PGRI, which is a result of its regular and assured distribution of plant germplasm to breeders for evolution of crop varieties. All the varieties released after the establishment of PGRI have been approved by the competent committee and recommended for commercial planting. Farmers were enjoying the good harvest of the crop through by using these new and approved varieties.

3.3 Follow-up of Recommendations by Terminal Evaluation Study

Terminal evaluation team recommended that PGRI should employ a permanent system engineer or out source the work in order to implement the expanding tasks of PGRI like preparation and up-dating of website etc., effectively. Director, PGRI during his interview informed that there is a centralized system in PARC and website of PARC is being up-dated regularly. PGRI has put its data on the same website thus no extra system engineer was recruited.

IV. Results of Evaluation

4.1 Summary of Evaluation Results

(1) Impact

PGRI is playing its due role in the national efforts by providing 1,286 germplasm per year and technical guidance to the national research institutes and university students as one and only special institute of plant genetic resources preservation and research. The contribution of germplasm can easily be assessed after reviewing the Table 1, which reveales that more than 50% varieties have been developed after the establishment of PGRI.

Table 1: Comparison of Total Varieties Developed So Far and After the establishment of PGRI

Period	Wheat	Maize	Rice	Oilseeds	Pulses
Total varieties developed so far since 1933	107	21	40	33	47
Varieties developed after establishment of PGRI after 1993.	56	7	13	18	37

Source: Seed certification and registration department, GOP.

Table 2: Crop yields of Pakistan

Crop yields (kg/ha)

Crop	1993-94	2004-05	% Increase
Wheat	1894	2586	36
Maize	1380	2849	106
Rice	1626	1994	23
Chickpeas	393	794	102

Source: Agric. Statistics GOP, 2004-05

imilarly, Table 2 reveals that highest increase from 1993-94 to 2004-05 in crop yields was observed in maize crop (106%) followed by 102% increase in chickpeas. Wheat yield increased by 36% while rice crop yield increased by 23% in the same period .

Unexpected positive impact is "Contribution to the world wide plant genetic resurces research frameworks"

(2) Sustainability

Organizational Sustainability

PGRI is one and only special institute of plant genetic resources preservation and research in Pakistan. The status of PGRI has been enhanced substantially as the importance of genetic resources has become widely known. A high degree of dedication and commitment among the professional staff was found, which indicates good applicability of the knowledge gained during the project period. Another evidence of the good use of the training is that the germplasm recipients are quite satisfied with the germplasm they receive and the facilities they avail at the PGRI.

There was 20 technical staff at the completion of project in 2003. Currently there are only 16 staff member on the strength of PGRI. The Existing staff is though overburdened but because of staff was well trained in Japan and is much motivated to work in laboratories and in the fields. This deficiency of shortage of staff is also being met by implementing new projects on different aspects of Plant Genetics Resources where contractual staff is hired for 3-5 years period. At present, 8 scientists have been recruited under these development projects. Some of the staff will be hired on permanent basis after the contract is completed.

No change has been made in the mission, system and structure of PGRI after completion of the project.

Technical Sustainability

Out of the 17 persons who received training in Japan there are only 12 who are currently working in PGRI. Two have retired and three have left the job. Any further loss of technical strength could threaten the project's sustainability.

The equipment received during the PTTC and aftercare project is in working order except some of the equipment received earlier during project period has become out of order. PGRI staff is capable of carrying out routine operational maintenance of equipment but in case of major repair or replacement of any part, it is dependent on the original manufacturers abroad. As most of equipment was supplied in 1993 and those models are presently out of production. PGRI is facing difficulty in obtaining the spare parts even from the original manufacturers.

In order to foster young researchers, PGRI is training young scientists and university students in diverse disciplines of conservation of plant genetic resources and their utilization.

Moreover, some of the universities have started offering regular courses in plant genetic resources to graduate and post graduate students. Yet there is no syllabus/regular training module developed for on-job training of the young scientists in the area of plant genetic resource conservation but PGRI staff along with university staff is preparing the outlines of such courses. Thirteen intern staff are also attached with PGRI.

Financial sustainability

The total annual budget has increased from Rs. 1.179 million in the year 1994-95 to Rs. 14.666 million in the year 2006-07.

An amount of Rs. 3.49 million annually is being spent on the operational cost. Other than the budget available with PGRI from federal government an additional support (US$)33.33 million) is received from other projects sponsored by Agricultural Linkages and other programmes. The availability of budget under different such development projects is a significant sign of its financial sustainability.

4.2 Factors that have promoted project

(a) Impact

The population of Pakistan is increasing 2.8% annually (1975-2005, UNDP) and in order to support such a rapid

growth in population, the country requires new varieties of all crops to meet the dire demand of not only cereals but oil seeds also. This situation creates pressure on the government to carry out development of new varieties.

(b) Sustainability

The reputation of PGRI is attracting researchers/organizations from all over the Pakistan. All research institutes recognize the germplasm storage facility of PGRI with the result that the germplasm distribution load is increasing day by day. The general awareness among the agricultural scientists too has compelled them to store their elite germplasm at PGRI. It is also helping a number of students to complete their research and theses and also providing post-graduate training to candidates aspiring to specialize in Biotechnology or molecular genetics. Thus PGRI is working as an important institution to assist universities. This factor adds to the prestige of the PGRI and contributes to the sustainability.

4.3 Factors Inhibiting Sustainability

A careful study and discussion with staff and other nation building institutes which have benefited from PGRI informed that there was no factor that should inhibit its sustainability.

4.4 Conclusion

This project made a substantial contribution to the overall goal, "to develop new varieties of crops to increase field crop yields in Pakistan". That is evidenced by the number of newly developed varieties after the establishment of PGRI. More than 50% of developed varieties have been developed after the establishment of PGRI.

PGRI is playing its due role in the national efforts by providing 1,260 germplasm per year and technical guidance to the national research institutes and university students as one and only special institute of plant genetic resources preservation and research in Pakistan.

The scope of the PGRI is not limited to providing germplasm to other relevant organizations only but also to extend facility of research work to various institutions. The PGRI has also created linkages with international research institutes to exchange germplasm and storage facility. The establishment of such activities has enabled Pakistani government to recognize the importance of PGRI and as a result the total annual budget has increased to a large extent.

4.5 Recommendations

- Efforts should be made to replace the few old models of equipment, which are not repairable and are going to be obsolete. (Cooling Units of Genebank).
- To further enhance and strengthen cooperation among scientists the regular exchange of scientist should continue. Any incentive system needs to be devised for retention of the trained staff.
- Keeping in view the importance of Plant Genetic Resources in crop improvement and sustainable agriculture, the Government of Pakistan should give top priority to financial and human resources to this important field.

4.6 Lessons Learned

1. The sustainability of projects involving germplasm collection, preservation techniques, evaluation and distribution, use of germplasm by the provincial institutes for developing high yielding cultivars require a good understanding among all stakeholders. This is only possible with high class trained manpower, sufficient operational funds, and state of the art building and equipment.

2. Support from short-term experts to improve the technical skills of trainers through counterpart training, provision of state of the art equipment, and overseas training of the staff of the implementatiing agency are excellent tools that would ensure a strong foundation for the project to sustain its benefits in the future.

I. OUTLINE OF THE EX-POST EVALUATION STUDY

1.1 Background of the Project

Pakistan is located in Central Asian Region, which is one of the centers of biodiversity. The climate and topography of this country is ideal for a variety of crop spieces that need to be preserved and that is why germplasm conservation is of critical importance.. Therefore Pakistan is well known as one of the most important country for research of genetic resources.

On the otherhund, under the dynamic agricultural growth policy of Government of Pakistan, high yield crops and improved varieties have been given a priority as indigenous species including potential high value varieties that are extinguishing rapidly.

In order to achieve its aim of increasing crop yields through high yielding varieties, Government of Pakistan in 1989 requested the Government of Japan to provide the support for facilities and introducing technologies for collection, preservation and evaluation of plant genetic resources that could be used as breeding material for developing improved varieties. In response to this request the Government of Japan agreed for the construction of a gene bank and allied laboratries and also support the transfer of technology for the gene bank system by the technical cooperation program.

In 1993, the facility for Genetic Resource Preservation and Research Laboratory (GRP&RL) was established by the Government of Japan in collaboration with Government of Pakistan through grant aid scheme. The facility is , now called "Plant Genetic Resources Institute" (PGRI) and it is located in the premises of National Agricultural Research Center. The Government of Pakistan arranged the land for establishment of buildings facilities and provision of scientific and research equipments. This was followed by a five-year (May 1993 to May 1998) Project-Type Technical Cooperation (PTTC) that was later on followed by aftercare technical cooperation (August 2001 to August 2003) to transfer technologies for the management of genetic resources of food crops. The total budget for establishment of GRP&RL was provided by Government of Japan. It includes 1,567 million Yen for building and fundamental equipment of laboratories work under the grant aid, 179.0 million yen for the PTTC and 37.4 million yen for aftercare project.

The objectives of the project were to establish and strengthen effective methods through transfer of technology by the Japanese Experts to the Pakistani scientists for collection, evaluation, preservation, documentation and distribution of plant genetic resources of crops plants, mainly cereals and grain legumes, to contribute to the future crop production and improvement in Pakistan.

Four years after termination of the project JICA intends to conduct an ex-post evaluation of the project's technical cooperation component through a team of local consultants organized by JICA Pakistan Office in order to verify the important issues relating to the project impact and sustainability.

1.2. Evaluation Team

Name	Designation
Mr. Takao Kaibara	Team Leader
Mr. Abdul Razzaq Saleemi	Consultant Team Leader (M&E) Evaluation & Analysis
Mr. Nisar Khan	Consultant Expert (M & E)
Mr. Sohail Ahmed	Management of the Evaluation
Mr. Shinsaku Fukazawa	Management of the Evaluation

1.3. Study Period

The study was conducted from December 1, 2007 to February 5, 2008 in Islamabad, Pakistan.

II. STUDY METHODS

2.1 Outline of PDMe

Outline of the Project (PDMe)

Narrative Summary	Indicators	Means of verification	Assumptions
Overall goal			
New high yielding varieties with insect and/or disease resistance and stress tolerance are developed in order to increase crop production in Pakistan.	New varieties are developed using PGRI germplasm	Reports by PARC	Activities of PGRI are being further strengthened and extended with the support of the Pakistan Government.
Project purpose			
Activities of PGRI are strengthened in order to serve crop breeders and researchers in Pakistan	・Number of germplasm distribution increased 15% at the end of the project.	・PGRI annual reports	Breeders use germplasm conserved at PGRI
Output			
1. More plant genetic resources are allocated and conserved in the gene bank. 2. Useful characters are evaluated by agronomical and bio-chemical analysis. 3. More genetic resources are multiplied for conservation and distribution. 4. Data management system is improved. 5. Plant Genetic Resources Management Manual is published. 6. Coordination with national breeders and researchers is strengthened. 7. PGRI activities are improved.	1. Total number of accessions in the mid-term storage is increased by 80% at the end of the project. 2. Total number of evaluated accessions is increased by 15% at end of the project. 3. Total number pf multiplied accessions are increased by 10% at end of the project. 4. Total amount of data entry are increased by 15% at the end of the project. 5. PGR is routinely well managed. 6. Two meetings are organized by the end of the project. 7. Outputs 1-4 are realized.	1. Reports of seed preservation lab 2. Reports of germplasm evaluation lab 3. Reports of germplasm evaluation lab 4. Reports of documentation lab 5. PGRI annual report 6. PGRI annual report. 7. PGRI annual report	PGRI's role is recognized by related organizations / neighboring institutes.
Activities	**Inputs**		
1-1 Plan for exploration and introduction. 1-2 Explore more areas to collect and conserve germplasm. 1-3 Introduce useful germplasm from abroad. 1-4 Establish systematic storage and its management. 1-5 Identify seed-born diseases of	(Japanese side) 1. Dispatch of long term experts 2. Dispatch of short term experts 3. C/p training programme 4. Provision of the equipment	Pakistani side 1. Provision of building and facilities 2. Assignment of counterpart personnel 3. Allocation of local project cost	- Trained counterpart personnel and technical staffs work at PGRI. - Appropriate budget

germplasm. 1-6. Preserve vegetative propagated crops in liquid nitrogen. 2-1 Plan for germplasm evaluation 2-2 Evaluate germplasm according to priority. 2-2 Evaluate germplasm according to priority. 3-1 Plan for germplasm multiplication. 3-2 Multiply germplasm 3-3 Open and socialize information system 4-1 Install new computers and software. 4-2 Construct database for germplasm management. 4-3 Publish catalogues. 5-1 Plan for "Manual" publication 5-2 Prepare and publish Manual 6-1 Organize meetings with national breeders and researchers. 6-2 Repair or replace machinery and equipment.			is secured.

2.2 Stakeholders and Study Methods

In this ex-post evaluation study, the project framework has been taken from the Joint Evaluation Report prepared in June 1995..Using this framework and the project outcome and anticipated impact described in the report of Joint Evaluation Study carried out at the completion of the project, the study plan, evaluation grid and questionnaires were prepared. The specific study targets and methods used are as shown below while schedule of study is presented as Annex-II.

Study target/stakeholders	Study methods
Responsible agency National Agricultural Research Center (NARC), Islamabad. Pakistan.	Interviews based on the interview sheet
Implementing agency Plant Genetic Resources Institute (PGRI) at NARC, Staff of the PGRI	Document Review Discussions Questionnaires Direct observation Photographs
Other related institutions and organizations Institutes those received and benefited from germplasm. Farmers benefited from research institutes and increased their crop yields through improved breeding material.	Questionnaires

III. STUDY RESULTS

Information on indicators listed in the PDMe was the basis of the evaluation grid. From evaluation grid (Annex 1) questionnaire was developed to gather the information from all stakeholders of PGRI. Information collected against these indicators and findings were analyzed to gauge sustainability and impact of the project.

3.1 Sustainability

Four main questions were looked in this section to determine various sustainability aspects of the project:

a) Is the project organization capable of maintaining over the period of time, the benefits accrued as a result of achieving project purpose and goals?
b) How likely are project outputs to be achieved?
c) What are the factors that contribute or inhibit the sustainability of project outcomes?
d) Are there any other donors involved in this project after project termination?

3.1.1 Organizational Sustainability

Issues that will be analyzed in this section include: changes in the mission, operational aspects, personnel aspects and trained staff.

(i) ***Changes in the Mission***: The present set up of the PGRI was designed to undertake expedition, collection, conservation, multiplication, and related research studies and to provide germplasm support to meet the needs of desired genes to all research institutes/organizations. No change has been made in the mission, system and structure of PGRI after completion of the project. However, the management of PGRI has strengthened their capability in three areas i.e., (i) detailed evaluation of crop germplasm for biotic and a biotic stress in collaboration with crop commodity programme and (ii) molecular evaluation of crop germplasm using different DNA marker techniques and its utilization as marker assisted breeding or developing new varieties. (3) The emphasis has been given to collection, conservation and evaluation of germplasm of under utilized crops/minor crops due to their enhanced potential in sustainable agriculture, present farming system and value addition.

(ii) ***Operational Aspect***: At the time of final evaluation of PGRI, the evaluation team recommended PGRI to employ a permanent system engineer or outsource the work in order to implement the expanding tasks of PGRI like preparation and up-dating of website, etc., effectively. As PGRI works under PARC regulations, the Director PGRI in his interview informed that there is a centralized system in PARC and website of PARC is being up-dated regularly. PGRI has put its data on the same website thus no extra system engineer was recruited.

(iii) ***Personnel Aspects:*** There were 20 technical staff members at the completion of project in 2003. Currently there are only 16 staff member on the strength of PGRI, out of which 4 are out of country for higher studies (three in Japan and one in New Zealand doing Ph.D). The existing staff is overburdened and is not sufficient to carry out extensive field and lab research. However, staff was well trained in Japan and is much motivated to work in laboratories and in the fields. This deficiency of shortage of staff is being met by implementing new projects on different aspects of Plant Genetics Resources where contractual staff is hired for 3-5 years period. Though their salaries are good and are at par with other PGRI staff but they are on contract for a certain period as per policy of GOP for any new recruitment in the country. The list of PGRI staff at present is given at Annex-VIII.

(iv) ***Trained Staff***: Out of the 17 technical staff members who received training in Japan, presently 12 are working in PGRI. Two have retired and three have left the job. GOP has imposed a ban on all new recruitments and allowed only the contract staff. Thus PGRI is also recruiting only contractual staff and imparting necessary on job training to them. Presently the retention of the trained staff is 60 %. This retention rate is very low and any further loss of technical staff could threaten the project's technical sustainability (Annex-IX).

As an overall assessment it can be conclude that the sustainability would be hindered by shortage of well-trained staff if retention rate of staff is not improved. It may be mentioned that thirteen intern staff is also working in PGRI.

3.1.2 Technical Sustainability

To determine whether the project management is capable of maintaining the benefits, the ex-post evaluation team looked into (a) the appropriateness of knowledge, skills and technology that were transferred through training and through Japanese experts for the improvement of technical level of scientists, and (b) system development for innovative techniques through equipment and physical infrastructure provided during the implementation of the project.

Improvement of technical level of scientists: Training and knowledge transferred to the local scientists by the Japanese experts for the capacity building in PGRI is still applicable. All the staff members of PGRI were trained either by Japanese experts in Japan or in Pakistan. The ex-post evaluation survey found a high degree of dedication and commitment of the professional staff indicating effective applicability of the knowledge gained during the project. Another evidence of successful training is that the germplasm recipients, the national research institutes viewed as PGRI as an asset for them and were satisfied with the germplasm they receive and the facilities they avail at PGRI like conservation of their material. The necessary knowledge, skills and technology for germplasm collection, conservation, multiplication, characterization, and distribution was shared through fortnightly seminars and on-the-job training delivered Japanese experts. Alongside, equipment was provided during the implementation and aftercare of the project. A short-term training was also arranged for scientist of NARC on collection and handling of crop germplasm. About 20 scientists from Afghanistan were trained on PGR with the assistance of IPGRI/JICA

After the project completion, the PGRI staff, in spite of above constraints, have succeeded in sustaining the technology and tuned to improve and updating their knowledge and skills regarding germplasm collection, conservation, multiplication, and distribution through lectures, seminars, workshops, conferences, training and daily work thereby ensuring technical sustainability.

The technical staff including field expedition and laboratory staff feels that their technical skill in exploration and collection of germplasm, seed conservation and genebank, germplasm evaluation, In-vitro conservation, plant health & seed health and data management capability has improved. The current level of training and working is sufficient to maintain the learned techniques. Individual and combined knowledge and experience is being publicized in the form of research papers and workshop seminar proceedings. A list of papers published before and after the project termination is given at Annex-III.

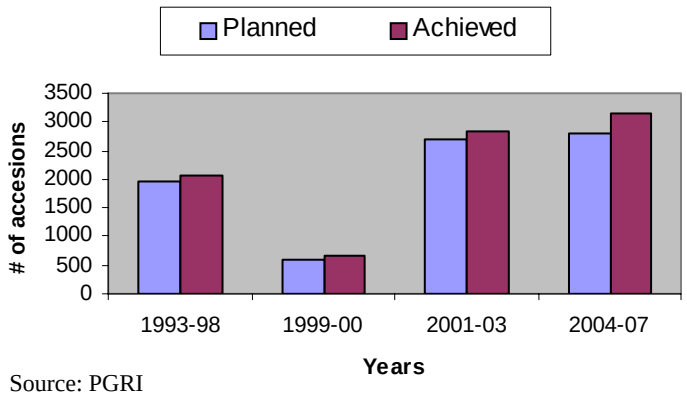
System development for innovative techniques through equipment &physical infrastructure provided during the implementation of the project: Necessary equipment is available, well maintained and was found in running and good condition except a few items. Most of the equipment was supplied at inception of the project while some was provided later during aftercare project. The equipment received by PGRI during aftercare project (Annex-III A) is 100% in working order while some of the equipment received earlier during project period (1993-98) has become out of order due to lack of facilities in the country for proper maintenance. The transferred technology like planning germplasm expeditions and collection, evaluation of useful characters, multiplication of germplasm, data management, preparation of manuals remained useful and the equipment received is being utilized frequently for research, analysis and training.

PGRI staff is capable of carrying out routine operational maintenance of equipment but in case of major repair or replacement of any part, it is dependent on the original manufacturers abroad. As most of equipment was supplied in 1993, the models are presently out of production. Thus PGRI is facing difficulty in obtaining the spare parts even from the original manufacturers. The specific example in this context is the availability of spare parts of cooling units of genebank. The problem of obsolescence is particularly severe with some of the equipment that is presented at Annex-IV while a few photographs of out of order and equipment in working condition are presented at the end of the annexes.

Physical Infrastructure: The original plan of the project was very comprehensive and was prepared mostly by technical personnel who were aware of the needs of various laboratories. Therefore, there was no need for any alternation or addition in the building. However, during aftercare project the staff noticed a difficulty in maintaining/multiplication of crop germplasm due to severe water shortage. This deficiency was also taken care of by JICA by installing a tube well in the premises of PGRI, which is working well.

Independent expeditions for Germplasm Collection: The PGRI staff is now capable of planning and conducting independent field expeditions for germplasm and analyzing the data and disseminating the results through: (a) publication of research papers with the support of analytical data and (b) exchange of germplasm with other national and international institutes. Fig. 1 presents expeditions carried out during project period, aftercare and after the termination of the project. In all cases it was found that collection of germplasm exceeded the planned targets. The data revealed that independent field germplasm collection and actual achievements in four years, after the project was terminated were fully achieved. Overall, during the four years of project from 2003 to 2007 the collection increased by 12% as compared to planned targets. Detailed list of planned and achieved targets is presented at (Annex-V).

Fig. 1 Expeditions Planned & Achieved



Source: PGRI

Supply of Germplasm to Neighboring Institutes or Germplasm distribution: PGRI continued supply of germplasm not only to national neighboring institutes but overseas also. Comparing active project period (1993-98), on an average 1247 accessions of germplasm were distributed with the period after the termination of the project (2004-07) 1286 accessions were distributed per year. Table-2 shows a slight increase in germolasm distribution from 1247 to 1286 accessions after the project was terminated. Similarly, before aftercare project (may 2001 –May 2003) 990 accessions per year were distributed while during aftercare project 574 accessions were distributed. Fig. 2 presents accessions distributed after the project period. Detailed distribution of

accessions is attached at Annex-VI. The breeders would use this germplasm as a source of drought tolerant, disease free accessions in their breeding programme to develop the desired crop varieties.

Cooperation with National Institutes: Keeping in view the time and resources, organizations and research institutes were visited to collect their views about cooperation extended by PGRI. Hazara University and Maize and Millet Research Institute, Yousafwala were contacted on phone as well as through e-mails to collect the required information while Wheat Research Institute, Faisalabad, Oilseeds Research Institute, Faisalabad, Nuclear Institute for Agriculture & Biology, Faisalabad (NIAB), University of Agriculture (UAF), Faisalabad, Nuclear Institute for Food & Agriculture, Peshawar (NIFA), University of Agriculture, Peshawar, Institute of Biotechnology & Genetic Engineering (IBGE), Peshawar and Farmers around Faisalabad area were visited and head of the institutes were interviewed to know the extent of cooperation carried out by PGRI. All the institutes visited were of the view that PGRI is an excellent and precious asset of Pakistan and the PGRI and it has provided a valuable share in the shape of germplasm collection. Detailed information collected from the different institutes visited is attached at Annex-VII.

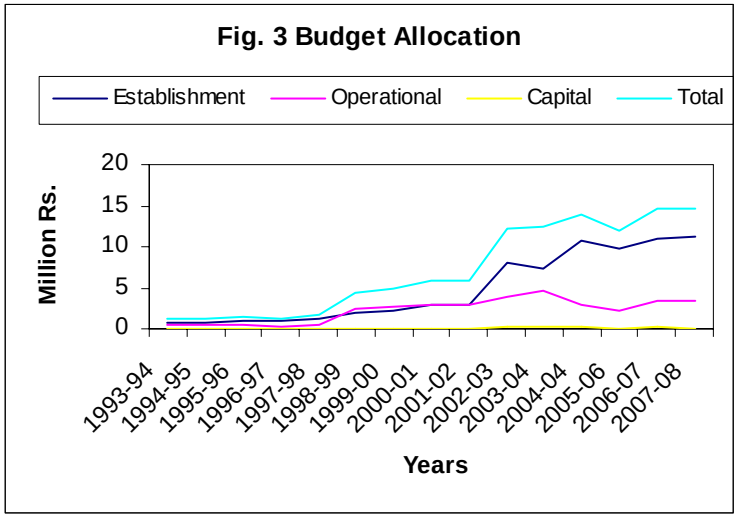
Table-2: Germplasm distribution (accessions)

Institutions	1993-98	1999-00	2001-03	2004-07
Within country	5029	1955	1653	5039
Abroad	1208	25	69	106
Total	6237	1980	1722	5145
Average/yr	1247	990	574	1286

Based on the above analyses, the evaluation team concluded that ***the technical sustainability has been achieved***.

3.1.3 Financial Sustainability

PGRI is completely dependent on the government funds for its functions like germplasm collection, conservation and distribution etc., and operation & maintenance of equipment. The total annual budget has increased from Rs. 1.179 million in the year 1994-95 to Rs. 14.666 million in the year 2006-07. Fig. 3 shows budget allocation from 1993 to 2008 and detailed budget is presented at Annex-X. Amount spent on repair and maintenance of equipment and vehicle has, however, risen by 800 % in 2006-07 (Rs. 0.240 million) as compared to year 1993-94 (0.03 million). It is due to the fact that vehicles and equipments were quite new and very little money used to be spent on its repair and maintenance. The average annual inflation rate however, during this period remained 7%. The budgetary provisions for previous and current years also remained sufficient to sustain the activities of PGRI. According to the Director, there has not much difference in the demand and supply of budget to PGRI. However there is no budget to up-date the equipment and replace some of the equipment that is becoming obsolete.



***Other Donor Assisted Projects*:** Other than the budget available with PGRI from federal government, support amounting to US$ 33.33 million has been received from other projects sponsored through agricultural linkages and other programmes. The availability of budget under different development projects is a significant positive change toward its financial sustainability. A list of such development projects is presented at Annexed –XI.

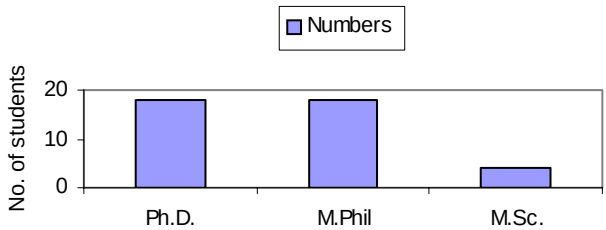
The PGRI can be concluded as financially sustainable

3.1.4 Sustainability of Project Effects

The sustainability of the project results from completion to present is expressed below.
(↗ very high; → maintained sustained; ↘ lower than at completion)

(i) Spread of technical knowledge ↗

Fig 4. Numbers of Students Benefitted by PGRI Facility



Source: PGRI

Senior scientists at PGRI are well qualified in their respective fields and are training young scientists and university students in diverse disciplines of conservation of plant genetic resources and their utilization, such as biochemical evaluation, plant seed health monitoring/management, In-vitro conservation/ cryopreservation, data management and gene bank management. A number of research theses were supervised and completed at PGRI of students hailing from Islamabad, Rawalpindi, D.I.Khan, and Peshawar Universities. A total of 40 students have so far benefited from this prestigious institute and completed their theses for M.Sc., M.phil and Ph.D. degrees Fig 4 shows that 44 students have benefited from PGRI facilities and completed their degree programmes. List of these theses is presented at Annex-XII.

Box-1Catalogues Prepared & Published

- 1995-Wheat germplasm catalog-I. PGRI.
- 1996-Rice germplasm catalog-I. PGRI.
- 1997-Barley germplasm catalog-I. PGRI.
- 1998-Plant germplasm catalogue - 97. PGRI.
- 2003-Plant germplasm catalogue - 2003. PGRI
- 2003-Mungbean germplasm catalogue. PGRI
- 2003-Blackgram germplasm catalogue. PGRI
- 2003-Cowpea germplasm catalogue. PGRI
- 2006-Medicinal plant germplasm catalogue. PGRI

Moreover, some of the universities namely, University of Agriculture, Faisalabad, University of Arid Agriculture, Rawalpindi, Hazara University, Agriculture University Tandojam, Sindh and others have started offering regular courses in plant genetic resources to graduate and post graduate students. Yet there is no syllabus/regular training module developed for on-job training of the young scientists in the area of plant genetic resource conservation but PGRI staff along with university staff is preparing the outlines of such courses.

The germplasm catalogues pertaining to all material available with PGRI have been published showing passport data of each line collected on various crops. It includes wheat, barley, mungbean, black gram, cowpea, and pea. Detail of catalogues published for the benefit of researchers and breeders is presented at Annex-XIII.

(ii) Contribution to food security ↗

A significant level of yield increase has been noted in all the crops due to the use of plant genetic resources after green revolution. A large number of high yielding, biotic and abiotic stresses tolerant, and better adapted varieties of various crops have been developed through management and utilization of diverse plant germplasm collected and distributed by PGRI, which ultimately contributed significantly to the food security and sustainable development in the country (Table 5). An increase of 36% in wheat and 23% in rice has been noted after the termination of the technical cooperation project.

(iii) Induced Sustainability in Agriculture ↗

Plant genetic resources have played a significant role in managing the crisis of sustaining the agriculture in Pakistan. Few examples of failure of crop production during previous years are highlighted below.

1) In 1978, leaf rust epidemic in wheat resulted in crop failure causing a loss of Rs.5.1 billion ($861M) to the national economy.
2) Chickpea blight outbreak during 1979-81 destroyed the standing crop in Pakistan resulting in a production loss of more than 50% in the country.
3) Similarly in 1989 epidemic of root rot caused heavy loss to chili crop in Pakistan. After the identification and management of resistance sources against root rot disease provided foundation for yield stability of chili in Pakistan.

4) The occurrence of banana bunchy top virus (BBTV) disease in 1990-91 destroyed the banana crop, which resulted in reduction of 75% production causing a loss of Rs.971 million to national economy.

After the establishment of PGRI no epidemic or failure of crop has been reported. Among other reasons it also includes a major reason of provision of rust and root rot resistant, locally adopted crop germplasm to plant breeders that facilitated the scientists to meet the emerging challenges of evolution of resistant varieties. PGRI has thus played a significant role towards maintaing food security.

(iv) International Agreements in Respect of Biodiversity Conservation

In order to fulfill the international obligations towards the conservation of crop genetic diversity, Pakistan has become member of several international agreements and conventions. The agreements and conventions include the following.

- Convention on Biological Diversity, Rio-De Janeiro, 1993
- World Food Summit, Rome, November 1996
- International Treaty on Plant Genetic Resources for Food and Agriculture. Rome, 2001

(v) Identification of germplasm against diseases and tolerance

The project goal for screening of germplasm has been achieved by Identifying Seed Borne Pathogens in two hundred twenty five (225) lines of rice and 245 lines of sorghum for 6 seed borne viruses. Eighteen lines of rice and 12 lines of sorghum have been isolated as clean lines and are made available to breeders that would be useful for them to include in the crossing programme as varieties free from seed born diseases. Details are presented at Annex-12.(or XII. This is for theses) ?????????

Table-3: Identification of Disease Tolerance Genetic Resources

Crop	Disease	Source	Reference
Chickpea	Blight	Dasht, NIFA 88, Balkasar	PJB,
Black gram	Charcoal rot	Pk-45718, Pk-45719, Pk-45721, Pk-45731	Pak J Phy 12:74-78
Cowpea	BICMV	Pk-27168, Pk-27192	Asian J Pl Sci 1:585-587
Peas	Powdery mildew	Pk-10603, Pk-10628	PJB 33:251-255

Source: PGRI

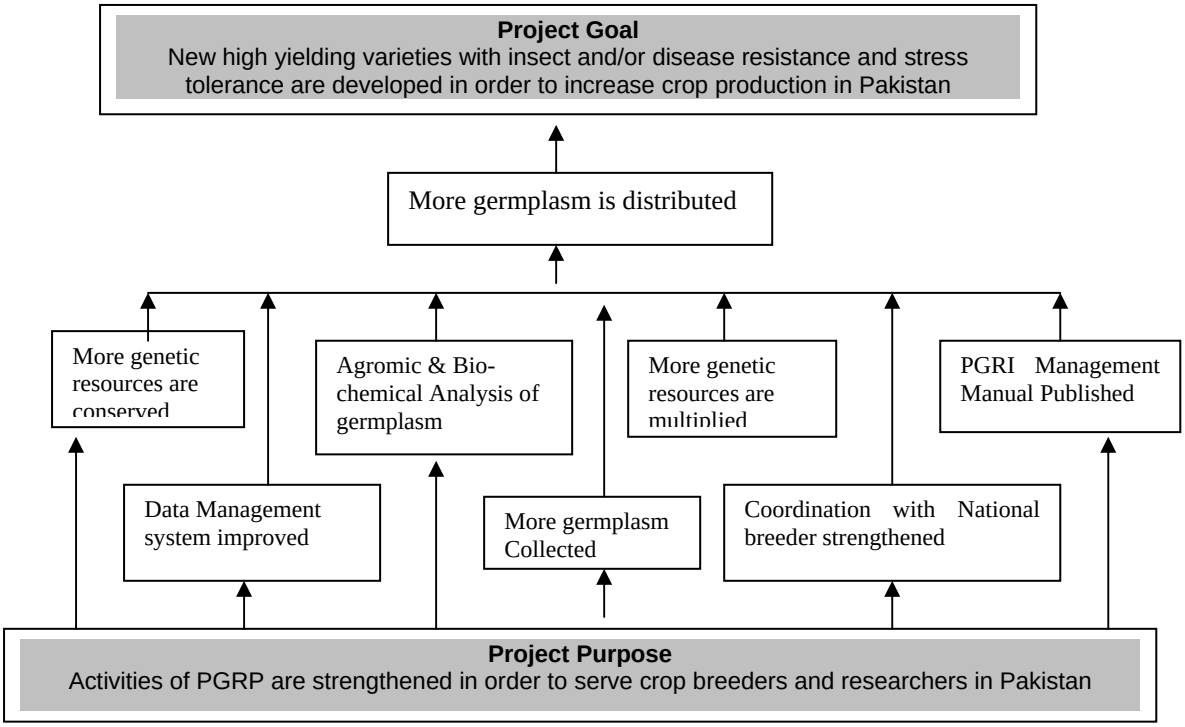
(vi) Development of New Rice Plan

Rice yield was stagnant for the last several years. For modification of plant type, 150 land races (germplasm collected from PGRI) were evaluated for phenotypic acceptability as plant type, harvest index and other yield and yield attributing traits. Ten accessions were selected and further evaluated. Two accessions (acc.335 & 3358) were selected on the basis of overall performance. These two accessions were used in breeding program. Double haploids were produced using anther culture. Newly developed lines have erect leaves, good phenotypic acceptability, long roots, stiff stem and large panicle size. Rice breeders at NARC, Rice Research Institutes, Kalashah Kaku (Punjab) and Dokri (Sindh) for the production of Super Hybrids are using these lines. Detail of evolution of new rice plant is available at Annex-XV.

Based on the information related to technical, organizational and financial sustainability of PGRI, there should not be any problem for the PGRI to carry on achieving its goal of developing new varieties to increase crop yields in the future.

3.2 Impact of the Project

3.2.1 Impacts Attained by Overall Goals



(i) Development of New Varieties

The contribution of germplasm can easily be assessed after reviewing the Table 4, which revealed that more than 50% varieties have been developed after the establishment of PGRI. The share of PGRI cannot be denied and could be attributed to; assured and regular supply of different kinds of plant germplasm to plant breeders for evolution of crop varieties. All the varieties have been approved by the competent authority and have been recommended for commercial planting by farmers. Farmers are enjoying the varieties through harvesting good crop. Detailed list of verities evolved so far with year of release and registration is provided in Annex-XVI

Table 4 Comparison of Total Varieties Developed So Far and After the Establishment of PGRI

Period	Wheat	Maize	Rice	Oilseeds	Pulses
Total varieties developed so far since 1933	107	21	40	33	47
Varieties developed after establishment of PGRI after 1993.	56	7	13	18	37

Source: Seed certification and registration department, GOP.

(ii) Increase in Crop Yields

Wheat, maize, rice and chickpea crop yields of Pakistan are presented in the table while details are attached at (Annex-XIV). Table 3 revealed that highest increase from 1993-94 to 2004-05 in crop yields was observed in maize crop (106%) followed by 102% increase in chickpeas. Wheat yield increased by 36% while rice crop yield increased by 23% in the same period duration.

Table 5 Crop Yields of Pakistan

Crop yields (kg/ha)

Crop	1993-94	2004-05	% Increase
Wheat	1894	2586	36
Maize	1380	2849	106
Rice	1626	1994	23
Chickpeas	393	794	102

Source: Agric. Statistics GOP, 2004-05

(iii) More Germplasm Collection

PGRI continued its main activity of germplasm collection

through expedition and collection from other sources. Comparison of germplasm collection during three phases like project period, aftercare period and after the project terminated is presented in Table-6. The table indicates a continued activity of germplasm collection after project termination and more germplasm was collected. On the average germplasm collection per year (1442) during project period was decreased by almost 20% after the project was over. However, before aftercare 1058 accessions were collected while during aftercare project 888 accessions were collected. It shows an increase of 16%. This increase or decrease was attributed to the availability of the staff. The staff were dispatched to Japan for training and no new staff recruitment on short-term basis was made. Table 6 presents germplasm collection figures during and after the project.

Table-6: Germplasm collection status

Period	Phases	Collection	Av/year
1993-98	During project	7210	1442
1999-00	With out project	2115	1058
2001-03	During aftercare project	2664	888
2004-07	After project termination	4624	1156

Source: PGRI

The detail of germplasm collected during exploration missions and through donations from different research institutes or breeders is given at Annex-XVII.

(iv) More Conservation of Germplasm

After the establishment of this new facility by Government of Japan, the germplasm conserved in previous genebank at NARC was also shifted to this new set-up under active and base collection. Germplasm conserved since inception of PGRI is discussed below.

(a) Active Collection In all 24,755 accessions have been kept under active collection. Detailed table of active collection for each crop is presented at Annex-XVIII.

(b) Base Collection At present, 14500 accessions have been preserved as base collection.

(v) More Germplasm Multiplied

As PGRI provides the germplasm to researchers for use in the crop improvement programs, germplasm with less quantity and low viability of seed always needs to be multiplied to maintain the minimum required quantity for the gene bank. Multiplication activities continued even after project termination. A total of 21,855 accessions have been multiplied (Annex-XIX). Table-7 presents a comparison of germplasm multiplication activities among project and without project periods. Maximum germplasm (2602 per year) was multiplied during project period. However, after the termination of the project average multiplication was decreased by almost 52% (1235). Similarly after the project during two years of period (1999-2000) a 59% decrease was found. The reason was that most of the staff went for training during the project period. Moreover, there were financial constraints after 1998 in the country.

Table-7: Germplasm Multiplied

Period	Phases	GP Multiplied	Av/year
1993-98	During project	13010	2602
1999-00	With out project	827	414
2001-03	During aftercare project	3079	1026
2004-07	After project termination	4939	1235

Source: PGRI

(vi) More Germplasm Evaluated & Conserved

During characterization and evaluation, three steps are performed, i) characterization and preliminary evaluation which is a record of highly heritable characters expressed under any environment, mostly done according to IPGRI (International Plant Genetic Resources Institute) descriptors, ii) detailed evaluation based on agronomic

characters and resistance to biotic stresses and iii) biochemical evaluation which examines the specific characters required for breeding. Electrophoretic analysis of seed proteins, DNA finger printings etc. are modern techniques used for germplasm evaluation. Table-8 presents data on germplasm evaluated for agro-morphological characters and biochemical evaluation during and after project is terminated. During the project maximum number of accessions were evaluated while it reduced during the coming years. The Director, PGRI informed that none of the evaluation was done before the project so maximum evaluation was carried out during first year of the project. Later more emphasis is given on evaluation of specific traits. However, good progress has been made after the project is terminated.

Table-8: Germplasm Evaluation & Conservation

Periods	Project phases	Agro-morphological evaluation (#)	Biochemical evaluation (#)	In-vitro Conservation (#)
1993-98 (5 yr)	During project	13010 (2602)*	871 (174)	16 (3)
1999-00 (2 yr)	With out project	827 (414)	211 (105)	8 (4)
2001-03 (3 yr)	During aftercare project	2750 (916)	981 (327)	10 (3)
2004-07 (4 yr)	After project termination	3482 (870)	1377 (344)	24 (7)

*Figures in parenthesis are average in one year. Source: PGRI

(a) Agro-morphological evaluation: Germplasm collected and preserved in the genebank is evaluated for different agro-morphological traits. The evaluation data revealed that diversity occurs in qualitative as well as quantitative traits in most of the cereals and legumes. More than 90% germplasm of four legumes (blackgram, mungbean, cowpea, and pea) and cereals (wheat, rice, and sorghum) has been characterized and evaluated. Some elite lines in various crops have been identified on the basis of yields potential for future utilization in the breeding programmes. Detail of germplasm preserved and evaluated is presented at Annex-XX.

(b) Biochemical Evaluation: Biochemical techniques including seed proteins and DNA finger printing etc. have been used, due to validity and simplicity, for describing genetic structure of crop germplasm and various genetic resources. Genetic diversity based on qualitative and quantitative traits along with molecular traits are useful in constitution of core collections for gene bank management and planning experiments that facilitates efficient and utilization of germplasm. List of germplasm evaluated since inception is presented at Annex-XX.

(c) *In-vitro conservation*: In-vitro conservation activities are related to conservation of vegetative propagated crops that cannot be conserved as seed either due to their recalcitrant behavior to conservation. Box 2 presents a list of germplasm conserved through in-vitro process that provided pure, virus free crop germplasm to the crop breeders to use them in evolution of varieties.

Box-2: List of crops being conserved through In-vitro techniques

Sr #.	Year	Crops conserved during the Year
1-	1993-94	Potato, Sweet potato
2-	1994-95	Potato, Sweet potato, peach
3-	1995-96	Sugarcane, Potato, Sweet potato
4-	1996-97	Banana, Sugarcane, Potato, Sweet potato
5-	1997-98	Banana, Sugarcane, Potato, Sweet potato
6-	1998-99	Banana, Sugarcane, Potato, Peach
7-	1999-01	Banana, Sugarcane, Potato, Peach
8-	2001-02	Grapes, Banana, Sugarcane, Potato, Sweet potato
9-	2002-03	Grapes, Banana, Sugarcane, Potato, Sweet potato
10-	2003-04	Grapes, Sugarcane, Potato, Sweet potato, Peach, Betel
11-	2004-05	Grapes, Sugarcane, Potato, Sweet potato, Peach, Betel
12-	2005-06	Grapes, Sugarcane, Potato, Sweet potato, Peach, Betel
13-	2006-07	Grapes, Sugarcane, Potato, Sweet potato, Peach, Betel

(vii) Data Management: The documentation of plant genetic resources is of paramount importance for utilization and retrieval of information pertaining to crops species and play a key role in the management of Genetic Resources Information (GRI). The documentation laboratory has computerized genetic resources information/passport data with thirty to forty parameters to establish plant genetic resources information database. Softwares of dBase-IV, FoxPro and Excel were previously used to maintain the current database. Therefore, a database system was designed and developed (using MS Access) on Plant Genetic Resources Information to maintain the database properly. Over 10900 accessions of different crop species were documented using their passport data. This data helps in publication of PGR catalogs.

(viii) Plant Genetic Resources Management Manual For easy understanding and smooth use of germplasm, operational manuals have been prepared and published. It includes a brochure and annual reports and a total of 6 germplasm management manuals pertaining to each laboratory established under JICA Technical Assistance Programme. A complete list of manuals published is presented at Annex-XXI.

(ix) ***Coordination with Neighboring Research Institutes*** During the project, two seminars were organized 28 agricultural research institutes and universities were visited to further introduce the activities to national breeders and researchers. Till 2006, 10 workshops/seminars (Annex-XXII) were organized for different objectives but mainly to introduce PGRI. The brochure and annual report as well as passport and characterization catalogues were published and distributed to the national neighboring institutions. For better utilization of PGR, all information related to germplasm collection, preservation, characterization, evaluation, research and utilization is disseminated to breeders through print material or online. Online availability of information on plant germplasm is available at PARC Website (www.parc.gov.pk).

3.2.2 Impacts not Anticipated at Project Completion

Following are impacts that were not anticipated at project completion and emerged after the project closed in 2003.

- Because of water shortage JICA Pakistan Office would be requested for installation of tube well in the premises of PGRI.
- The plant genetic resources programme has been upgraded to Plant Genetic Resources Institute (PGRI)
- Availability of diverse germplasm has necessitated the need to emerge a new a Genomic Research studies at NARC
- The International Treaty on Plant Genetic Resources for Food and Agriculture has facilitated access and benefit sharing.
- Convention on Biological Diversity with special reference to Traditional Knowledge associated with PGR has significantly increased its importance.
- Ministry of Environment has promulgated Biodiversity Act. This act regularized the activities on biological resources of Pakistan

3.3 Analysis of Factors of Impacts and Sustainability

(i) ***Contributing factors of Impact:***

(a) The reputation of the unique PGRI is attracting researchers/organizations from all over the Pakistan. The germplasm distribution load is increasing day by day. Students of the universities also wanted authentic germplasm lines for their research work. Population of Pakistan is also increasing and country requires new varieties of all crops to meet the dire demand of not only cereals but oil seeds also. This situation creates pressure on the government to carry out developing new varieties. Therefore, it is unlikely that the government will allow the increased demand of germplasm load to adversely affect the sustainability of the PGRI.

(b) The technology introduced and transferred to the local scientists in the fields of germplasm collection, preservation, evaluation, muliplicationa and distribution was appropriate and helped to introduce new varieties for increased food production

(c) Students of the universities also want authentic germplasm lines for their research work. Population of Pakistan is increasing and country requires new varieties of all cultivars to meet the dire demand of not only cereals but also of oil seeds. This situation creates demand for the government to develop new varieties and hence an ever increasing role of PGRI.

(ii) ***Contributing factor of Sustainability*:**

(a) PGRI is also helping a number of students to complete their research and is providing post-graduate training to candidates aspiring to specialize in biotechnology. Thus PGRI is working as an important institution to assist universities. This factor adds to the prestige of PGRI and contributes to the sustainability.

(b) Funding by Donor for their projects, that are expected to contribute to the various aspects of genetic resources have added to the financial sustainability of the PGRI.

( ) ***Inhibiting factors***

No major inhibiting factor was observed in achieving the goals of the PGRI. However, because of ban on new recruitments vacancies are filled with contract employment which although help meet the institutional targets but are considered to inhibit sustainability in longer run.

3.4 Issues/Problems

No serious problem or issues with PGRI were found.

3.5 Conclusion

(i) Sustainability

PGRI is financially, institutionally and organizationally sustainable. In case of finances government of Pakistan has increased its budget, which is now almost 10 times more than what it was at the inception of the project. The staff of the PGRI is maintaining its knowledge regularly through seminars, workshops and producing research papers for the benefit of other researchers. PGRI should not face problem of financial sustainability in the time to come.

Most of the equipment is in good working conditions and is being used properly except a few equipments that have become very old like cooling units. The importance of cooling units is described in Box-3. There is budget provision for maintenance of the equipment.

Box 3: Cooling Units and genebank

In any Plant Genetic Resources Programme, the proper functioning of genebank is very important. The genebank is based upon efficient cooling system. The cooling units installed in PGRI genebank in 1993 have become old now and required frequent repair. If the cooling system fails, it means all the efforts made so far will go waste. It is a geneuine need if new ones replace these units now.

PGRI has good coordination with other institutes in the country as well as overseas. Regular exchange of germplasm leads it tom its sustainability.

(ii) Impacts

This project made a substantial contribution to the overall goal, "New high yielding varieties with insect and/or disease resistance and stress tolerance are developed in order to increase crop production in Pakistan". PGRI is playing its due role by providing germplasm and technical guidance to the national research institutes and university students. The scope of PGRI is not limited to providing germplasm to other relevant organizations but also to extend facility of research work to various institutions. PGRI has also created linkages with international research institutes to exchange germplasm and storage facility. There is little impediment to technical sustainability.

IV RECOMMENDATIONS AND LESSONS

4.1 Recommendation for Government of Pakistan

- To further enhance and strengthen cooperation among scientists a regular exchange of scientists among national and international organizations should continue. An incentive system needs to be devised for retention of the trained staff.
- Keeping in view the importance of Plant Genetic Resources in crop improvement and sustainable agriculture, the Government of Pakistan should give top priority for financial and human resources to this important field.
- In view of the expected food shortages in the country, a more efficient system of germplasm should be introduced to include those areas and institutes that have the potential to help in introducing new food varieties.
- A comprehensive training plan for the staff outside the project area should be seriously considered. This is important in view of the fact that in next few years many existing experienced staff will retire. Therefore, before they leave, a program to take advantage of their experience should be put in place.
- Efforts should be made to replace the few old models of equipment, which are not repairable and will be obsolete. (Cooling Units of Genebank).

4.2 Lessons

1. The sustainability of projects involving germplasm collection, preservation techniques, evaluation and distribution, use of germplasm by the provincial institutes for developing high yielding cultivars requires a good understanding among all stakeholders which is possible only with high class trained manpower, sufficient operational funds, and state of the art building and equipment.
2. A good project design matrix, activity planning for implementation, periodic joint performance reviews, aftercare evaluation help keep the project implementation on track and eventually realize its goal.
3. Support from short-term experts to improve technical skills of trainers through counterpart training, provision of state of the art equipment, and technical cooperation for overseas training of the staff of the implementation agency are excellent tools that ensure a strong foundation for project to sustain its benefits over a long time after its completion.

ANNEXURES

ANNEX-I

EX-POST EVALUATION GRID

Criteria	Evaluation Questions: Main questions	Evaluation Questions: Sub-questions	Achievement: Criteria/Measures	Data source	Data collection methods
Impacts	a) Was the overall goal accomplished	1. How much and in what ways has the system contributed to the national policy.	-Did the breeders and researchers received desired germplasm	PGR record and registers, Plant collection registers	Records perusal Literature review Interviews perusal of reports
			-Did breeders were ale to evolve new varieties using this germplasm.	Neighbouring research institutes.	
		2. Did germplasm useful and improved yields?	-Did crop yields increased	Director PGRI	
			-How much and in what ways did PGR participate in establishing the technical and professional assistance system in neighboring research Institutes?		
		3. If yes, is it due to improved breeding material	-Reasons of increase (improved technologies, trained staff, better facilities,	PGR germplasm documentation	
			-Number of germplasm collection, preservation, evaluation, & distribution	Annual Reports	
			-Material dispatched to/received by other research Institutes		
			-Number of meetings organised with national breeders and researchers		
	b) What are the positive & negative impacts of the project; what was originally intended?	4. To what extent have the research capabilities of the researchers been improved?	-Staff number and number of trained staff	Germplasm distribution lists	Records perusal In-depth interviews
			-Change in the research abilities of researchers	Results of discussion with the IA	
		5. What are the gains from the project?	-Ways PGR participates in establishing the technical and professional assistance system in neighboring research institutes	Staff feedback	
		6. What are the negative and positive effects	-Federal & provincial research institutes that have directly or indirectly benefited from the project.	Responses from beneficiaries and other research institutes	
			-Negative or positive effects of the project	Publications to be added	
	c) Has the project improved the institutional capacity of the implementing agency?	7. Has training been imparted to the staff of other institutes?	-Number of personals with improved skills and competencies	Training programs outputs	Interviews, Structured questionnaire Record and interviews with staff of other institutes
			-Number of workshops and seminars held to disseminate information and attended by other institutes	Results of discussion with the IA, and	
		8. Are the linkages with neighboring institutes strengthened;	-Number of awareness programs	Responses from research institutes	
			-Exchange of germplasm with other institutes	Discussion with Director PGRI and other institutes	
			-Access to facilities provided by PGRI to breeders and researchers		

		9. How successful were the activities?	-Level of satisfaction of the neighboring institutes/trainees		
	d) Are there any external factors that influenced the achievement of project's overall goal?	10. Any change in govt. policy that affected project goals?	-Specific policies, statements of the Govt, programs and/or projects with tenures, funding, and implementing agencies	Discussion with implementing agency, PGRI staff, Govt staff, and budget, Documentations	Interviews, literature review, professional knowledge
		11. Any other Govt, or neighboring institutes programs or policies that complemented or adversely affected the national focus on increase crop yields?	-Perception of staff and neighboring institutes		
	e) Budgetary support for strengthening the research output?	12. Did allocation of budget remain sufficient to carry out activities?	-Budget allocations		
Sustainability	a) Is the project organization capable of maintaining over time the benefits accrued as a result of achieving project purpose and goals?	1. Is the training and knowledge gained still applicable?	-Change in germplasm collection technology vis-à-vis training imparted	PGRI Records	Record review
			-Change in demand and supply of germplasm		Site visits
		2. Is the equipment fully utilized, functional or obsolete?	-Ratio of equipment in working order vs. obsolete	Neighboring institutes' records	
			-Frequency and replacement of equipment		
			-Annual maintenance record of building and equipment	Observations	
			-New equipment introduced and ability to operate it		
	a) Is the project organization capable of maintaining over time the benefits accrued as a result of achieving project purpose and goals?	3. Are the indoor and outdoor buildings, lab etc sufficient, in good order?	-Any changes occurred in building		
		4. Is various categories of staff sufficient for the PGRI?	-Trained staff's turn-over		
			-Staff vacancies		
		5. Are budget funds adequate, and whether additional funds are required?	-Budget allocation for maintenance and repair		
			-Variance of budget funds vs. utilization (Automatic change in budget)		
		6. Is there close liaison with neighboring research institutes?	-Synchronized and compatible system of work with the neighboring institute		
	b) How likely are project outputs to be maintained?	7. What are the trends in germplasm collection after project termination?	-Changes in germplasm collection technology	Data on germplasm collection and distribution from PGRI records,	

		8. What is the performance level of seed health care after project termination?	-Rate of change in performance of seed health care in pre and post project termination	Director, PGRI and staff	Record review,
		9. What improvements have taken place in germplasm collection system?	-Change in seed analysis and storage Capacity of PGRI	Other research Institutes	Interviews
		10. To what extent is PGRI meeting the requirements of neighboring institutes?	-Number of unmet and met demands of neighboring institutes		
	c) What are the factors that contribute or inhibit the sustainability of project outcomes?	11. What changes have taken place in technical staff, administrative and budgetary size at PGRI?	-Change in number of technical personnel	PGRI (Implementing agency), Equipment registers/ records,	Interviews, PGRI records,
			-Changes in administrative staff		
			-Changes in budgetary allocations		
		12. What changes have taken place in inventory of equipment procured for PGRI?	-Change in inventory of equipment		
			-Status of working of equipment that was provided by JICA?		
		13. To what extent have training and capacity building changed in terms of frequency, diversity of training areas, etc?	-Number of training courses		
			-Awareness programs launched		
		14. To what extent has the building structure of the institute undergone changes with changing needs and priorities since 2003	-Change in infrastructure and physical facilities		
			-Extension of building structure, creation of more rooms and spaces, etc.		
	d) Are there any other donors involved in this project after project termination?	15. Apart from the Govt, is PGRI part of any other donor-assisted project or program?	-Objective and components of the additional project/program, if any	PGRI records	Interviews, PGRI document search
		16. If yes, how much incremental budget is now available?	-Performance indicators and annual budget activities conducted under that support		

ANNEX-II
SCHEDULE OF CONSULTANT'S WORK
EX-POST EVALUATION OF PROJECT TYPE TECHNICAL COOPERATION (PTTC)
PLANT GENETICS RESOURCES INSTITUTE,

S. #	Date	Day	Work Details
1.	Dec. 01- Dec 04, 07	Saturday	Review of literature
2.	Dec. 05, 07	Wednesday	Meeting with PGRI
3.	Dec. 06, 07	Thursday	Preparation of Evaluation Grid
4.	Dec. 07, 07	Friday	Preparation of Evaluation Grid
5.	Dec. 08, 07	Saturday	Finalize Evaluation Grid
6.	Dec. 09, 07	Sunday	
7.	Dec. 10, 07	Monday	Preparation of PDMe
8.	Dec. 11, 07	Tuesday	Preparation of PDMe
9.	Dec. 12- Dec 14, 07	Wednesday	Preparation of Inception Report
10.	Dec. 15, 07	Saturday	Submission of inception report
11.	Dec. 16 07	Sunday	
12.	Dec. 17- Dec 18, 07	Monday	Preparation of questionnaires for Other institutes
13.	Dec. 19- Dec 25,07	Wednesday	Holidays
14.	Dec. 26, 07	Wednesday	Dispatch Letters to Other Institutes
15.	Dec. 27, 07	Thursday	Dispatch Letters to Other Institutes
16.	Dec. 28, 07	Friday	Phone calls to Other Institutes
17.	Dec. 29, 07	Saturday	Phone calls to Other Institutes
18.	Dec. 30, 07	Sunday	
19.	Dec. 31, 07	Monday	Visit to PGRI, interviews and data collection
20.	Jan. 01, 08	Tuesday	Visit to PGRI, interviews and data collection
21.	Jan. 02, 08	Wednesday	Visit to PGRI
22.	Jan. 03, 08	Thursday	Visit to Crop Sciences Institute, NARC Islamabad
23.	Jan. 04, 08	Friday	Visit to Crop Sciences Institute, NARC, Islamabad.
24.	Jan. 05, 08	Saturday	Data compilation of NARC
25.	Jan. 06, 08	Sunday	Data compilation of NARC
26.	Jan. 07, 08	Monday	Visit to Seed certification Department, Islamabad
27.	Jan. 08, 08	Tuesday	Visit to Arid Agriculture University, Rawalpindi
28.	Jan. 09, 08	Wednesday	Visit to University of Agriculture Faislabad
29.	Jan. 10, 08	Thursday	Visit to Wheat Research Institute, Faislabad
30.	Jan. 11, 08	Friday	Visit to Ayub Agricultural Research Institute, Faislabad
31.	Jan. 12, 08	Saturday	Visit to NIAB, Faislabad
32.	Jan. 14, 08	Sunday	Data compilation of NARC
33.	Jan. 15, 08	Monday	Visit to University of Agriculture, Peshawar
34.	Jan. 16, 08	Tuesday	Visit to Institute of Biology & Engineering, Peshawar
35.	Jan. 17, 08	Wednesday	Visit to NIFA, Peshawar
36.	Jan. 18, 08	Thursday	Back to Islamabad.
37.	Jan. 19- Jan 22, 08	Friday	Compilation of data of Faisalabad
38.	Jan. 23- Jan 25, 08	Tuesday	Compilation of data of Peshawar
39.	Jan. 26, 08	Friday	Start report writing
40.	Jan. 27, Feb 01, 08	Saturday	Report writing
41.	Feb. 02, 08	Friday	Visit to PGRI, Islamabad
42.	Feb. 03, 08	Saturday	Draft report completion
43.	Feb. 04, 08	Sunday	
44.	Feb. 05, 08	Monday	Submission of draft report

ANNEX-III
LIST OF EQUIPMENT THAT REQUIRED REPLACEMENT

No.	Name of Equipment	Qty	Model	Maker	Remarks
1	pH Meter	1	HM-60V	-	Electronic problems and very old, out-dated, repair cost very high, unavailability of proper expertise for repair and guanine spare parts in local markets. It is needed to replace instead of continuous repair.
2	Automatic area meter	1	AAM-8	Hahyashi Denkoh Co., Japan	-do-
3	DNA Thermal Cycler 480	1	480	Perkin Elmer, USA	-do-
4	UV-Fluorescent Table	1	TFX-35C	Vilber Lourmat, France	-do-
5	Rotator RT-50	1	6012295	-	-do-
6	CU-5 Polroid Instant Camera	1	CU-5X	AATO Corporation	-do-
7	Medical and Pharmacy Refrigerator	1	MRP-510R	Japan	-do-
8	No Frast Refrigerator	1	B28T2	Japan	-do-
9	Piper Washer	1	AW31	Japan	-do-
10	Shaking Dryer	1	HV-100	-	-do-
11	Distillation Plant	1	WA53	Japan	-do-
12	UV-Visible Spectrophotometer	1	UV-1601	Japan	-do-
13	pH meter	1	Ø34	Beckman	-do-
14	pH meter	1	HM-60	TOA	-do-
15	Autoclave	1	SM52	Yamato	-do-
16	pH meter	1	SM50V	TOA	-do-
17	Refrigerator	1	GR-A41EC	Toshiba	-do-
18	Lobbies cooling unit of Gene Bank (GB)	2	RU-30HC	Hitachi	-do-
19	Main chambers Cooling Unit - GB	4	RU-50HC	Hitachi	-do-
20	Small chambers cooling unit of GB	8	-	Hitachi	-do-
21	Seed Drier	1	HNSD1250	KOITO	-do-
22	De-humidifier of GB	1	56P-600 2E	Scibu Giken	-do-

Source: PGRI

ANNEX-III A
LIST OF EQUIPMENT AND SPARE PARTS
RECEIVED DURING "AFTER CARE PROJECT"

Priority	Equipment	Maker	Model	Qty
Germplasm Evaluation Laboratory				
A	Epi-light, UV Series	AISIN	EU – 1100 EU – 1150	1
B	pH meter	TOA DKK	HM-60G	1
A	Refrigerated Micro-Centrifuge	Tomy	MX-300	1
C	Mini Lab type Electropheresis	ATTO	AE-6400	4
C	Micro Pipetters	Luchi	Pipetter, 10~100µ1	2
			Pipetter, 20~200µ1	2
			Pipetter, 100~1000µ1	2
			Pipetter, 0.5~10µ1	2
			Pipetter, 1000~5000µ1	2
Seed Preservation Laboratory				
A	Aspirator	Luchi	A-3S	1
B	Conductivity Meter	Horiba	B-173	1
A	O_2 Analyzer	Riken keiki	O2 Sensor	1
A	CO_2 Analyzer	Riken keiki	Unidentified	1
A	Dehumidifiers	National	CD-701P-225 (CD-B160F-W)	5
A	Plastic Bottles	Nikko	Unidentified	12000
B	Aluminum Foil Bags	Ryuzan	Small	5000
B	Aluminum Foil Bags	Ryuzan	Big	5000
Documentation Laboratory				
A	Computer	Compaq	Unidentified	8
A	Printer	HP	HP Laser	5
A	MOU	I/O Data	MOF-S640/UPCIN	1
A	Scanner	Unidentified	Unidentified	1
In-vitro Preservation Laboratory				
C	Purchase of adjustable, automatic media dispensr 1 ml to 1000ml per dispensing	Sigma	Unidentified	1
A	Mister/Fogger High Capacity	takabayasirika	Unidentified	1
A	Shredder (of plants material wooden material)	Necessary confirm	CP-300	1
C	Bioreactors, Transparent 1r, al capacity	EYLA	MBRS-051J	1
B	EC meter	TOADKK	CM-20S	1
B	PH meter	Shibata	PV-1	1
Plant Introduction & Seed Health Laboratory				
A	Commercial water distillation unit	YAMATO	(WA33 WB21)	2
A	Electrical conductivity meter	Shibata	SC-170	1

ANNEX-III A (Continued)
LIST OF THE EQUIPMENT (SPARE PARTS)

Priority	Required Part name	Maker	Model	Qty	Remark
Germplasm Evaluation Laboratory					
C	Heater AC, 115V,250 W	YAMATO	MH-81 (M-41 was wrong)	1	Mag Mixer
B	Sterilizing Heater (141)	YAMATO	SMM22	1	Auto Clave
B	Sensor For inside Temperature of the can (160)			1	
A	Heater 92530-16-112)	YAMATO	WB-21	1	Auto Still
A	Heater, AC,220 V		WA-53	1	
A	Relay (Flow Switch)			1	
	Filter			4	
B	Magnetron	SANYO	FMO-900T	1	Microwave Oven
Seed Preservation Laboratory					
A	Voltage sensor SDV-FH7	KOITO	HNSD-1250 (Koitotron)	4	Seed Dryer
A	Humidity Controller SDC2006 DC01A003T1			8	
A	Temperature Controller SDC2009 DC01A003T1			8	
B	Control Relay AHX-ALX-1Y,LX3,RX1, RX2,SV2X			36	
A	Illuminating Lamp SL-18V,2W			100	
B	Heaters	Fuji IMPULSE	V-300 R 35	6	Vacuum Sealer
Documentation Laboratory					
A	REPAIR	Un identified	4029	1	IBM Printer
A	Up Gradation	Un identified	Acer-486	2	Computer
A	Drum unit, Oily Roller, Developer Spacer F & R Sorter	Canon	NP-1215	1	Canon Photocopier Machine
In-Vitro Preservation Laboratory					
A	AC Adapter ADV-200	TOA	HM 60V	2	Ph Meter
A	Electrode GST-5421C			2	
A	Compressor (Hermetic Type) 250W	SANYO	MDF-U331	1	Medical Freezer
B	Freon No. 500&503 (GAS)	SANYO	MDF-429AT	20KG	Ultra low Freezer
B	pH Electrode 39848(Lot.S701B)	BECKMAN	34Ph	1	pH Meter
A	Hepa Filter	HITACHI	PCV1913BN	4	Clean Bench
A	Hepa Filter		PCV843BN	4	
B	Steam generator	YAMATO	SM52	1	Auto Clave
B	Steam generator	HIRAYAMA	HL36AE	1	Auto Clave

Plant Introduction & Seed Health Laboratory					
A	25ml*6*4	HITACHI	SR17CR20C	1	Rotary for ultracentrifuge
A	Carbon Brush (334373)	HITACHI	SCT 5B	4	Table Top Centrifuge
B	Motor BT 47-203	YAMATO	BT47	2	Shaking Water Bath
B	Sensor BT-23-212A			2	
B	Thermo-regulator B-T47-207			2	
A	Heater BT-47-110			2	
A	Solenoid Valve(For Boiler Drain) 253044-126 J244-023AC100V	YAMATO	WA 33	2	Auto Still
A	Heater 253044-126 bobbin coil 1.5 (quartz glass)			8	
A	Heater Shell Tube 253044-151 (quartz glass)			4	
B	Condenser 2530444-155 20*25*T30			6	
A	Pure Water Filter 253044-212 DFA3201 NAEY			24	
B	Water Leakage Detector 253044-234 (0.7M)			4	
B	ION Exchanger 253044-286ICR-II (standard resin)			12	
B	Raw Water Filter 253044-287SWPP-01001			12	
B	Scale Remover 253044-301 (orgasol 10)			24	
B	Control Circuit board 231511-202 GZY-QB0A/F (for 115V)	YAMATO	LH-21	1	LSC Homogenizer
A	Heater 5302615A	HITACHI KOKI	SCP85G	2	Ultracentrifuge
A	Noise Filter 5301762			2	
A	Micro Switch (464021)			4	
A	Solenoid (465307)			2	
A	MPG sensor assay (S404325B			1	
A	Imbalance sensor assay (S302356B)			2	
A	Gasket (465366)			12	
A	Oil Diffusion Pimp 213790 A	HITACHI KOKI	SCP85G	8	Ultracentrifuge
A	Rotary Pump Oil (3058512)			4 Liter	
A	LSI UPD 780G S402834			4	
A	RAM HM 62640LP			4	
A	C-mos 1c µ PD71054C			1	
A	Drive Board S201723A			1	
A	Control Panel S100618A			1	

ANNEX III.-A (Continued)
LIST OF EQUIPMENT (ADDITIONAL REQUEST)

Priority	Equipment	Maker	Model	Qty
Germplasm Evaluation Laboratory				
C	Incubator	ALP	ILD-120G	1
Seed Preservation laboratory				
C	PID Panel Set	Simaden	unidentified	1set
C	C/ RH Data Logger	Sato	EA742GC	8
Documentation Laboratory				
C	UPS	BACK-UPS (1250)	APC BS-1000	2
C	IBM Printer	Un identified	Un identified	1
Plant Introduction & Seed Health Laboratory				
C	ELISA Plate Reader	BIORAD	550	1
As General				
C	Tool	Esco	EA612SA-3	1
C	Cramp Meter	Esco	EA708MC	1
C	Earth Leakage Breaker	ELB	400	1
C	AVR	Matsunaga	EA709MC	10
C	REQUIRED EQUIPMENT MANUALS	Hitachi	305 FH2 T	1
C			RAS045 6S	1
C			RAS-140H65	1

ANNEX-IV
PUBLICATIONS (PGRI) 2001-2007

Books

1. Khan, M.A.; I. Ahmad; N.I. Hashmi and M.A. Matin. 2003. Strategic Environment for Research: Environment Analysis & Strategic for National Agricultural Research Centre, Islamabad – Pakistan ISNAR, PARC. Pp:101.

2. Rashid, A., M. Afzal and Zahoor Ahmad. 2006. PARC in the Service of Nation: Research Based Knowledge and Technologies, Pakistan Agricultural Research Council, Islamabad. 110pp.

Chapters

1. Toriyama, K., Tanabe, M., and H. Rashid. 2001. Transgenic Moricandia. In: Biotechnology in Agriculture and Forestry. Transgenic Crops III (ed. By Y.P.S. Bajaj). Springer- Verlag Berlin Heidelberg, P.352-358.

2. Rafique E., A. Rashid, A.U. Bhatti, G. Rasool and N. Bughio. 2002. Boron deficiency in cotton grown on calcareous soils of Pakistan. I. Distribution of B availability and comparison of soil testing methods. In HE Goldach (ed.), Boron in Plant Animal Nutrition, Kluwer academic/ Pelnum Publishers, New York pp. 349-356 (USA).

3. Rashid A., E. Raique and N. Bughio. 2002. Boron deficiency in rainfed alkaline soils of Pakistan. II. Incidence and internal boron requirement of wheat. IN he Goldbach (ed.) Boron in Plant and Animal Nutrition, Kluwer Academic/Pelnum Publishers, New York. pp. 3673-3700 (USA).

4. Rashid A., E. Rafique, S. Muhammad and N. Bughio. 2002. Boron deficiency in rainfeds alkaline soils of Pakistan. Incidence and genotypic variation in rapeseed-mustard. In HE Goldbach (ed.). Boron in Plant and Animal Nutrition, Kluwer academic/Pelnum Publishers, New York. pp. 371-379 (USA).

5. Ahmad Zahoor, A. Qayyum and A. Ghafoor. 2003. Plant Genetic Resources in SAARC Countries: Their conservation and management (Pakistan chapter) In: Plant Genetic Resources in SAARC Countries: Their Conservation and Management. SAARC Agricultural Information Centre, Dhaka, Bangladesh. 423-480 pp.

6. Ahmad Zahoor. 2006. Medicinal and Aromatic Plants of Pakistan. In: Guide on Medicinal & Aromatic Plants of SAARC Countries. SAARC Agriculture and Information Centre, Dhaka. pp 415-628.

7. Ahmad Zahoor and A. Ghafoor. 2007 *Nigella sativa* – a potential commodity in crop diversification traditionally used in healthcare. . In: Breeding of neglected and underutilized crops, spices and herbs. Editors (Ochatt, C & Jain, S.M). Science Publishers, Inc. New Hampshire, USA. Chapter 14. pp: 215-230.

8. Ahmad Zahoor and A. Ghafoor. 2007. *Plantago ovata* – a crop of arid and dry climates with immense herbal and pharmaceutical importance. In: Breeding of neglected and underutilized crops, spices and herbs. Editors (Ochatt, C & Jain, S.M). Science Publishers, Inc. New Hampshire, USA. Chapter 15. pp: 231-249.

Refereed Journals

2001

1. Ahmad, Z., A. Ghafoor, S.M. Iqbal and M.S. Iqbal. 2001. Yield potential of local and exotic germplasm with special reference to powdery mildew disease in peas [*Pisum sativum* (L.)]. Pakistan Journal of Botany, 33(3): 251-255.

2. Akram, M., M. Munir., K.A.Saifullah, M.Shaukat and F.M.Abbasi 2001. Seed and seedling vigor in rice: genetic variability among the varieties. Pak J. Biol. Sci. 4(3) 217 - 219.

3. Ashraf, M., A.S. Qureshi, A. Ghafoor and N.A. Khan. 2001. Genotype-environment interaction in wheat. Online Journal of Biological Sciences, 1(5): 356-357.

4. Aziz, T., M.A. Gill and I. Ahmed. 2001. Differential growth response of cotton genotypes infected with root rot to silicon nutrition. *Pak. J. Soil Sci*. 20: 101–108.

5. Bughio N., Nakanishi H., Kiyomia S., Matsuhashi S., Ishioka N-S. Watanabe S., Uchida H., Tsuji A., Osa A., Kume T., Hashimoto S., Sekine T. and Mori S. 2001. Real-time [^{11}C]-methionine translocation in barley in relation to mugineic acid phytosiderophore biosynthesis. Planta 213:708-715. (Germany).

6. Chaudhry, Z. I. Feroz., W.Haider., H. Rashid., B. Mirza., & A. Quraishi. 2001. Varietal Response of *Lycopersicon esculentum L*. to Callogenesis and Regeneration. OnLine J. of Biol. Sci. 1(12): 1138-1140.

7. Ghafoor, A., A. Sharif, Zahoor Ahmad, M.A. Zahid., M.A. Rabbani. 2001. Genetic diversity in blackgram. Field Crops Research. 69:183-190. (Elsevier, Netherlands)

8. Ghafoor, A., Z. Ahmad, S.M. Iqbal and Z. Riaz. 2001. Genetic diversity in local collection of *Vigna mungo* (L.) Hepper with relation to geographic pattern. Pakistan Journal of Botany, 33(3): 239-249.

9. Hussain, I. A. Muhammad, H. Rashid and A. Quraishi. 2001. *In vitro* multiplication of gladiolus (*gladiolus crassifolius*). Plant Tissue Culture 11(2): 121-126.

10. Hussain, I. Muhammad, A. and Quraishi, A. 2001. *In vitro* cormlet production in *Gladiolus crassifolius* L. cv. Pink. Pak. J. of Biological Sciences. Vol.4(5): 535-536.

11. Hussain, I. Muhammad, A. Hamid, R. and Quraishi, A. 2001. *In vitro* multiplication of *Gladiolus crassifolius* L. Plant Tissue Culture. Vol.11 (2): 125-127.

12. Iqbal Sh. M., A. Ghafoor, Zahoor Ahmad and N. Ayub, (2001). Yield potential of promising Pea cultivars under natural infection of powdery mildew. Pakistan J. Phytopath. 13(1):61-63.

13. Iqbal, M., F.M. Abbasi., M. Salim., H.M. Ahmed., and M.A. Sagar 2001. Selection of breeding parents from different land races of rice. Pak. J. Biol. Sci. 4(4) 357 - 358.

14. Iqbal, R.J., A.M. Ranjha, T. Waheed and I. Ahmed. 2001. Genotypes differences among cotton genotypes for phosphorus use efficiency and stress factor. *Intl. J. Agri. & Biol.*, 3 (2): 186–187.

15. Iqbal, S.M., A. Ghafoor, Z. Ahmad and N. Ayub. 2001. Yield performance of promising pea cultivars under natural infection of powdery mildew. Pakistan Journal of Phytopathology. 13(1):61-63.

16. Javaid A; S.Masood and N.M.Minhas. 2001. Analysis of combining ability in wheat (*Triticum aestivum*.L) using F2 generation. Pak.J..of Biological Sciences. 4(11): 1303 -1305.

17. Mitsueda, T., M. Bashir., Zahoor Ahmad and N. Murata. 2001. Mechanism of "Seed to Seedling Infection" by *Ascochyta rabiei* (Pass.) Lab. in Chickpea. On Line Journal of Biological Sciences 1 (5):384-386.

18. Quraishi, A and A. Muhammad. 2001. Impact of banana biotechnology in Pakistan. J.Sci. Tech and Dev. Vol 20(1): 1-5

19. Rabbani M. A., A. A. Quareshi, M.afzal, R.anwar and S. Kamatsu 2001. Characterization of mustard (*brassica juncea*) germplasm by sds-page of total seed proteins. Pak.j.bot; 33(2): 173-179.

20. Rabbani, M.A., H. Abe, F. Saito, M. Narusaka, M. Seki, K. Shinozaki and K. Yamaguchi-Shinozaki. 2001. Monitoring expression profiles of osmotic stress-inducible genes using cDNA microarray in rice (*Oryza sativa* L.). *Plant Cell Physiol*. 42 (Suppl): s129.

21. Rabbani, M.A., M.A. Khan, S.M. Kazim and R. Anwar. 2001. Evaluation, classification and usefulness of radish (*Raphanus sativus* L.) germplasm for morphological characters. *Quarterly SCIENCE VISION* 6(3): 47-52.

22. Ranjha, A.M., I. Ahmed, M. Iqbal and M. J. Ahmed. 2001. Rice response to applied phosphorus, Zinc and farmyard manure. *Intl. J. Agri. & Biol.*, 3 (2): 197–198.

23. Rashid, H., S. Y. A. Bokhari and A. Quraishi. 2001. Callus Induction, regeneration and hygromycin selection of rice (Super Basmati*).* Online J. of Biol. Sci. 1(12): 1145-1146.

24. Saleem M., Shaukat Ali, Z. Ali and F. Hameed. 2001. Cause and effect relationship of yield attributes in chickpea. Journal of Pure & Applied sciences, 20(19:43-49.

25. Shakeel Ahmad Jatoi, Muhammad Afzal, Shahzad Nasim and Rashid Anwar, 2001. Seed deterioration study in pea using accelerted ageing techiniques. Pak. J.Biol. Sci. 4(12):1490-1494.

26. Shazia Irum, Iftikhar Ahmad, Shazia Batool and Shahid Masood. 2001. Variation in protein profiles of *Phytophthora infestans* collected from potato production zones of Pakistan. Pak. J. of Bot. 33: 841-

848.

27. Zubair, M. and A. Ghafoor. 2001. Genotype Environment Interaction in Mungbean. Pakistan Journal of Botany, 33(2): 187-190.

2002

28. Ali, A., I. Ahmed, B. Zaman and M. Salim. 2002. Nutritional effect of calcium on growth and ionic concentration of wheat under saline conditions. *Pak. J. Agri. Sci*. 39 (4): 258–264.

29. Ashraf, M., A. Ghafoor, N.A. Khan and M. Yousaf. 2002. Path-coefficient in wheat under rainfed conditions. Pakistan Journal of Agricultural Research, 17(1): 1-6.

30. Bashir, M, Z. Ahmad and A. Ghafoor, 2002. Identification of resistance in cowpea against blackeye cowpea mosaic virus. Pakistan Journal of Botany, 34(1): 53-54.

31. Bashir, M., A. Ghafoor and Z. Ahmad. 2002. Response of cowpea germplasm to virus infection. Pakistan Journal of Agricultural Research, 17(2): 159-162.

32. Bashir, M., M. Sajjad, A. Ghafoor, Zahoor Ahmad and A.S. Afsari. 2002. Variability in cowpea germplasm for reaction to virus infection under field conditions. Pakistan Journal of Botany. 34(1):47-48.

33. Bashir, M., Z. Ahmad and A. Ghafoor. 2002. Cowpea aphid borne mosaic poty-virus- A Review. International Journal of Pest Management, 48(2): 155-168.

34. Bashir, M., Z. Ahmad and A. Ghafoor. 2002. Cowpea germplasm evaluation for virus resistance under greenhouse conditions. Asian Journal of Plant Sciences, 5: 585-587.

35. Bughio N., Yamaguchi H., Nishizawa N-K., Nakanishi H., and Mori S. 2002. Cloning an iron–regulated metal transporter. J. Exp. Bot. 53(374):1677-1687. (UK).

36. Ghafoor, A., Z. Ahmad, A.S. Qureshi and M. Bashir. 2002. Genetic relationship in *Vigna mungo* (L.) Hepper and *V. radiata* (L.) R. Wilczek based on morphological traits and SDS-PAGE. Euphytica, 123(3): 367-378.

37. Hussain, M. I., S.H. Shah, S. Hussain and K. Iqbal. 2002. Growth, yield and quality response of three wheat (Triitcum *aestivum* L.) varieties to different levels of N, P and K. Intl. J. Agric. Biol. Vol 3. p 362-364.

38. Hussain, S., A. Sajjad, M.I. Hussain and M. Saleem. 2002. Growth and yield response of three wheat (*Triticum aestivum* L.) varieties to different seeding densities. Intl. J. Agric. Biol. Vol 2. p 228-229.

39. Iqbal, S.M., A. Ghafoor, A. Bakhsh and M. Bashir. 2002. Disease resistance status of chickpea genotypes against ascochyta blight. Pakistan Journal of Phytopathology, 14(2): 135-139.

40. Iqbal, S.M., C.A. Rauf, N. Ayub and A. Ghafoor. 2002. Morphological characters of chickpea related to resistance against blight. International Journal of Agriculture & Biology, 4(4):496-499.

41. Jatio, S.A., G.M. Sajid, M. Munir, Zahoor Ahmad and R. Anwar. 2002. Genotype dependant callogenic and morphogenic response of *Lycopersicon esculentum* hybrids. The Nucleus, 39(3-4):233-237.

42. Javaid, A., A. Ghafoor and R. Anwar. 2002. Evaluation of local and exotic pea (*Pisum sativum*) germplasm for vegetable and dry grain traits. Pakistan Journal of Botany, 34(4): 419-427.

43. Khalid, S. and *Siddiqui S. U.* 2002. Wild oats (*Avena fatua* L.) seed viability and dormancy as influenced by seed age and size, and the variable germination temperature regime. PJAR.17 (4): 335-341.

44. Khaliq, A., H. Rashid, A. Quraishi. 2002. Tissue culture studies of tea (*camellia sinensis* L.). Pakistan J. Agric. Res., 17 (3): 297-301.

45. Khan M.R., H. Rashid and A. Quraishi. 2002. *In vitro* shoot development from juvenile cuttings of field-grown olive (*Olea europaea L.*) cv. Leccino. OnLine J. of Biol. Sci. 2(7): 438-440.

46. Khan, M.R., H. Rashid and A. Quraishi. 2002. Effects of various growth regulators on callus formation and regeneration in *Brassica napus* c.v. Oscar. Pak. J. of Biol. Sci. 5(6): 693-695.

47. Khan, M.R., H. Rashid and A. Quraishi. 2002. High frequency shoot regeneration from hypocotyl explants of *Brassica napus*. Pl. Tiss. Cult. 12(2).

48. Maher A.B., M. Arshad, Shaukat Ali, S,M. Iqbal M.S. Hussain and M. Bashir. 2002. Parbat" a new high

yielding variety of Desi Chickpea for Potowar region in Pakistan. Journal of Animal and Plant Sciences, 12(4): 142-144

49. Naqvi, S.M.S., T.Yasmin, H. Rashid, Z. Chaudhry and A. Quraishi. 2002. Callus induction from seeds of zee mays Var. EV-2097. Pakistan J. of Biol. Sci. 5(9): 956-958.

50. Rashid A., Ghulam Raza Hazara, Nasir Javed, Malik Shah Nawaz and G.M. Ali. 2002. Genotype x environmental Interaction and stability analysis in Mustard (B. juncea), Asian Journal of Plant Science 1 (5): 591-592 Pakistan

51. Rashid, H., R. A. Ghani, Z. Chaudhry, S.M.S. Naqvi and A. Quraishi. 2002. Effect of media, growth regulators and genotypes on callus induction and regeneration in (*Triticum aestivum*): Biotechnology, 1 (1). 49-54.

52. Shaukat Ali, A.B. Maher, M. Anwar and A.M. Haqqani. 2002. Exploitation of genetic variability for grain yield improvement in chickpea. International Journal of Agriculture and Biology, 4(1): 148-149

53. Tahir, F. H. Rashid, Z. Chaudhry and A. Quraishi. 2002. Protein estimation of embryogenic calli as a monitor of salt tolerance. Pak. J. of Agri. Research. 17(1): 55-56.

54. Yoshiyuki Notsu, Shahid Masood, Tomotaro Nishikawa, Nakao kubo, Gaku Akiduki,Mikio Nakazono, Atsushi Hirai and koh-ichi Kadowaki. 2002. The complete sequence of rice (*Oryza sativa* L.) mitochondrial genome: frequent DNA sequence acquisition and loss during evolution of flowering plants. Mol Genet Genomics (Germany) 268: 434-445.

2003

55. Ahmad, B., Wahid, M.A., Bugti, R.A., M.A. Zahid and Shaukat Ali. 2003. Evaluation of Chickpea germplasm for Semi-Arid zones of Balochistan. International Journal of Agriculture and Biology, 5(2): 113-116.

56. Akhtar, J ., A. Shahzad, T. Haq, M. Ibrahim, M. A. Haq. 2003. Screening of 20 wheat lines against salinity in hydroponics. Pak. J. Life Soci. Sci. 1(2): 92-97.

57. Akhtar, J., T. Haq, A. Shahzad, M. A. Haq, M. Ibrahim and N. Ashraf. 2003. Classification of different wheat genotypes in salt tolerance categories on the basis of biomass production. Int. J. Agri. Bio. 5(3): 322-325.

58. Akhtar, J., W.M. Bhutta, M. Ibrahim, M.A. Haq, A. Shahzad, T. Haq. 2003. Performance of wheat to NaCl stress at early growth stages in solution culture. Pak. J. Soil Sci. 22(4): 11-14.

59. Akhtar, M.A., Zakria, M and F.M.Abbasi 2003. Incidence of bacterial blight of rice in Pakistan during 2002. Pak. J. Bot. 35 (5) 993-997

60. Ali, A., M. Salim, I. Ahmed, I. A. Mahmood, B. Zaman and A. Sultana. 2003. Nutritional role of calcium on the growth of *Brassica napus* under saline condition. *Pak. J Agri. Sci.,* 40 (3–4): 106–113.

61. Arshad, M., A. Bakhsh, M. Zubair and A. Ghafoor. 2003. Genetic variability and correlation studies in Chickpea (*Cicer arietinum* L.). Pakistan Journal of Botany, 35(4): 605-611.

62. Ashraf, M., A.S. Qureshi and A. Ghafoor. 2003. Genetic diversity in wheat under different crop-ecological zones. Pakistan Journal of Botany, 35(4): 597-603.

63. Ashraf, M., A.S. Qureshi and A. Ghafoor. 2003. Total wheat DNA variation in to varieties using known primers of genes induced in dehydration and salinity stress. Pakistan Journal of Biological Sciences, 6(5):437-440.

64. Ghafoor, A and Z. Ahmad. 2003. Exploitation of *Vigna mungo* (L.) germplasm using multivariate analysis based on agronomic traits. Pakistan Journal of Botany, 35(2):187-196.

65. Ghafoor, A, Z. Ahmad, A. Javaid and M. Ashraf. 2003. Multivariate analyses in chickpea (*Cicer arietinum* L.). Pakistan Journal of Botany, 35(3): 369-376.

66. Ghafoor, A., F.N. Gulbaaz, M. Afzal, M. Ashraf and A. Arshad. 2003. Inter-relationship between SDS-PAGE markers and agronomic characters in chickpea (*Cicer arietinum* L.). Pakistan Journal of Botany, 35(4): 613-624.

67. Ghafoor, A., Z. Ahmad, M. Munir and A.S. Qureshi. 2003. Inheritance and linkage among morphological markers in diverse hybrids of *Vigna mungo* L. SAARC Journal of Agriculture, 1: 181-192.

68. Ghafoor, A., Z. Ahmad, N.I. Hashmi and M. Bashir. 2003. Genetic diversity based on agronomic traits and SDS-PAGE markers in relation to geographic pattern of blackgram [*Vigna mungo* (L.) Hepper]. Journal of Genetics & Breeding, 57: 5-14.

69. Iqbal, M.S., A. Ghafoor, A.S. Qureshi and Z. Ahmad. 2003. Genetic dissimilarities in cowpea (*Vigna unguiculata* L.Walp.) for protein peptides and their significance for quantitative traits loci. Pakistan Journal of Botany, 35(3): 377-386.

70. Iqbal, M.S., A.S. Qureshi, A. Ghafoor and A. Qayyum. 2003. Identification of superior genotypes based on morphological, physiological and agronomic traits in local and exotic cowpea germplasm. Pakistan Journal of Botany, 35(1): 69-77.

71. Iqbal, S.M., A. Bakhsh, A. Ghafoor, N. Ayub and M. Bashir. 2003. Reaction of chickpea genotypes to isolates of Ascochyta *rabiei* (Pass) Lab. Pakistan Journal of Plant Pathology, 2(1): 39-47.

72. Iqbal, S.M., A. Ghafoor, M. Arshad and M. Bashir. 2003. Screening of urdbean (*Vigna mungo* L.) germplasm for resistance to charcoal rot disease. Pakistan Journal of Plant Pathology, 2(2): 107-110.

73. Iqbal, S.M., A. Ghafoor, N. Ayub, I. Ahmad and A. Bakhsh. 2003. Effect of Ascochyta blight on productivity of chickpea. Pakistan Journal of Botany, 35(3): 431-437.

74. Iqbal, S.M., A. Ghafoor, Z, Ahmad and A.M. Haqqani. 2003. Pathogenicity and fungicidal efficiency for *Sclerotium* Rot of Brinjal. International Journal of Agriculture & Biology, 4: 618-620.

75. Khan, M. R., Ansar M., H. Rashid and Z. Chaudhry. 2003. High frequency shoot regeneration and Agrobacterium-mediated DNA transfer in Canola (*Brassica napus* L.). Pl. Cell Tiss & Org. Cult. 75: 223-231.

76. M. Ashraf, A A Cheema, Zia-ul-qamar, M. Rashid and Zahid Mahmood. 2003. Development of Rice Varities through Induced Mutations. Pak. J. Bot., 35(5) pp: 811-818.

77. M. Shahid Masood, A. Qayyum, Rashid Anwar, and Shahbaz Ahmad. 2003. Level of genetic diversity for agro-morphological traits in landrace genotypes of barley (*Hordeum vulgare*). Pak. J. of Arid Agric. 6 (1): 73-79.

78. Muhammad, A., I. Hussain, M. F. Akbar and H. Rashid. 2003. Enhanced rate of multiplication of tissue cultured raised banana (*musa*) plants in the field. Pakistan J. of Biol. Sci. 6(6): 587-588.

79. Noor, F., M. Ashraf and Ghafoor, A. 2003. Path analysis and relationship among quantitative traits in chickpea (*Cicer arietinum* L.). Pakistan Journal of Biological Sciences, 6(6):551-555.

80. Rabbani, M.A., K. Maruyama, H. Abe, M.A. Khan, K. Katsura, Y. Ito, K. Yoshiwara, M. Seki, K. Shinozaki and K. Yamaguchi-Shinozaki. 2003. Monitoring the expression profiles of rice (*Oryza sativa* L.) genes under cold, drought and high-salinity stresses, and ABA application using both cDNA microarray and RNA gel blot analyses. *Plant Physiology* 133(4): 1755-1767.

81. Rahmatullah, M. Salim, I. Ahmed, M.A. Gill and K. Hussain. 2003. Phosphorus retension in an Alfisol amended with lime and gypsum. *Pak. J. Agri. Sci*. 40 (1-2): 12–17.

82. Rashid Anwar, Shahid Masood, Mir Ajab Khan and S.Nasim. 2003. The high-molecular-weight glutenin subunit composition of wheat (*Triticum aestivum* L.) landraces from Pakistan. Pak. J. Bot..35 (1): 61-68.

83. Rashid, H., S. N. Rahim, Z. Chaudhry, S. M. S. Naqvi. 2003. Studies on genotype response to callus induction from three Basmati cultivars of rice *(oryza sativa* L.). Pakistan J. of Biol. Sci. 6(5): 445-441.

84. Tariq Rafique, Muhammad Jafar Jaskani, Hussnain Raza and Mazhar Abbas. 2003. *In vitro* studies on microtuber induction in potato. *International Journal of Agriculture and Biology.* 6(2): 375-377.

2004

85. Abbasi F.M.and M. Salim. 2004. Tracking alien chromosomes in *sativa* background by genomic *in situ* hybridization. J. Sci. Technology and development 23(2) 64-66.

86. Abbasi, F.M. and Komatsu, S. 2004. A proteomic approach to analyze salt responsive proteins in rice leaf sheath. Proteomics. 4: 2072-2081.

87. Abbasi, F.M. and Komatsu, S. 2004. OsCDPK13 a calcium dependent protein kinase gene from rice is induced by cold and gibberellin in rice leaf sheath. Plant Molecular Biology. 55: 541-552

88. Akhtar, M.A., Zakria, M and F.M.Abbasi. 2004. Trends in occurance of Bacterial blight of rice in Pakistan. Pak. J. Phytopathology. 16 (1) 69-71.

89. Arshad, M., A. Bakhsh and A. Ghafoor. 2004. Path coefficient analysis in chickpea (*Cicer arietinum* L.) under rainfed conditions. Pakistan Journal of Botany, 36(1): 75-81.

90. Athar Tariq and Zahoor Ahmad. 2004. Taxonomy, distribution and medicinal uses of legume trees of Pakistan. SIDA , 21(2): 951-962. (USA).

91. Bhutta, W.A., M. Ibrahim, J. Akhtar, A. Shahzad, T. Haq and M. A. Haq. 2004. Comparative performance of Sun flower (Helianthus annus) genotypes against NaCl salinity. Caderno Pesquisa Serie Biologia. 16(1):8-17

92. Chaudhry Z., D. Habib, H. Rashid and A. S. Qureshi. 2004. Regeneration from various explants of *in vitro* seedling of tomato (*Lycopersicon esculentum*. L., c.v. Roma). Pakistan J. of Biol. Sci. 7(2):269-272.

93. Farooq M., H. Rashid, I. Ullah, Z. Chaudhry and K. B. Marwat. 2004. Comparative tissue culture response of wheat cultivars and evaluation of regenerated plants. Pakistan J. of Biol. Sci. 7(3):406-408.

94. Ghulam. M. Ali, Collins, J.C and McNeilly, T. 2004. Effect of increasing concentrations of sodium carbonate on pearl millet *pennisetum americanum*. International Journal of Food, Agriculture & Environment. 2 (2) 265-272. Finland

95. Ghulam. M. Ali, Murtaza N., Khan N. M., Collins, J.C. and McNeilly T. 2004. The pH stress on plant growth of *Arabidopsis thaliana* and pearl millet in NaCl and Na_2CO_3 solutions. International Journal of Food Agriculture & Environment. 2 (3 & 4) 229-232. Finland

96. Ghulam. M. Ali, N. M. Khan, Hazara R. and T. McNeilly. 2004. Variability in pearl millet *Pennisetum americanum* (L.) Leeke accessions to salinity. Acta Agronomica Hungarica 52 (3) 277-286. Hungry

97. Haq, T., K. Mahmood., A. Shahzad and J. Akhtar. 2004. Tolerance potential of wheat cv. LU-26s to high salinity and waterlogging interaction. Int. J. Agri. Biol. 5(2): 162-65.

98. Iqbal, S.M., A. Ghafoor and N. Ayub. 2004. Screening of chickpea germplasm against Ascochyta blight disease. Pakistan Journal of Agricultural Research, 18(1): 8-15.

99. Iqbal, S.M., A. Ghafoor, N. Ayub and Z. Ahmad. 2004. Pathogenic diversity in *Ascochyta rabiei* isolates collected from Pakistan. Pakistan Journal of Botany, 36(2): 429-437.

100. Iqbal, S.M., Z. Ahmad, A. Ghafoor and M. Bashir. 2004. *In-vitro* evaluation of fungicides against *Macrophomina phaseolina*. Pakistan Journal Agricultural Research, 18(1): 99-100.

101. Irshad, M., M. A. Gill, T. Aziz, Rahmatullah and I. Ahmed. 2004. Growth response of cotton cultivars to zinc deficiency stress in chelator-buffered nutrient solution. *Pak. J. Bot.,* 36 (2): 373–380.

102. Javaid, A., A. Ghafoor and R. Anwar. 2004. Seed storage protein electrophoresis in groundnut for evaluating genetic diversity. Pakistan Journal of Botany, 36(1): 25-29.

103. M. Shahid Masood, M. Asghar and Rashid Anwar. 2004. Genetic diversity in wheat landraces from Pakistan based on polymorphism for high molecular weight glutenin subunits (HMW-GS). Pak. J. of Bot. 36(4): 835-843.

104. M. Shahid Masood, T. Nishikawa, S. Fukuoka, P. K. Nenga, T. Tsuzuki and K. Kadowaki. 2004. The complete nucleotide sequence of wild rice (*O. nivara*) chloroplast genome: first genome wide comparative sequence analysis of wild and cultivated rice. GENE (An international Jour. of Genes and Genomes) 340: 133 - 139.

105. M. Shahid Masood, Yanagihara Seiji, Z. K. Shinwari and Rashid Anwar. 2004. Mapping QTL for salinity tolerance in rice (*Oryza sativa* L) using RFLPs. Pak. J. of Bot. 36(4): 825-834.

106. Malik S.M. H. Rashid, T. Yasmin and N. M. Minhas (2004). Plant regeneration by somatic embryogenesis from callus of mature seed explants of bread wheat (*Triticum aestivum* L) Pakistan J. Botany 36(3) “629-634”.

107. Muhammad, A., I. Hussain, S.M. Saqlan Naqvi & H. Rashid. 2004. Banana plantlet production through tissue culture. Pak. J. Botany 36(3): 617-620.

108. Nabeela Zafar, Summaira Aziz and Shahid Masood. 2004. Phenotypic divergence for agro-morphological

traits among landrace genotypes of rice (*O. sativa* L.) from Pakistan. International Jour. of Agri. and Biology (IJAB) 2: 335 - 339.

109. Qureshi, A.S., A. Shaukat, A. Bakhsh, M. Arshad and A. Ghafoor. 2004. An assessment of variability for economically important traits in chickpea (*Cicer arietinum* L.).Pakistan Journal of Botany, 36(4): 779-785.

110. Rahsid, H., M. Saleem, Z. Chaudhry, S. T. Gilani and A. S. Qureshi. 2004. Studies on developing a high regeneration from seed derived calli of rice (*Oryza sativa* L.), c.v. Super Basmati. Pakistan J. of Biol. Sci. 7(2):273-276.

111. Sarwar M. and *S. U. Siddiqui.* 2004. In vitro conservation of Sugarcane (Saccharum officinarium L.) germplasm. Pak. J. Bot. 36(3): 549-556.

112. Shaukat Ali, Xue, Q-Z. and Zhang, X-Y. 2004. Assessment of various factors involved in the culture system of rice. Rice Science, 11(5-6); 345-349.

113. Shaukat Ali. 2004. Somatic cybridization between *Nicotiana tabacum* and *N. repanda* based on a single inactivation procedure of nuclear donor parental protoplasts. Plant Science, 168, 303-308

114. Ullah, I., H. Rashid and M. R. Khan. 2004. Establishment of tissue culture protocol in Brassica (*B. napus* L.). Pakistan Journal of Biological Sciences 7 (2): 277-278.

115. Zahid Mahmood, Saif Ullah Ajmal, Ghulam Jilani and Muhammad Ashraf. 2004. Genetic Studies for High Yield of Maize in Chitral Valley. International Journal of Agriculture and Biology (06-5) pp: 790-791.

116. Zahid Mahmood, Shahid Riaz malik, Raheel Akhter and Tariq Rafique. 2004. Heretability and Genetic Advance Estimates from Maize Genotypes in Shihsi Lusht a valley of Karakurm. International Journal of Agriculture and Biology, (06-5) pp: 788-789.

2005

117. Ahmed, I, A. Ali, I.A. Mahmood, M. Salim, N. Hussain and M. Jamil. 2005. Growth and ionic relations of various sunflower cultivars under saline environment. *Helia* 28 (42): 147–158.

118. Akhtar, A.F., Abbasi, F.M. and A. Rafi 2005. Studies on bacterial blight of rice incedence in Pakistan. Pak. J. Phytopathology. 17(2) 137-140.

119. Ali, A., M. S. Zia, F. Hussain, M. Salim, , I. A. Mahmood, A. Shahzad. 2005. Efficacy of different methods of potassium fertilizer application on paddy yield, K uptake and agronomic efficiency. Pak. J. Agri. Sci. 42(1/2): 27-32.

120. Ali, A., M. Salim, M. S. Zia, I. A. Mahmood, A. Shahzad. 2005. Performance of rice as affected by foliar application of different K fertilizer sources. Pak. J. Agri. Sci. 42(1/2): 38-41.

121. Arshad, M., A. Ghafoor and A.S. Qureshi. 2005. Inheritance of qualitative traits and their linkage in blackgram [*Vigna mungo* (L.) Hepper]. Pakistan Journal of Botany, 37(1): 41-46.

122. Aslam, M., Q.B. Bloch, M. Muslim and Zahoor Ahmad. 2005. Agro-economics of Medicinal Herbs and Spices as Crop. Science Technology & Development. 24(1):47-50.

123. Bashir Muhammad., Zahoor Ahmad and A. Ghafoor. 2005. Sources of genetic resistance in mungbean and blackgram against urdbean leaf crinkle virus (ULCV). Pakistan Journal of Botany, 37 (1):47-51.

124. Bhutta, W. M., A. Shahzad, J. Akhtar and M. Ibrahim. 2005. Assessment of genetic divergence among wheat (*Triticum aestivum* L.) genotypes using random amplified polymorphic DNA (RAPD) analysis. Biologia Bratislava, Section Cellular and Molecular Biology. 60(6): 671-674.

125. Ghafoor A., and Zahoor Ahmad. 2005. Diversity of Agronomic Traits and Total Seed Protein in Blackgram [*Vigna mungo* (L.) Hepper]. ACTA Biologica Cracoviensia Series Botanica. 47(2):69-75. (Poland).

126. Ghafoor A., Zahoor Ahmad and M. Afzal. 2005. Use of SDS-PAGE markers for determining quantitative raits loci in Blackgram [*Vigna mungo* (L.) Hepper] Germplasm. Pakistan Journal of Botany, 37(2): 263-269.

127. Ghafoor A., Zahoor Ahmad and R. Anwar. 2005. Registration of 'PK-45921', a dual season blackgram cultivar. Crop Science. 45: 1659 pp. (USA).

128. Ghafoor A., Zahoor Ahmad and Rashid Anwar. 2005. Genetic Diversity in *Pisum sativum* and a strategy for indigenous biodiversity conservation. Pakistan Journal of Botany 37(1): 71-77.

129. Ghafoor, A., Z. Ahmad and R. Anwar. 2005. Registration of Pk–45921, a dual season black gram [*Vigna mungo* (L.) Hepper] cultivar. Crop Science, USA, 45:1659.

130. Hassan, M.J., Wang, F., Shaukat Ali and Zhang. G. 2005. Toxic effect of cadmium on rice as affected by nitrogen form. Plant and Soil, 277, 359-365

131. Hussain, I., A. Muhammad, Z. Chaudhry, R. Asghar, S.M. S. Naqvi and H. Rashid. 2005. Morphogenic potential of three potato (*Solanum tuberosum*) cultivars from diverse explants, a prerequisite in genetic manipulation. Pakistan J. Botany, 37(4): 889-898

132. Hussian, I., Z. Chaudhry, I.S. Hafiz, N. Saleem and N.A. Abbasi. 2005. *Invitro* callogenesis and regeneration response of four tomato (*Lycopersicon esculentum* M.) cultivars. Pak. J. Phytopathol. Vol. 17(1): 66-72.

133. Iqbal, S.H. and A. Ghafoor. 2005. Identification of blight resistant genotypes from local and exotic chickpea genetic resources. Pakistan Journal of Botany, 37(1): 79-86.

134. Iqbal, S.H., A. Ghafoor and N. Ayub. 2005. Relationship between SDS-PAGE markers and *Ascochyta* blight in chickpea. Pakistan Journal of Botany, 37(1): 87-96.

135. Jabeen, N., Z. Chaudhry, H. Rashid and B. Mirza. 2005. Effect of genotype and explant type on *in vitro* shoot regeneration of tomato (*Lycopersicon esculentum* Mill). Pakistan J. Botany, 37(4): 899-903

136. Kashif, M., Sajid, G.M and R. Anwer. 2005. Effect of duration of mercuric chloride treatment on culture viability, contamination and mortality of various accessions of grapes. Sarhad Journal of Agriculture. 21:1.25-28.

137. Komatsu S., Abbasi, F., Kobori, E., Fujisawa Y., Kato, H., and Iwasaki, Y. 2005. Proteomic analysis of rice embryo: An approach for investigating Gα protein-regulated proteins. Proteomics 5, 3932 – 3941.

138. M. Shahid Masood, Asif Javed, M. Ashiq Rabbani and Rashid Anwar. 2005. Phenotypic diversity and trait association in bread wheat (*Triticum aestivum* L.) landraces from Baluchistan, Pakistan. Accepted in PJB. 37 (4): 949 - 957.

139. Murtaza N., Ghulam M. Ali, H. Rahman. 2005. Inheritance of fiber quality characters in upland cotton genotypes having non-preference traits for insect pests. International Journal of Food Agriculture & Environment 3 (1) 179-183 Finland

140. Naveed Murtaza, Motomitsu Kitaoka and Ghulam M. Ali. 2005. Genetic differentiation of cotton cultivars by poly acrylamide gel electrophoresis. Journal of Central European Agriculture. 6 (1) 69-76. Czech Republic

141. Noor, A., H. Rashid, Z. Chaudhry and B. Mirza. 2005. High frequency regeneration from *scutellum* derived calli of basmati rice cv. Basmati 385 and super basmati. Pakistan J. Botany, 37(3): 673-684

142. Saqlan, S.M. N., R. Sultana and H. Rasheed. 2005. Tissue culture studies in *Oryza sativa* L. cvs. Basmati 385 and Super Basmati. Pakistan J. Botany, 37(4): 823-828

143. Sultana, T., A. Ghafoor and M. Ashraf. 2005. Genetic divergence in lentil germplasm for botanical descriptors in relation with geographic origin. Pakistan Journal of Botany, 37(1):61-69.

144. Yousaf Ali, Ghulam Sarwar, Zahoor Aslam, Faqir Hussain and Tariq Rafique. 2005. Evaluation of rice germplasm under water stress enviornment. International Journal of Enviornmental Sciences and Technology. 2(1): 223-225.

2006

145. Ahmad, Z., A. Ghafoor and M. Bashir. 2006. Effect of seed borne pathogens on seed longevity in chickpea and cowpea under storage at 25^{o}C to –18^{o}C. Seed Science and Technology. 34(1): 69-75. (Netherlands)

146. Ali, A., *S. U. Siddiqui*, M. Afzal and M. F. Chaudhary. 2006. Response of wheat (*Triticum aestivum* L.) var. Chakwal-97 to artificial ageing in relation to its viability under mid-term conservation in genebank. Pak. J. Bot. 38(4):1071-1078.

147. Arshad, M., N. Ali and A. Ghafoor. 2006. Character correlation and path coefficient in soybean *Glycine*

max (L.) Merrill. Pakistan Journal of Botany, 38(1): 121-130.

148. Bashir M., Zahoor Ahmad and Shahid Mansoor. 2006. Occurrence and distribution of viral diseases of mungbean and mashbean in Punjab, Pakistan. Pakistan Journal of Botany. 38 (4):1341-1351.

149. Bashir.M., A.R. Jamali and Zahoor Ahmad. 2006. Genetic resistance in mungbean and mashbean germplasm against mungbean yellow mosaic begomovirus. Mycopathology 4(2):1-4.

150. Bhutta, W. M., J. Akhtar, M. Ibrahim and A. Shahzad. 2006. Genetic variation between Pakistani wheat (*Triticum aestivum* L.) genotypes as revealed by Random Amplified Polymorphic DNA (RAPD) markers. South African J. Bot. 72(2): 280-283.

151. Ghulam M. Ali and Setsuko Komatsu. 2006. Proteomic analysis of rice leaf sheath during drought stress. Journal of Proteome Research. Feb: 5(2): 396-403.

152. Ghulam. M. Ali, Collins, J.C. and McNeilly, T. 2006. Study of salt tolerance parameters in pearl millet *pennisetum americanum*. Journal of Central European Agriculture. 7(2) 365-376 Czech Republic.

153. Hussain, I., Z. Chaudhry, A. Muhammad, R. Asghar, S.M.S. Naqvi and H. Rashid. 2006. Effect of chlorocholine, sucrose and BAP on *in vitro* tuberization in potato (*Solanum tuberosum*). Pakistan J. Botany, 38(1): 275-282.

154. Iqbal,S.M., Rauf, A. and Shaukat Ali. 2006. Pathogenic variability among isolates of *Ascochyta lentis*. Pathogenic variability among isolates of *Ascochyta lentis*.8(5);618- 620.

155. Khan, T.N., M. Shahbaz, S. Ajmal., Ghulam M. Ali and M. F. Joyia. 2006. Performance of four varieties of fine rice for best yield and yield components under climatic conditions of Bahawalpur. Journal of Agriculture and Social Sciences. 2 (3) 187-188

156. Malik, M.F.A., A.S. Qureshi, M. Ashraf and A. Ghafoor. 2006. Genetic variability of the main yield related characters in soybean. International Journal of Agriculture and Biology, 8:815-819.

157. Malik, M.F.A., M. Ashraf, A.S. Qureshi and A. Ghafoor. 2006. Utilization of diverse germplasm for soybean improvement. Asian Journal of Plant Sciences, 5:663-667.

158. Nisar, M., A. Ghafoor, M.R. Khan and A.S. Qureshi. 2006. Screening of *Pisum sativum* (L.) Germplasm against *Erysiphe pisi* Syd. in relation with vegetative traits and SDS-PAGE profile. Acta Biologica Cracoviensia, Series Botanica, Poland, 48(2): 33-37.

159. Noor, A., Z. Chaudhry, H. Rashid and B. Mirza. 2006. Evaluation of resistance of rice varieties against bacterial blight caused by *Xanthomonas Oryzae* pv. *Oryzae*. Pakistan J. Botany, 38(1): 193-203.

160. Qian, H.F., Shaukat Ali, Hong, L., Xu, H. 2006. Establishment of Genetic Transformation System via *Agrobacterium* in Tall Fescue Cultivar. Journal of Forestry Research. 17 93); 238-242

161. Rashid, H., A. Noor and Z. Chaudhry. 2006. Improvement of basmati rice for disease resistance by Agrobacterium mediated transformation. Plant Tissue Cult. 15(2): 165-174.

162. Sajid, G.M., Kashif, M. and R.Anwer.2006. Effect of diverse hormonal regimes on in vitro growth of grape germplasm. Pakistan Journal of Botany, 38(2):385-391.

163. Sultana, T., A. Ghafoor and M. Ashraf. 2006. Geographic patterns of diversity of cultivated lentil germplasm collected from Pakistan, as assessed by seed protein assays. Acta Biologica Cracoviensia, Series Botanica, Poland, 48(1): 77-84.

164. Yousaf, Z., M.S. Masood, Z.K. Shinwari, M.A. Khan and M.A. Rabbani. 2006. Evaluation of taxonomic status of medicinal species of the genus *Solanum* and *Capsicum* based on poly-acrylamide gel electrophoresis. *Pak. J. Bot.* 38(1): 99-106.

165. Zubaida Yousaf, Shahid Masood, Z.K. Shinwari, Mir Ajab Khan and Ashiq Rabbani. 2006. Evaluation of taxonomic status of medicinal species of the Genus Solanum and Capsicum based on poly-acrylamide gel electrophoresis. Pak. J. of Botany. 38(1) 99 -106.

2007

166. Ahmed, I., A. Yokota and T. Fujiwara. 2007. A novel highly boron tolerant bacterium, *Bacillus boroniphilus* sp. nov., isolated from soil, that requires boron for its growth. *Extremophiles* 11: 217–224. DOI: 10.1007/s00792-006-0027-0.

167. Ahmed, I., A. Yokota and T. Fujiwara. 2007. *Chimaereicella boritolerans* sp. nov., a novel boron-tolerant

and alkaliphilic bacterium of the family Flavobacteriaceae, isolated from soil. *Intl. J. Syst. Evol. Microbiol.* 57 (5): 986-992.

168. Ahmed, I., A. Yokota and T. Fujiwara. 2007. *Gracilibacillus boraciitolerans* sp. nov., a novel highly boron tolerant and moderately halotolerant bacterium isolated from soil. *Intl. J. Syst. Evol. Microbiol.* 57 (4): 796–802.

169. Ahmed, I., A. Yokota, A. Yamazoe and T. Fujiwara. 2007. Proposal of *Lysinibacillus boronitolerans* gen. nov., sp. nov., and transfer of *Bacillus fusiformis* to *Lysinibacillus fusiformis* comb. nov., and of *Bacillus sphaericus* to *Lysinibacillus sphaericus* comb. nov.. *Intl. J. Syst. Evol. Microbiol.* 57 (5): 1117-1125.

170. Asghar, A., H. Rashid, M. Ashraf, Z. Chaudhry and M. H. Khan. 2007. Improvement of basmati rice against fungal infection through gene transfer technology. Pakistan J. Botany, 39(3):

171. Bashir, M.A., H. Rashid and M.A. Anjum. 2007. *Invitro* initiation from nodal explants of jojoba (*Simmondsia chinensis*) strains. Biotechnology 6 (2): 165-174.

172. Bashir, M.A., H. Rashid and M.A. Anjum. 2007. *Invitro* shoot multiplication of six promising strains of jojoba (*Simmondsia chinensis*). Biotechnology 6 (3): 309-315.

173. Chaudhry, Z., A. Afroz and H. Rashid. 2007. Effect of variety and growth regulators on callus proliferation and regeneration of three tomato cultivars (*Lycopersicon esculentum* M.). Pakistan J. Botany, 39(3):857-869.

174. Ghulam. M. Ali, Yasumoto S. and Katsuta M. 2007. Assessment of genetic diversity in sesame (*Sesamum* indicum L.) detected by Amplified Fragment Length Polymorphism (AFLP) markers using PAGE. Electronic Journal of Biotechnology. 10(1) January 15, 2007. Chile.

175. Khan, M. A., H. Rashid, Z. A. Sawati and Z. Chaudhry. 2007. *Agrobacterium* mediated transformation to build resistance against bacterial blight in rice. Pakistan J. Botany, 39(3).

176. Malik, M.F.A., M. Ashraf, A.S. Qureshi and A. Ghafoor. 2007. Assessment of genetic variability, correlation and path coefficient analyses for yield and its components in soybean. Pakistan Journal of Botany, 39:2: 405-413.

177. Shaukat Ali, Zhang Xianyin, Qingzhong Xue, M.Jaffar Hassan and Qian Haifeng. 2007. Investigation for improved genetic transformation mediated by *Agrobacterium* in two rice cultivars. Biotechnology. 6 (1):138- 139.

178. Siddiqui, S. U., T. Kummamaru and H. Satoh. 2007. Pakistan rice genetic resources-I: Grain morphological diversity and its distribution. Pak. J. Bot. 39(3):

Papers published in Proceedings

2001

1. Ahmad Z. and R. Anwar. 2001. Pakistan's national germplasm system with emphasis on acquisition, evaluation access and exchange. In: Glowka, L., B. Pisupati, S.deSlica (Editors). Access to Genetic Resources and Traditional knowledge: Lessens from South and Southeast Asia. IUCH, Regional Biodiversity Programme, Asia (Sri Lanka), 89-97 pp.

2. Ahmad Zahoor and P. Lapinskas. 2001. Evening Primrose: A plant of nutritional and pharmacological importance. In: Proceedings of National Symposium on Medicinal Plants of Pakistan held on 2-3 December, 1998 at Plant Genetic Resources Institute, NARC, Islamabad, 13-15 pp.

3. Ahmad, Z. and A. Ghafoor. 2001. Resource base and conservation strategies of medicinal and aromatic plants in Pakistan. Paper presented in "Regional workshop on sharing local and national experience in conservation of medicinal plants" at Pokhra, Nepal from 21-23 January, 2001 organized by MAPPA/ IDRC.

4. Hussain, I., H. Rashid and A. Quraishi. 2001. *In vitro* multiplication of date palm: In Second International Conference on Date Palm: 24-27th March, Al-Alin, U.A.E.

5. Notsu, Y; G.Akiduki; M.Shahid Masood; N, Kubo; A.Hirai; and K.Kadowaki. 2001. Determination of flanking sequence of rice pseudo rps 14 gene. Breeding Research (Japan). 3 (1): 41.

6. Rashid A. and Shahid Masood; 2001. Status of herbs and other economic plants of Pakistan. In:(R.Anwar, N.Haq and S.Masood, eds).P 49-53. Medicinal Plants of Pakistan.

2002

7. Afzal, M., A. Ghafoor, S.A Jatoi, S. Fakuoka, K. Okuno and M. Katsuta. 2002. Classification of rice core collection using restriction fragment length polymorphism markers. Paper presented in international seminar on "sustainable utilization of plant genetic resources for agricultural production" held from 17-19 December, 2002. PARC/IPGRI/JICA, Islamabad, Pakistan.

8. Ahmad Zahoor and A. Ghafoor. 2002. Conservation and sustainable utilization of medicinal plants resource base in Hindukush Himalayan Region of Pakistan. Paper published in proceedings of a Seminar on "Sustainability of Natural Resources and Agriculture in Mountain areas of Pakistan" organized by PARC and ICIMOD at Islamabad on April 30, 2001. 56-67 pp.

9. Ahmad, Z., A. Ghafoor. 2002 Resource base and conservation strategies of medicinal and aromatic plants in Pakistan. Proceedings of Regional workshop on "Sharing Local National Experience in Conservation of Medicinal and Aromatic Plants" held at Pokhra, Nepal. pp.105-109.

10. Ahmad, Z., M. Bashir. N. Ullaha, M. Sajjad and A. Ghafoor. 2002. Seed borne pathogens in legume and cereal germplasm collection and potential resistance sources. Paper presented in international seminar on "sustainable utilization of plant genetic resources for agricultural production" held from 17-19 December, 2002. PARC/IPGRI/JICA, Islamabad, Pakistan.

11. Arshad, M., M. Bashir, A.S. Qureshi and A. Ghafoor. 2002. Exploitation of black gram genetic resources for sustainable utioization in variety development process. Paper presented in international seminar on "sustainable utilization of plant genetic resources for agricultural production" held from 17-19 December, 2002. PARC/IPGRI/JICA, Islamabad, Pakistan.

12. Awan, M.R., G. Akbar, D.H. Bokhari and Zahoor Ahmad. 2002. Ethnobotany of Cholistan Desert, Southern Punjab, Pakistan. pp: 77-83. In: Proceedings of the workshop on "Curriculum Development in Applied Ethnobotany". Eds. Z.K. Shinwari; A. Hamilton, and A.A. Khan, WWF, Pakistan.

13. Ghafoor, A., M. Afzal and R. Anwar. 2002. Diversity in food legumes for sustainable utilization of plant genetic resources. Paper presented in international seminar on "sustainable utilization of plant genetic resources for agricultural production" held from 17-19 December, 2002. PARC/IPGRI/JICA, Islamabad, Pakistan.

14. Javaid, A. and A. Ghafoor. 2002. Genetic diversity for agro-morphological traits in *Pisum sativum* germplasm. Paper presented in international seminar on "sustainable utilization of plant genetic resources for agricultural production" held from 17-19 December, 2002. PARC/IPGRI/JICA, Islamabad, Pakistan.

15. Masood, M.S., M. Asghar and Rashid Anwar. 2002. High molecular weight glutenin subunit (HMW-GS) variation in hexaploid wheat landraces from Pakistan. Proc. of National Seminar on utilization of plant genetic resources for agricultural production.Pp. 158 - 168.

16. Yasin M., M.A. Zahid, A. Ghafoor and Zahoor Ahmad. 2002. Genotypic behavior of Lentil (*Lens culinaris*) towards salinity. In: Prospects for Saline Agriculture (Eds.) R.Ahmad & K.A. Malik. Kluwer Academic Pulbishers, Netherlands. 231-235 pp.

2003

17. Ahmad, Z., M. Bashir, M. Naeemullah and M. Sajad. 2003. Seed borne pathogens in legume and cereal germplasm collection and potential resistant sources. In: Proceeding of National Seminar on "Sustainable Utilization of Plant Genetic Resources for Agricultural Production" held at NARC, Islamabad. 261-268 pp.

18. Bashir, M., S. Hussain, S.A. Khanzada, M. Zubair, M. Arshad, M. Anwar and Z. Ahmad. 2003. In: Proceeding of national seminar on "Sustainable Utilization of Plant Genetic Resources for Agricultural Production", held at NARC, Islamabad. 284-290 pp.

19. Hussain, S., A. Ali, M. Bashir, S. M. Iaqbal, S. A. Khanzada and Zahoor Ahmad, (2003). Evaluation of lentil germplasm against ascochyta blight disease. In: Proceeding of national seminar on "Sustainable Utilization of Plant Genetic Resources for Agricultural Production", held at NARC, Islamabad. 280-283 pp.

20. Masood, M. S., T. Nishikawa, P. K. Nenga and K. Kadowaki. 2003. Analysis of the ancestor of cultivated rice using chloroplast sequence. Breeding Research (Japan). 5(2): 109.

21. Rashid, H., Hussain, I and Chaudhry, Z. 2003. Application of Tissue Culture Techniques for Seed Potato Production in Northern Areas. Proceeding of an International Symposium held at Higher Education, Islamabad.Pakistan.Sep.8-10, 2003.PP.76-80.

22. Siddiqui S. U., H Satoh and T. Kumamaru. 2003. Variation in seed storage proteins of Pakistani rice germplasm. In Khus G.S., Brar D.S., Hardy, B. editors. 2003. Advances in rice genetics. Supplement to Rice Genetics IV. P: 198-200.

2004

23. H. Rashid, I. Hussain and Z. Chaudhry. 2004. Proceeding of an International Symposium on Biodiversity of Northern Areas of Pakistan. pp.76-80.

24. Iqbal, S.A., A. Ghafoor, A.S. Qureshi and Zahoor Ahmad. 2004. Biodiversity and Cultivation Potential in Black Cumin (*Nigella sativa*). In: International Symposium on "Medical Plants: Linkages beyond National Boundaries" held at NARC on September 7-9. pp.105-116-142.

25. Yousaf N., Zahoor Ahmad, I. Ahmad and Z. Yousaf. 2004. Genetic Diversity in Fennel (*Foeniculum vulgare* Mill*)* Germplasm based on some Morpho-Agronomic characters. In: International Symposium on "Medical Plants: Linkages Beyond National Boundaries" held at NARC on September 7-9, 2004. pp.133.

26. Yousaf Najma, Zahoor Ahmad and Sajjad Hussain. 2004. "Genetic Diversity in Fennel (Foeniculum *vulgare* Mill) Germplasm Based on Some Morpho-agronomic Characters". International Symposium on "Medicinal Plants: Linkages beyond National Boundaries". SOCJ-JAPAN, National Agricultural Research Center, Islamabad. , 7-9 September.

27. Yousaf Zubaida, Shahid Masood, Zabta khan Shinwari, and Mir Ajab Khan. 2004. Taxonomic relationship of medicinally important species of Family Solanaceae revealed by SDS-PAGE. Proc. Of International Symposium on medicinal plants: linkage beyond National Boundaries, Sept. 7-9.pp 36.

2005

28. Ahmad Zahoor. 2005. Agro-biodiversity of Pakistan with emphasis to Northern Areas. In: Proceedings of international symposium on "Bio-diversity in Northern Mountains" held at Higher Education Commission, Islamabad from 08-10, Sept., 2003. 1-13 pp.

29. Ahmad, Z., Sajjad Hussain, Naeemullah and Sadar uddin Siddiqui 2005. "Better Economic promises for Marginal Land Farmers by sustainable utilization of Underutilized plant Biodiversity". National Workshop on "Global Change Research in Pakistan." April 28-30. Global Change Impact Studies

Centre, Islamabad.

30. Ghulam M. Ali and Setsuko Komatsu. 2005. A proteomic approach to analyze drought responsive proteins in rice leaf sheath. 18th FAO BMB symposium 19-23 Nov. Organized by School of Biological Sciences University of Punjab, Lahore.

31. Masood, M.S., Yanagihara Seiji and Rashid Anwar. 2005. Identification and evaluation of salt tolerance in rice (O. sativa) using molecular markers. International Conference on biotechnology for salinity and drought tolerance in plants. March 28 -31.

32. Sajjad Hussain, Zahoor Ahmad and Sadaruddin Siddiqui. 2005. "Diversity in Chicory (*Cichorium intybus* L.) Germplasm – A Weed of Medicinal Importance". 6th National Weed Sciences Conference. March 28-30. NWFP Agricultural University, Peshawar.

33. Sajjad Hussain. 2005. "Conservation of medicinal plants genetic resources in the National Gene bank." Conference on Conservation of National Resources of Herbs and Medicinal Plants of Commercial exploitation. 12-14 April. The Agricultural Foundation of Pakistan, Islamabad.

2006

34. Muhammad, A., H. Rashid, I. Hussain, & S.M. Saqlan Naqvi. 2006. Comparison of BAP and kinetin on proliferation rate of banana (*Musa spp.*) cv. Basrai. Proceedings of XVII International ACORBAT Conference w.e.f. 15-20 October. Joinville Brazil. Vol-2: 494-497.

35. Sajjad Hussain, Sadar uddin Siddiqui, Shahida Khalid, Atif Jamal. 2006. "Allelopathic effect of Senna (*Cassia angustifolia*) on germination and growth of major cereal crops and their associated weeds". Second International Weed Science Conference" held at University of Arid Agriculture, Rawalpindi. March 20-22.

2007

36. Sajjad Hussain, Sadar uddin Siddiqui, Shahida Khalid and Atif Jamal. 2007. "Screening medicinal herbs for autotoxicity and allelopathic activity against wheat (*Triticum aestivum* L.) and major weeds of wheat". International Conference on "Role of Allelopathy in Sustainable Agriculture. March 22-24, 2007. University of Arid Agriculture, Rawalpindi.

37. Sajjad Hussain, Zahoor Ahmed 2007. "Conservation and Sustainable Utilization of medicinal plants resource base in Northern areas of Pakistan". "Sustainable Production of Medicinal Herbs in Northern Areas of Pakistan". organized by Korakorum. Agricultural Research Institute for Northern Areas (KARINA), Jaglot, May 29-30, 2007.

Papers presented at seminars/workshops/symposia

1998

1. Anwar, R. and M.A. Rabbani. (1998) Natural occurrence, distribution and uses of *Pistacia* species in Pakistan. IPGRI International Workshop on "Pistachio: towards a comprehensive documentation of distribution and uses of its genetic diversity in the CWANA region". Irbid, Jordan (*December 14-17, 1998*).

2. Rashid Anwar, Mir Ajab Khan, Shahid Masood, M.Tahir; 1998. Diversity in Pakistani wheat germplasm as revealed by RAPD. In: Triticeae 111 (A.A.Jaradat ed) Pp: 171-174. Proc. of International Triticeae Symposium, Allepo, Syria, May 4- 8.

1999

3. Ahmad Zahoor, (1999). Priorities for medicinal plants research and development in Pakistan. Paper presented in national seminar on "Medicinal Plants Research and Development in Pakistan" held on July 21, 1999 at Pakistan Agricultural Research Council, Islamabad.

4. Ahmad Zahoor, (1999). Status of traditional and indigenous vegetable crops in Pakistan. Paper presented at regional workshop on "Conservation and Utilization of Vegetables in Asia and Pacific" held at PCARRD, Philippines on 10-12 August, 1999.

5. Bashir, M., Zahoor Ahmad and Iqbal T. (1999). Detection and identification of two seed borne viruses from imported seeds of cowpea from Nigeria. Pakistan. Proceedings of 2nd National Conference of Plant Pathology, September 27-29, 1999, 41-46 pp.

2000

6. Ahmad Zahoor, A. Ghafoor, M. Afzal, M.A. Zahid and M. Yasin, (2000). Identification and potential of under-utilized crops for saline agriculture. Paper presented in international seminar on "Prospects for Saline Agriculture" held at NARC, Islamabad from April 10-12, 2000.

7. Ghafoor, A., Zahoor Ahmad and M. Afzal, (2000). Utilization of Mungbean Genetic Resources of Pakistan. Paper presented in 7th National Conference of Plant Scientists, Lahore, and 14-16 November, 2000.

8. Iqbal, S.M., A. Ghafoor, Zahoor Ahmad and N. Ayub, (2000). Genetic variability for resistance against powdery mildew in peas. Paper presented in 7th National Conference of Plant Scientists, Lahore, 14-16 November, 2000.

9. Lang N, Masood S,Yanagihara S, and Bui chi Buu 2000. QTL mapping for salt tolerance in rice. Proc. .of International Rice Genetics Symposium , IRRI Phillipine. October 22-27.

10. *Siddiqui S. U.*, Kumamaru, T and Satoh, H. 2000. Diversity in Pakistan rice genetic resources for endosperm storage. *In* Integration of Biodiversity and Genome Technology for Crop Improvement. NIAR, Tsukuba, Japan; 167-167.

2001

1. Ahmad Zahoor and A. Ghafoor. 2001. Resource base and conservation strategies of medicinal and aromatic plants in Pakistan. Paper presented in regional workshop on "Sharing Local and National Experience in Conservation of Medicinal Plants" at Pokhra, Nepal from 21-23 January organized by MAPPA/ IDRC.
2. Ahmad, Z. and A. Ghafoor. 2001. Conservation and sustainable utilization of medicinal plants resource base in Hindukush Himalayan region of Pakistan. Paper presented in seminar on "Sustainability of natural resources and agriculture in mountain areas of Pakistan organized by PARC and ICIMOD at Islamabad on April 30.
3. Bashir, M, Zahoor A. and A. Ghafoor. 2001. First report of pea seed borne mosaic virus in lathyrus (*Lathyrus sativus*) in Pakistan. Poster presented in 3rd National Conference of Plant Pathology, 1-3 October, 2001, Islamabad. Abstracts pp.66.
4. Bashir, M., M.S. Iqbal, A. Ghafoor and Z. Ahmad. 2001. Variability in cowpea germplasm for reaction to virus infection under field conditions. Poster presented in 3rd National Conference of Plant Pathology, 1-3 October, 2001Islamabad. Abstracts pp 65.
5. Bashir, M., Z. Ahmad and A. Ghafoor. 2001. Pathogenic variability between two isolates of black eye cowpea mosaic potyvirus. Paper presented in third National Conference of Plant Pathology, 1-3 October, 2001, Islamabad. Abstracts pp 61.
6. Bashir, M., Z. Ahmad, T. Iqbal and A. Ghafoor. 2001. Identification of resistance to black eye cowpea mosaic potyvirus. Poster presented in 3rd National Conference of Plant Pathology, 1-3 October, 2001, Islamabad. Abstracts pp. 66.

2002

7. Rabbani, M.A., H. Abe, F. Saito, K. Maruyama, K. Yoshiwara, M. Seki, K. Shinozaki and K. Yamaguchi-Shinozaki. 2002. Monitoring expression profiles of osmotic stress-inducible genes in rice (*Oryza sativa* L.) using cDNA microarray. Proc. 25th Ann. Meet. Mol. Biol. Soc. Japan; Dec. 11-14, Yokohama, Japan, p-506.
8. Siddiqui S. U., T. Kumamaru, R. Anwar and H. Satoh. 2002. Evaluation for Sustainable Utilization of Rice Genetic Resources of Pakistan. *In* Sustainable Utilization of Plant Genetic Resources for Agricultural Production. NARC, Islamabad; 169-178.

2003

9. Abbasi, F.M and Komatsu, S. 2003. Monitoring protein profile of rice under salt stress. Japanese Biochemical Society Conference. Japan. Vol. 75. No.8, pp. 1098.

10. Abbasi, F.M., Yang, G., Asano, T., Iwasaki, Y., and komatsu, S. 2003. Characterization of OsCDPK13 in response to cold stress and gibberellin in rice. The 26th annual meeting of the Molecular Biological Society of Japan, December 10-13, Kobe Japan. Pp 543.

11. Javaid, A. and A. Ghafoor. 2003. Inter and intra-specific genetic diversity for seed storage proteins in *Medicago* as revealed by SDS-PAGE. Paper presented in the 8th National Meeting of Plant Scientists. February 24-28 organised by Pakistan Botanical Society at University of Karachi, Pakistan.

12. Rashid, H., A. Faroz and Z. Chaudhry. 2003. *Agrobacterium* mediated transformation in Basmati Rice for Bacterial Blight Resistance. In 8th National conference of Plant Scientists at Karachi from Feb. 24-28.

2004

13. Abbasi, F.M., Yukimoto, I., and Komatsu, S. 2004. A proteomic analysis of embryo proteins regulated by Gα-protein in rice. Frontier in plant protein research. February 23, Tsukuba Japan.

14. Ahmad Zahoor, Naeemullah, S. Hussain, A. Ghafoor and A. Rabbani. 2004. Cultivation of medicinal plants at farmer field – an experience. Paper presented in international symposium on "Medicinal Plants: Linkages Beyond National Boundaries" held at Islamabad 7-9 September.

15. Ashraf, M., A.A. Cheema, Zia-ul-Qamar, M. Rashid and Zahid Mahmood. 2004. Induction and Breeding for Long Grain Basmati Rice. 2nd National Conference of Biology April 22-24, G.C. University, Lahore.

16. Ashraf, M., A.A. Cheema, Zia-ul-Qamar, M. Rashid and Zahid Mahmood. 2004. Breeding rice through mutagenesis and hybridization. 4th International Science Conference at the University of Azad Jammu and Kashmir, Muzafarabad. October.

17. Ashraf, M., A.A. Cheema, Zia-ul-Qamar, Zahid Mahmood and M. Rashid. 2004. Detection of Polymorphism in Rice Germplasm using RAPD Marker. 9th National Conference of Plant Scientists, Feb. 13-15, University of Sindh, Jamshoro.

18. Katsuta M. and Ali, G. M. 2004. Assessment of genetic diversity in sesame (*Sesamum indicum* L.) detected by Amplified Fragment Length Polymorphism (AFLP) markers. Presented in the 105th conference of Japanese society of breeding university of Tokyo March 29-31. Japan.

19. Rashid, M., A.A. Cheema, M. Ashraf, Zia-ul-Qamar, and Zahid Mahmood. 2004. Studies on physicochemical grain characteristics of basmati rice. 4th International Science Conference at the University of Azad Jammu and Kashmir, Muzafarabad. October.

20. Zahid Mahmood, A A Cheema, M. Rashid M. Ashraf, and. Zia-ul-qamar. 2004. Optimum Time for Transplanting to Harvest Maximum Yield in Rice. 2nd National Conference of Biology April 22-24, GC University, Lahore.

21. Zahid Mahmood, A A Cheema, M. Rashid M. Ashraf, and. Zia-ul-qamar. 2004. Optimum time for basmati rice transplanting Faisalabad conditions. 4th International Science Conference at the University of Azad Jammu and Kashmir, Muzafarabad. October.

22. Zia-ul-qamar, A A Cheema, M. Ashraf, M. Rashid and Zahid Mahmood. 2004. Selection Indices for Rice Improvement. 2nd National Conference of Biology April 22-24, GC University, Lahore.

23. Zia-ul-qamar, A A Cheema, M. Ashraf, M. Rashid and Zahid Mahmood. 2004. Dynamics of phytate salts in cereals and legumes. 4th International Science Conference at the University of Azad Jammu and Kashmir, Muzafarabad. October.

2005

24. Ahmad Zahoor. 2005. Importance of germplasm in crop genetic improvement. Paper presented at Centre of Agricultural Biochemistry and Biotechnology (CABB), University of Agriculture, Faisalabad in 2nd national training course on "Integration of Modern Biotechnological Tools with Conventional System of Crop Genetic Improvement" held on 7-12 February.

25. Ghulam, M. Ali and Setsuko Komatsu. 2005. To analyze drought-responsive proteins in rice leaf sheath using 2-D PAGE. 3rd International conference on Biotechnology 15-18 December. Organized by

Institute of biotechnology and genetic engineering, University of Sindh, Jamshoro.

26. Khalid, S and *S. U. Siddiqui.* 2005. Potential medicinal use of noxious flora of Pothwar. *In* International symposium on "Medicinal Plants: Linkages beyond National boundaries". 7-9 Sept., National Agricultural Research Centre, Islamabad: 88-94.

27. Rabbani, M.A. 2005. Monitoring expression profiles of rice (*Oryza sativa* L.) genes under abiotic stresses using cDNA microarray analysis. Proc. of International Conference on Biotechnology for Salinity and Drought Tolerance in Plants, March 28-31, Islamabad.

28. Rafique Tariq, Muhammad Jafar Jaskani, Zubeda Chaudhry, Hamid Rashid and Zahid Mahmood. 2005. Response of different potato (*Solanum tuberosum* L.) cultivars to microtuber induction and *in vitro* growth. 3rd international symposium on biotechnology, from 15-18 Dec. at IBGE, University of Sindh, Jamshoro.

29. Siddiqui S. U. 2005. Medicinal weedy plants: their role in human health-care and cure. In Proceedings – National Conference on Conservation of Natural Resources of Herbs and Medicinal Plants for Commercial Exploitation. April 12-14, National Agricultural Research Centre, Islamabad: 29-38.

30. Siddiqui S. U. and S Khalid. 2005. Ethnic remedies of hepatitis C- A review. In International symposium on "Medicinal Plants: Linkages beyond National boundaries". 7-9 Sept., 2004. National Agricultural Research Centre, Islamabad: 121-132.

31. Zahid Mahmood, Hamid Rashid, Ihsan Khaliq and Tariq Rafique. 2005. Effect of water stress on early seedling growth of wheat (*triticum aestivum* l.). 3rd International Symposium on Biotechnology, from 15-18 Dec., University of Sindh, Jamshoro.

2006

32. Ahmed Zahoor. 2006. Paper presented on "Prospects of Saffron (*Crocus sativus*) Cultivation in Pakistan" at International Seminar on Olive and Saffron Cultivation in D-8 Countries held at Peshawar form 12-13 June, 2006 organized by Ministry of Foreign Affairs & PARC.

33. Cheema, A.A., M. Ashraf, Zia-ul-Qamar, Zahid Mahmood and M. Rashid. 2006. Studies on Genetic Diversity for Morphological Traits in Rice Germplasm. 9th National Conference of Plant Scientists, 13-15 Feb., University of Sindh Jamshoro.

34. Rafique Tariq, Zubeda Chaudhry, Asghari Bano, Zahid Mahmood and Hamid Rashid. 2006. Selection of tomato accessions with respect to salinity. Three day international symposium on "Strategies for Crop Improvement against Abiotic Stress" from 18-20 September, held at Department of Botany, Faculty of Sciences, University of Agriculture, Faisalabad.

35. Rashid, M., A A Cheema, Zahid Mahmood, M. Ashraf and Zia-ul-qamar. 2006. Hetrosis and Genetic Analysis in Basmati Rice Hybrids. 9th National Conference of Plant Scientists, Feb. 13-15, University of Sindh, Jamshoro.

36. Zahid Mahmood, A A Cheema, M. Rashid, M. Ashraf and Zia-ul-qamar. 2006. Genetic Studies for High Yield of Basmati Rice. 9th National Conference of Plant Scientists, 13-15 Feb., University of Sindh, Jamshoro.

37. Zahid Mahmood, Ihsan Khaliq, Hamid Rashid and Tariq Rafique. 2006. Effect of Different PEG Concentrations on Seedling Growth of Wheat (*Triticum aestivum* L.). Three day international symposium on "Strategies for Crop Improvement against Abiotic Stress" from 18-20 September, held at Department of Botany, Faculty of Sciences, University of Agriculture, Faisalabad.

38. Zia-ul-qamar, A A Cheema, M. Ashraf, Zahid Mahmood and M. Rashid. 2006. Trends towards Marker Free Transgenic Rice. 9th National Conference of Plant Scientists, 13-15 Feb., University of Sindh, Jamshoro.

ANNEX-V
INDEPENDENT GERMPLASM COLLECTION, PRESERVATION PLANNED AND CONDUCTED SINCE 2003

Crops	2003-04		2004-05		2005-06		2006-07	
	Planned	Achieved	Planned	Achieved	Planned	Achieved	Planned	Achieved
Wheat		4	-	2	-	-	-	3
Rice	-	-	-	-	-	-	-	-
Maize	-	2	-	-	-	-	80	90
Millet	-	1	-	-	-	-	-	1
Sorghum	-	-	-	-	-	-	10	8
Barley	-	2	-	1	-	-	-	-
Pulses	10	15	-	13	-	7	-	-
Fruits	50	60	50	53	50	64	20	22
Vegetables	200	223	210	220	100	106	70	80
Fodder/Forage	20	24	20	23	-	-	-	-
Oilseed	50	60	70	73	60	64	15	18
Medicinal	30	32	30	31	300	319	-	-
Minor cereal crops	-	1	-	-	-	3	-	-
Total	**720**	**842**	**760**	**830**	**1020**	**1126**	**310**	**351**

Source: PGRI

ANNEX-VI
GERMPLASM DISTRIBUTION

	No. of Accessions Distributed		
	Year	**Locally**	**Abroad**
1-	1993	140	-
2-	1994	337	169
3-	1995	1375	415
4-	1996	398	324
5-	1997	1952	300
6-	1998	827	-
7-	1999	985	25
8-	2000	970	-
9-	2001	321	57
10-	2002	1292	12
11-	2003	40	-
12-	2004	661	-
13-	2005	1788	-
14-	2006	1114	106
15-	2007	1476	-
	Total	**13676**	**1408**

Source: PGRI

LIST OF INTERNATIONAL RESEARCH ORGANIZATIONS, UNIVERSITIES AND INSTITUTIONS AND KIND OF GERMPLASM DISTRIBUTED

S.No.	Organization/Country	Crop species
1-	Argentina	Cowpea
2-	Argentina	Lentil
3-	China	Wheat, Lentil, etc.
4-	Germany	Barley
5-	Germany	Onion
6-	Germany	Wheat
7-	ICARDA, Syria	Aegilops
8-	ICARDA, Syria	Barley
9-	ICARDA, Syria	Chickpea
10-	ICARDA, Syria	Faba Bean
11-	ICARDA, Syria	Groundnut
12-	ICARDA, Syria	Lathyrus
13-	ICARDA, Syria	Lentil
14-	ICARDA, Syria	Maize
15-	ICARDA, Syria	Medics
16-	ICARDA, Syria	Miscellaneous
17-	ICARDA, Syria	Oats
18-	ICARDA, Syria	Onion
19-	ICARDA, Syria	Safflower
20-	ICARDA, Syria	Sesame
21-	ICARDA, Syria	Secale
22-	ICARDA, Syria	Trifolium
23-	ICARDA, Syria	Vicia
24-	ICARDA, Syria	Wheat
25-	India	Millet
26-	India	Safflower
27-	Iran	Kala Zeera
28-	Iraq	Mungbean/Mashbean
29-	Japan	Brassica
30-	Japan	Minor cereals
31-	Japan	Peas
32-	Japan	Rice
33-	Japan	Safflower
34-	Japan	Vegetable
35-	Japan	Wheat
36-	Japan	Miscellaneous
37-	Korea	Wheat
38-	Korea	Amaranthus
39-	Korea	Barley
40-	Korea	Chick pea
41-	Korea	Cow pea
42-	Korea	Lablab bean
43-	Korea	Lentil
44-	Korea	Maize
45-	Korea	Mash
46-	Korea	Millet
47-	Korea	Ming
48-	Korea	Paper bean
49-	Korea	Pigeon pea

50-	Korea	Rice
51-	Korea	Rice bean
52-	Korea	Sord bean
53-	Korea	Sorghum
54-	Korea	Wheat
55-	Mexico	MAIZE
56-	Mexico	Wheat
57-	Netherlands	Barley
58-	Nepal	Barley
59-	Rome	Wheat
60-	Sri Lanka	Cowpea
61-	Sri Lanka	Lentil
62-	Sri Lanka	Mash bean
63-	Sri Lanka	Mung bean
64-	Sri Lanka	Rice
65-	Sri Lanka	Chickpea
66-	Taiwan	Legumes
67-	Taiwan	Mungbean
68-	USA	Barley
69-	USA	Chickpea
70-	USA	Dacus Spp.
71-	USA	Fruit
72-	USA	Lentil
73-	USA	Maize
74-	USA	Medics
75-	USA	Miscellaneous
76-	USA	Moru Spp.
77-	USA	Oats
78-	USA	Pisum
79-	USA	Secale
80-	USA	Trifolium
81-	USA	Vicia
82-	USA	Wheat
Source: PGRI		

ANNEX-VII
VISIT TO NEIGHBORING NATIONAL RESEARCH INSTITUTES/ORGANIZATIONS

Following Organizations or Research Institutes were visited to collect their views about cooperation extended by PGRI. Hazara University was contacted on phone as well as through e-mails to collect the required information.

- Wheat research Institute, Faisalabad.
- Oilseeds Research Institute, Faisalabad.
- Nuclear Institute for Agriculture & Biology, Faisalabad
- University of Agriculture, Faisalabad.
- Nuclear Institute for Food & Agriculture, Peshawar
- University of Agriculture, Peshawar
- Institute of Biotechnology & Genetic Engineering, Peshawar
- Hazara University, Mansehra
- Maize and Millet Research Institute, Yousafwala
- Farmers around Faisalabad area.

Extracts of the information received from neighboring research institutes/organizations is presented below.

Nuclear Institute For Food and Agriculture, Peshawar

A database of about **2000** accessions of six major oilseed crops of Pakistan developed during the studies. A valuable share in the shape of germplasm collection has been provided by the Plant Genetic Resource Institute (PGRI), Islamabad. PGRI provided more than **300** different accessions of different species of rapeseed and mustard (Brassica napus/Brassica campestris/Brasicas juncea). This valuable germpalsm has been utilized for the designing of reference database for the non-destructive NIR analysis process through the development of calibration equations and prediction. Now after the development of database and calibration equations routine quality analysis service of the oilseed germplasm and breeding materials as well as commercial and industrial oilseed samples for oil, protein, fatty acid profile and glucosinolate in whole seeds through non-destructive Near Infrared Technology is being provided to all stakeholders of oilseed crops in the country. The NIR multivariate calibration equations developed at NIFA Peshawar with the collaboration of a number of institutions such as Pakistan Agricultural Research Council, National Agricultural Research Centre, Plant Genetic Resource Institute, Pakistan Oilseed Development Board, NWFP Agricultural University Peshawar, Arid Agricultural University, Rawalpindi, and many others.

NIAB Faisalabad

This institute is collabotaing with PGRI since 1999 till to-date. Improved traits from the germplasm received from PGRI are used for crossing purposes at this institute. A number of nine research papers have been published by staff of NIAB using germplasm received from PGRI. NIAB always had stable linkages with PGRI before 2003 and after the project is over.

PGRI is the only institute of its kind in the country that is meant for the preservation of the plant genetic resources. These genetic resources are available to plant breeders/scientists on their request, which use them for increasing the agricultural production. So this type of facility must exist in the country that is essential to sustain the agriculture sector.

Maize & Millet Research Institute, Yousafawala

PGRI is very useful in research point of view because it is the only gene bank in the country, which saves the germplasm and supplies to the needy Research Organizations on their demand to boost up the research activities, and these Institutions are storing valuable accessions. So this project remained useful for breeding program of MMRI, Yusafwala, Sahiwal. This Institute has also contributed to store its Pearl Millet accessions with PGRI for long term storage**.**

Agricultural Universities

Head of the Departments basic sciences and Plant Breeding Departments of all Agricultural Universities and Hazara University that were visited told that PGRI is the only institute from where one can get authentic breeding material. Students of Pakistan were lucky enough to have such institute in Pakistan. A number of students every year collect germplasm from PGRI and have completed their Master Degrees. Most of the Universities are getting material since PGRI establishment and are satisfied with cooperation PGRI is extending to them.

Federal Seed Certification &Registration Department

FSC&RD is in close collaboration with Plant Genetic Resource Institute (PGRI) of NARC, Islamabad since last few years through our Seed Development Project "Establishment of Cultivars Adaptability Testing and Registration System (ECATRS)". The ECATRS project 2006-07 to 2008-09 has been approved by the DDWP on 13-2-2006 for a period of three years from 2006-07 to 2008-09 with total cost of 35,000 million.

The basic objective is to establish a mechanism for testing adaptability and genetic suitability of imported seed material to save the farmers from the losses expected from the sowing un-adaptable poor quality seed supplied by the importers and to minimize the chances of spreading new disease, insect/pest and weeds in the country.

PGRI is in close collaboration with this department through this project for adaptability testing and morphological characterization of imported cultivars/hybrids under different environmental conditions and determination of Distinctness, Uniformity and Stability of morphological, yield and quality characteristics etc.

Department is also a focal point for ministerial activities of "International Treaty on Plant Genetic Resources for Food & Agriculture", Biosafety/Bio-security Issues, Plant Breeder/Farmers Rights etc where collaboration with PGRI is also sought.

FSC&RD also want to strengthen its collaboration through cooperation of PGRI in molecular characterization of all the imported varieties of vegetables and other field crops.

Farming Community:

All the farmers met told that they were happy to get small quantity seed of advanced lines from research institutes that prove high yielder than the previous variety. Due to a variety of germplasm availability research institutes are able to release a number of varieties for different crops that are quite useful and our agricultural production has increased by many folds since 1985.

ANNEX-VIII
LIST OF PGRI SCIENTISTS AS ON 2007

Sr. #	NAME	DESIGNATION
1-	Dr. Zahoor Ahmad	PSO/Program Leader
2-	Mr. Muhammed Afzal	SSO (Seed Preservation Lab.)
3-	Dr. Mustafa Sajid	SSO (In Vitro Preservation. Lab.)
4-	Dr. Abdul Ghafoor	SSO (Germplasm Evaluation Lab.)
5-	Mr. Abdul Qayyum	SSO (Data Management Lab.)
6-	Dr. Saddar uddin Siddiqui	SSO (In Vitro Preservation Lab.)
7-	Dr. Ashiq Rabbani	SSO (Germplasm Evaluation Lab.)
8-	Mr. Asif Javaid	SO (Germplasm Evaluation Lab.)
9-	Mr. Shakeel Ahmed	SO (Seed Preservation Lab.)
10-	Mr. Muhammed Ishtiaq	SO (In Vitro Preservation Lab.)
11-	Mr. M. Arif	ASO (Plant Exploration Lab.)
12-	Mr Sajid Hussain	Studying Ph. D. in Newzeland
13-	Mr Zahid Mehmood	SO
14-	Mr. Tariq Rafiq	SO
15-	Mr. Atif Jamal	SO (Plant Pathology) on PH.D in UK
16-	Mr. Muhamamd Ishtiaq	SO (Bio-chemistry) on PH.D. in Japan

LIST OF SCIENTISTS UNDER THE PROJECT IPR-MINFAL (AT PGRI)

Sr. #	Name	Designation
1	Dr Rashid Anwar	Chief Scientific Officer
2	Ms. Shazia Erum	Scientific Officer
3	Mr. Muhamamd Afzal	Examiner Plant Biotechnology
4	Syed fahad Shabbir	Data Base Officer

Source: PGRI

LIST OF INTERNEES WORKING IN PGRI

Sr. #	Name	Title
1	Ms. Sajida Batool	M. Sc. Bio Plant Science
2	Ms. Saiqa Shahab	M. Sc. Bio Plant Science
3	Ms. Hina Rafiq	M. Sc. Botany
4	Syeda Muhammad Kaukab	B. Sc. Botany
5	Ms. Ghousia Andleeb	M. Sc. Bio Plant Science
6	Ms. Sana wali Muhammad	M. Sc. Botany
7	Ms. Tehseen Rubab	M. Sc. Bio Plant Science
8	Ms. Azeema Nighat	M. Sc. Botany
9	Mr. Haroon Ahmad Khan	B. Sc. Horticulture
10	Mr. Muhamamd farooq Ahmad	B. Sc. Hons Agriculture
11	Mr. Muhamamd Zubair Rafiq	M. Phil Bio-technology
12	Ms. Sadia Tehreem	M. Phil. Advanc in Plant Physiology
13	Mr. Muhamamd Khalid	M. Sc. Plant Breeding & Genetics

Source: PGRI

ANNEX-IX
SCIENTISTS TRAINED IN JAPAN

Name	Title	Period
Dr. M. Shahid Masood	Evaluation of Germplasm	13 Sept., 1993 – 21 Dec., 1993
Mr. Shahzad Naseem	Evaluation of Germplasm	13 Sept., 1993 – 21 Dec., 1993
Mr. Sadar Uddin Siddiqui	In-vitro Preservation	29 Aug., 1994 – 22 Jan., 1995
Mr.Mohammad Sadiq Bhatti	Genebank Management	5 Sep., 1994 – 12 Mar., 1995
Mr. Muhammad Rashid	Maintenance of Facilities	15 Nov., 1994 – 12 Mar., 1995
Mr. Muhammad Arif	Group Training	8 May, 1995 – 3 Oct., 1995
Mr. Abdul Qayyum	Data Management	15 Nov., 1995 – 17 Dec., 1995
Mr. Rashid Anwar	Evaluation of Wheat Diversity	21 Jan., 1996 – 28 apr., 1996
Mr. Muhammad Munir	Genebank Operation	25 May, 1996 – 22 Sept., 1996
Mr. Abdul Ghafoor	Group Training	6 May, 1996 – 1 Nov., 1996
Mr. Muhammad Afzal	Biochemical Evaluation	20 May, 1996 – 17 Nov., 1996
Dr. Muhammad Sarwar	Preservation of Recalcitrant Seed	20 May, 1996 – 8 Sep., 1996
Mr. Zafar Riaz	Identification of Pathogens	20 May, 1996 – 15 Sep., 1996
Dr. Muhammad Bashir	Detection of Plant Viruses	16 Sep., 1996 – 18 Dec., 1997
Dr. Zahoor Ahmad	Genebank Administration	22 Jun., 1997 – 11 Jul., 1997
Ms. Abida Akhtar	Production of Virus-free Plant	6 Jun., 1997 – 20 sep., 1997
Ms. Nayyar Kazmi	Design of Database	Mar., 1998 – July 1998
Dr. Sajid Mustafa		March., 2000 – July
Mr. Muhammad Rashid	Maintenance and management of equipments	24 Mar., 2002 – 13 Apr., 2002
Mr. Abdul Qayyum	Data Management	01 Oct., 2002 – 22 Dec., 2002
Dr. Sajid Mustafa	Cryo-preservation	15 Oct. , 2002 – 26 Dec., 2002

Source: PGRI

ANNEX-X
BUDGET ALLOCATIONS SINCE 1993-94
(Million Rupees)

Year	Institute	Establishment	Operational	Capital	Total
1993-94	PGRI	0.735	0.399	-	1.134
1994-95	-do-	0.808	0.371	-	1.179
1995-96	-do-	0.977	0.417	0.045	1.439
1996-97	-do-	1.052	0.148	-	1.2
1997-98	-do-	1.188	0.4	-	1.588
1998-99	-do-	1.935	2.39	-	4.326
1999-2000	-do-	2.127	2.761	-	4.888
2000-01	-do-	2.844	3	-	5.844
2001-02	-do-	2.952	3	-	5.952
2002-03	IABGR	8.153	3.853	0.147	12.153
2003-04	-do-	7.323	4.719	0.281	12.323
2004-04	-do-	10.796	2.862	0.138	13.796
2005-06	-do-	9.792	2.2	-	11.929
2006-07	-do-	10.951	3.49	0.225	14.666
2007-08	-do-	11.245	3.425	0.075	14.745

Source: PGRI

ANNEX-XI
OTHER DONOR ASSISTED PROJECTS/
LIST OF DEVELOPMENT PROJECTS BY DIFFERENT SOURCES

Name of Project Title	Budget (Million Rs.)	Sources
Collection, conservation, evaluation and documentation of horticultural crops germplasm and its wild relatives.	2.360	*ALP-I
In-vitro conservation and cryopreservation plant germplasm of vegetatively propagated crops.	2.100	ALP-II
Acquisition, screening and utilization of pea's germplasm for development of superior cultivars.	1.665	ALP-III
Conservation and sustainable utilization of agro-biodiversity of under-utilization crops.	1.896	ALP-IV
Introduction of medicinal herbs and spices as crops.	6.640	**MINFAL
Molecular characterization of rice germplasm using RAPD analysis.	5.498	ALP-V
Collection, conservation and characterization of vegetables crop biodiversity.	0.579	***PSF
Establishment of National Information Sharing Mechanism (NISM) on Implement of Global Plan of Action on PGR and preparation of Country Report.	1.200	FAO
Collection, evaluation and conservation of Amla (*Phyllanthus emblica*) and Tamarind (*Tamarindus indica*) germplasm.	0.440	****ACUC
Plant genetic diversity analysis and marker assisted breeding.	0.300	ICRISAT
Production of medicinal herbs in collaboration with private sector.	10.652	*****PSDP
Regeneration of chickpeas, grasspea, lentil and rice germplasm	0.83	Global Crop Division trust

*	Agriculture Linkages Programme
**	Ministry of Food Agriculture & Livestock, Government of Pakistan
***	Pakistan Science Foundation
****	xx
*****	xx

Source: PGRI

ANNEX-XII
RESEARCH THESES SUPERVISED AND COMPLETED AT PLANT GENETIC RESOURCES PROGRAM

S. No.	Name of University	Research Title	Degree
1-	Quaid-i-Azam University	Effect of modified developmental stages on yield and yield components in maize (*Zea mays* L.)	Ph.D.
2-	Quaid-i-Azam University	Gene-action for some important morpho-physiological traits in wheat (*Triticum aestivum* L.) under field conditions	Ph.D.
3-	Quaid-i-Azam Univ.	Assessment of genetic diversity in chickpea (*Cicer arietinum* L.) germplasm based on morphological and biochemical gene markers	Ph.D.
4-	Quaid-i-Azam Univ.	Genetic diversity in *Lens culinaris* for morphological, biochemical and molecular markers	Ph.D.
5-	Quaid-i-Azam Univ.	Inheritance and breeding methods in *Vigna mungo*	Ph.D.
6-	Quaid-i-Azam Univ.	Biodiversity in Black Cumin (*Nigella sativa* L.) for morpho–physiological, agronomic and biochemical markers	Ph.D.
7-	Quaid-i-Azam Univ.	Biodiversity in Tomato	Ph.D.
8-	Quaid-i-Azam Univ.	Genetic diversity and inheritance in *Pisum sativum* L.	Ph.D.
9-	Quaid-i-Azam Univ.	Genetic diversity in local and exotic cowpea [*Vigna unguiculata* (L.) Walp.] germplasm based on plant traits and SDS-PAGE	M. Phil.
10-	Quaid-i-Azam Univ.	Phylogenetic relationship among *Vigna* spp. for morphological traits and biochemical markers	M. Phil.
11-	Quaid-i-Azam Univ.	Evaluation and characterization of local and exotic peas germplasm based on morphological traits and SDS-PAGE markers	M. Phil.
12-	Quaid-i-Azam Univ.	Effect of diethyl sulphate on okra (*Abelmoschus esculentus*)	M. Phil.
13-	Quaid-i-Azam Univ.	Phylogentic relationships in *Vigna* species based on morphological traits, seed proteins and quality characters	M. Phil.
14-	Quaid-i-Azam Univ.	Genetic diversity in local and exotic pea germplasm	M. Phil.
15-	Quaid-i-Azam Univ.	Diversity in *Pisum sativum* for SDS-PAGE markers and agronomic traits	M. Phil.
16-	Quaid-i-Azam Univ.	Genetic diversity in chickpea (*Cicer arietinum* L.)	M. Phil.
17-	Quaid-i-Azam Univ.	Genetic diversity in local and exotic germplasm of *Pisum sativum* for SDS-PAGE markers and agronomic traits	M. Phil.
18-	University of Arid Agriculture	Morphological and Biochemical evaluation of wheat germplasm collected from various parts of Pakistan	Ph.D.
19-	University of Arid Agriculture	Characterization and morphological/biochemical evaluation of landrace genotypes of barley	Ph.D.
20-	Quaid-i-Azam Univ.	Taxonomic and biochemical studies of medicinally important Species of family Solanaceae from Pakistan	Ph.D.
21-	University of Arid Agriculture	Genetic diversity for morpho-physiological and biochemical traits in Indian mustard [*Brassica juncea* (L.) Czern. & Coss]	Ph.D.
22-	Gomal University, D.I. Khan	Inheritance and genetic variability of wheat (*Tritium aestivum* L.) germplasm from NWFP, Pakistan determined by morphological traits and bio-chemical markers	Ph.D.
23-	Quaid-i-Azam Univ.	Morphological and biochemical evaluation of landrace genotypes of rice.	M.Phil.
24-	Quaid-i-Azam Univ.	Germplasm Evaluation, Morphomolecular Diversity and Fertilizer Response in Castor (*Ricinus communis*)	M.Phil.
25-	Quaid-i-Azam Univ.	Germplasm Evaluation of *Trachyspermum ammi* (L.) Sprague Based on Morpho-Physiological and Biochemical Markers.	M.Phil.
26-	Univ. of Arid Agriculture	Characterization of Local Fennel (*Foeniculum vulgare* Mill) for oil contents and Genetic Variability.	Ph.D.
27-	Univ. of Arid Agriculture	*In vitro* culture of sugarcane	M.Sc.
28-	Univ. of Arid, Agriculture	*In vitro* culture of grape	M.Sc.
29-	NWFP Agri. Univ.,	*In vitro* morphogenesis under various hormonal regimes in	M.Sc.

	Peshawar.	sugarcane.	
30-	Quaid-i-Azam University	Genetic diversity in *Ocimum basilicum* and *O. sanctum* and their mycoflora in germplasm collections from Pakistan.	M.Phil.
31-	University of Arid Agriculture	Genetic diversity in wheat	M.Sc. Internship
32-	University of Arid Agriculture	Genetic diversity in barley	M.Sc. Internship
33-	Quaid-i-Azam Univ.	Artificial seed ageing and callgenic response in wheat (*Triticum aestivum* L.) seeds	M.Phil.
34-	University of Arid Agriculture	Report writing on research methods in genebank management	B.Sc. Internship
35-	Univ. of Arid Agriculture	Inter and intra-specific variation in SDS-PAGE electrophoresis of total seed protein in chickpea germplasm	M.Sc. Internship
36-	Univ. of Arid Agriculture	Inter and intra-specific variation in SDS-PAGE electrophoresis of total seed protein in rice germplasm	M.Sc. Internship
37-	Quaid-i-Azam Univ.	Screening of rice Germplasm for salt tolerance	M.Phil
38-	Quaid-i-Azam Univ.	Studies of high-molecular weight glutenin sub-unit polymorphism in wheat	M.Phil
39-	Quaid-i-Azam Univ.	Morpho-physiological and biochemical analysis of genetic diversity of rice form Pakistan	M.Phil
40-	Quaid-i-Azam Univ.	Morpho-physiological and biochemical analysis of genetic diversity of barley from West Asia and North Africa	M.Phil
41-	Quaid-i-Azam Univ.	Geographical diversity in local wheat germplasm based on morphological and biochemical traits	Ph.D.
42-	Univ. of Arid Agriculture	Morphological and Biochemical evaluation of wheat Germplasm collected form various parts of Pakistan	Ph.D.
43-	Univ. of Arid Agriculture	Characterization and morphological/biochemical evaluation of landrace genotypes of barley	Ph.D.
44-	Quaid-i-Azam Univ.	Taxonomic and biochemical studies of medicinally important species of family solanaceae from Pakistan	Ph.D.

ANNEX-XIII
CATALOGUES PREPARED & PUBLISHED

1995. Afzal, M. Z. Ahmad, M.S. Bhatti and A. Qayyum. (1995). Wheat germplasm catalog-I. Plant Genetic Resources Institute. Pp:103.

1996. Bhatti, M.S., A. Qayyum and N. Kazmi. (1996). Rice germplasm catalog-I. Plant Genetic Resources Institute. Pp:67.

1997. Masood, M.S., M.S. Bhatti., A. Qayyum and R. Anwar. (1996). Barley germplasm catalog-I. Plant Genetic Resources Institute. Pp:78.

1998. Bhatti, M.S., A. Qayyum and N. Kazmi. (1997). Plant germplasm catalogue - 97. Plant Genetic Resources Institute. Pp:103.

2003. Qayyum, A., R. Anwar, S. Nasim and M. Afzal. (2003). Plant germplasm catalogue - 2003. Plant Genetic Resources Institute. Pp:719.

2003. Ghafoor, A., Z. Ahmad and A. Qayyum. (2003). Mungbean germplasm catalogue. Plant Genetic Resources Institute. Pp: 91.

2003. Ghafoor, A., Z. Ahmad and A. Qayyum. (2003). Blackgram germplasm catalogue. Plant Genetic Resources Institute. Pp: 77.

2003. Ghafoor, A., Z. Ahmad, M. S. Iqbal and A. Qayyum. (2003). Cowpea germplasm catalogue. Plant Genetic Resources Institute. Pp: 49.

2006. Zahoor A., A. Qayyum, M.Sajjad Hussain, Atif Jamal and M. Sajjad Iqbal (2006). Medicinal plant germplasm catalogue. Plant Genetic Resources Institute. Pp: 48.

ANNEX-XIV

DEVELOPMENT OF IMPROVED VARIETIES OF VARIOUS CROPS THROUGH USE OF GENETIC RESOURCES IN PAKISTAN

Sl. No.	Name of Crop	Varieties Developed	Yield (kg/ha) In 1993-94	Yield (kg/ha) In 2004-05	%age Increase
1	Wheat	107	1894	2586	36.5
2	Maize	21	1380	2849	106.4
3	Rice	40	1626	1994	22.6
4	Chickpea	27	393	794	102.0
5	Sugarcane	37	46.1*	48.9*	6.1
6	Rapeseed & Mustard	22	735	839	14.1
7	Barley	9	967	1009	4.3
8	Mung	20	413	577	39.7

*Yield per ha. in tones **Yield per ha. in 1986-87.

Source: Agricultural Statistics of Government of Pakistan, 2004-05.

ANNEX-XV

DEVELOPMENT OF NEW PLANT TYPE IN RICE USING LAND RACES

Fida M Abbasi-

Summary

Rice yield is stagnant for the last several years. There are two options for increasing yield potential of rice, either by heterosis breeding or modification of plant type. For modification of plant type, 150 land races were evaluated for phenotypic acceptability as plant type, harvest index and other yield and yield attributing traits. Ten accessions were selected and further evaluated. Two accessions (acc.335 & 3358) were selected on the basis of overall performance. These two accessions were used in breeding program. Double haploids were produced using anther culture. Newly developed lines have erect leaves, good phenotypic acceptability, long roots, stiff stem and large panicle size. These lines will be used for the production of Super Hybrids.

Introduction

Agriculture is the backbone of the economy of Pakistan and provides direct and in direct employment to over 70 % of the labor force of the country. Amongst the three top agricultural crops of the country (wheat, cotton and rice): Rice is the only crop that is exported after processing for consumption as food. Nationally and internationally we need options for the solution of some enduring problems associated with sustainable food security. The well being of future generations depend upon achieving the correct balance between profitable production of high quality rice and the demand for the conservation of natural resources and environmental enhancement. Food security in the face of expanding populations is not guaranteed. There is a need to enhance the rice yield, reduce cost of production and increase the income of farmers. One of the main reasons for low yield is the Low potential of presently grown varieties of rice. These varieties produce large number of unproductive tillers and have excessive leaf area that may cause mutual shading and reduction in canopy photosynthesis and sink size.

Most of these varieties have high tillering capacity and small panicles. The large numbers of unproductive tillers that limit sink size and contribute to lodging susceptibility. In the past a quantum jump in rice production was achieved during sixties when plant architecture was modified from tall to semi dwarf. After this increase in production, only a marginal increase in potential yield was achieved. Further modification of present plant type of rice varieties using the biotechnological advancement is one of the better options to increase production. By utilizing new plant type as parental material, a super hybrid is possible with 35% higher yield potential as compared to present high yielding varieties of rice. The same have however been virtually ignored in Pakistan and we run the risk of ever falling behind the rest of the world in rice research. Keeping in view the importance of rice in the economy of Pakistan, present investigation was undertaken for further modification of present plant type and to develop a new plant type (NPT) with reduced number of unfertile tillers, stiff stem, long root system, erect and dark green leaves, large panicle size with more than 300 grains per panicle.

Evaluation of Land races

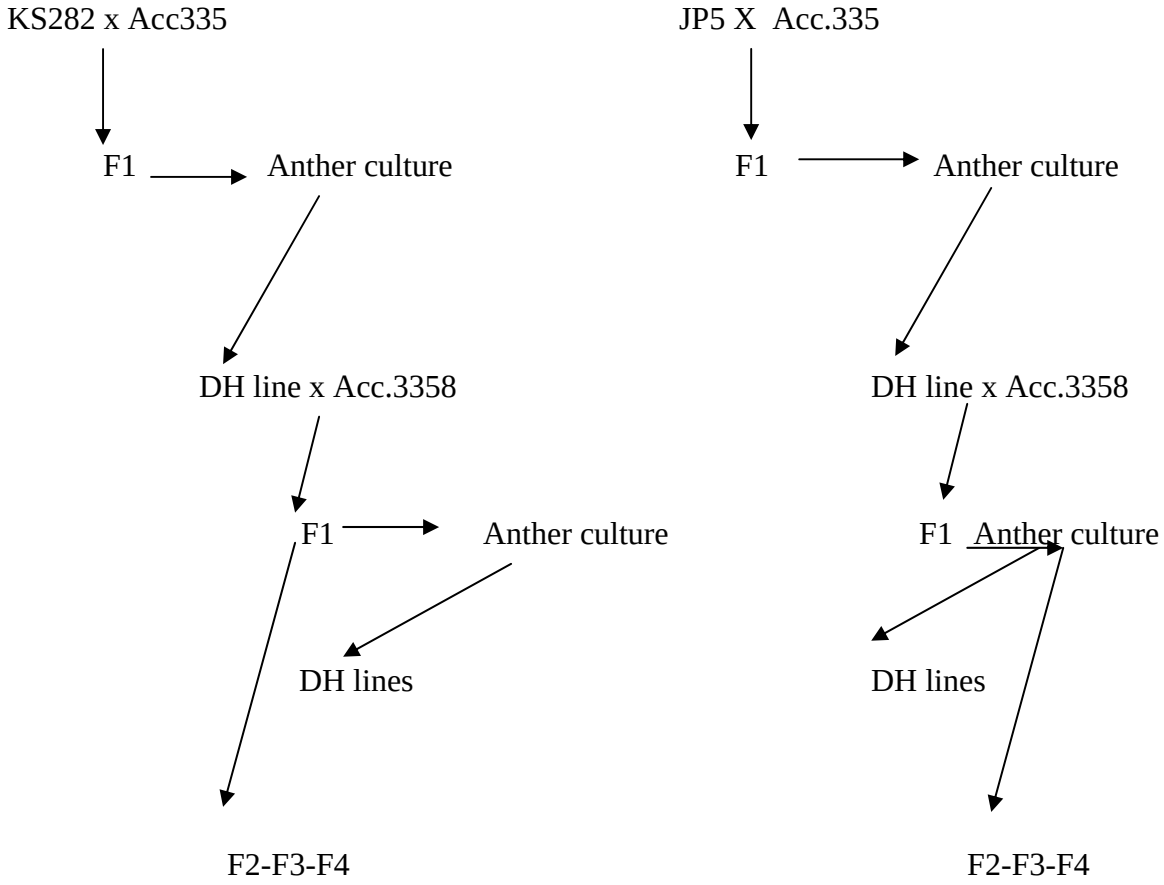
One hundred and fifty land races were acquired from PGRI, NARC and tested in the experimental field of Rice Program NARC in 1999. Based on visual observation for phenotypic acceptability for plant type, high yield potential, early maturity, short plant height and high harvest index, ten land races were selected (Tabe 1). These selected land races were reevaluated and finally two land races viz. accession No.335 and 3358 were used in the breeding program for the development of new plant type.

Performance of of rice land racesat NARC during 2000

Accession	Productive tillers (No)	Plant height (cm)	Flag leaf area (cm2)	Maturity (days)	Panicle length (cm)	Filled grain (No)	Paddy yield (kg/ha)	Harvest index
PK0000335	18.7a	140cd	90.7a	135c	27.7b	226a	10.0a	0.32d
PK0000367	15.6bc	149a-c	54.7b	129c	29.0ab	114cd	5.6de	0.30d
PK0003058	19.3a	145b-d	31.3d-f	138b	27.7b	216a	7.3b	0.41bc
PK0003078	13.7c	153ab	23.3g	143a	30.0a	83 e	6.2cd	0.38c
PK0003162	18.3ab	98h	27.7e-g	124f	21.0d	113cd	6.5bc	0.44ab
PK0003167	14.7c	110g	23.7g	117g	21.0d	70 f	5.1e	0.39bc
PK0003198	18.3ab	119fg	29.7d-f	125f	20.3d	89e	5.1e	0.30d
PK0003215	18.7a	135de	33.7d	136bc	28.7ab	109d	6.8bc	0.31d
PK0003358	13.3c	125ef	39.7c	117g	25.0c	124bc	9.2a	0.49a
PK0003394	18.3ab	159a	32.7de	143a	30.0a	116b-d	7.1b	0.30d
Basmati 385	14.7c	124f	28.0d-g	132d	29.7ab	128b	5.4de	0.47a
KS282	15.7bc	90h	26.7fg	124f	23.3c	87e	6.8bc	0.48a

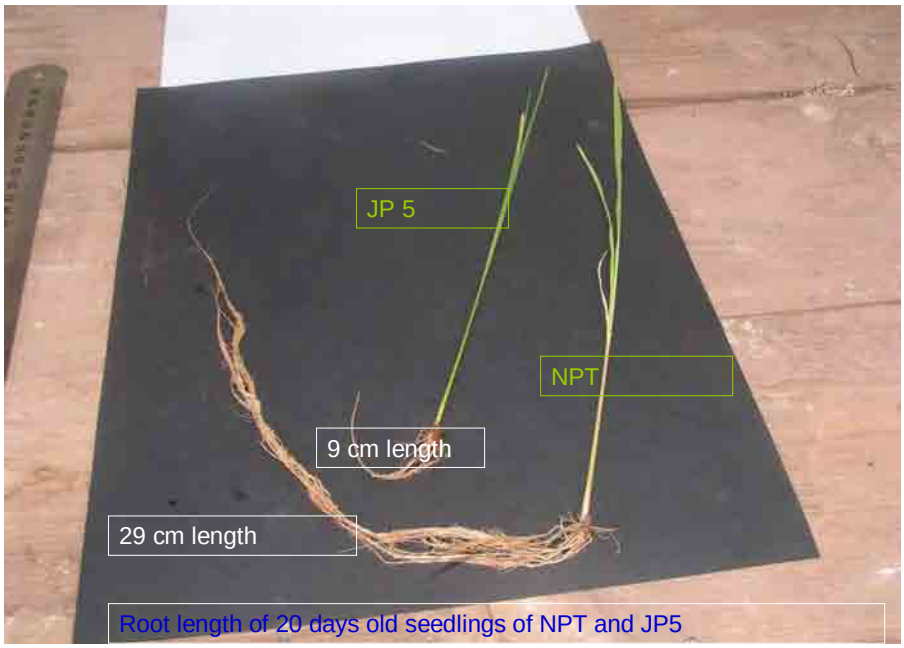
Means followed by different letters differ significantly from each other at p = 0.05

Diagrammatic representation for the development of NPT lines



Characteristics of NPT and inbred variety

Characters	KS282	NPT
Leaves	Narrow, semi erect	Erect
Stem	Weak	Stiff
Roots (no)	Less	More (50%)
Productive tillers	70%	100%
Grains/panicle	80-120	250-500



Root length of 20 days old seedlings of NPT and JP5

NPT KS282 NPT

NPT

NPT and JP-5 planted at ARS Buffa Mansehra

NPT JP5

ANNEX-XVI
VARIETIES DEVELOPED SINCE 1994 AND THEIR STATUS

S. #	Variety Name	Breeding Centre	Province	Year of Release	Year of Registration.	Status
1.	Agaiti 85	MMRI, AARI, Yousufwala	Punjab	1994	1996	Recommended (Rec).
2.	Golden 85	MMRI, AARI, Yousufwala	Punjab	1994	1996	Rec.
3.	Babar 98	CCRI, Pirsabak	NWFP	1997	1999	Rec.
4.	Ghauri 98	CCRI, Pirsabak	NWFP	1997	1999	Rec.
5.	Agaiti 2002	MMRI, AARI, Yousufwala	Punjab	2002	2004	Rec.
6.	Sahiwal 2002	MMRI, AARI, Yousufwala	Punjab	2002	2004	Rec.
7.	Jalal 2003	CCRI, Pirsabak	NWFP	2003		Rec.
	OIL SEEDS					
	Peanut					
1.	Swat phali 96	ARS, Mingora, Swat	NWFP	1996	1976	Rec.
2.	BARI 2000	BARI, AARI, Chakwal	Punjab	2000	2004	Rec.
3.	Golden Chakwal	BARI, AARI, Chakwal	Punjab	2002	2004	Rec.
4.	Fakhar-i-Swat SP-2004	ARS, Mingora, Swat	NWFP	2004		Rec.
	Rape & Mustard					
1.	Chakwal Raya	BARI, AARI, Chakwal	Punjab	1994	1996	Rec.
2.	Abasin 95	NIFA, Peshawar	NWFP	1996	1997	Rec.
3.	Bulbul 98	PODP, ARI, Tarnab	NWFP	1997	1999	Rec.
4.	Khanpur Raya	ORI, AARI, Faisalabad/ORS Khanpur	Punjab	2000	2004	Rec.
5.	Zafar 2000	PODB, Tarnab, Peshawar	NWFP	2000	2004	Rec.
6.	Chakwal Sarson	BARI, AARI, Chakwal	Punjab	2002	2004	Rec.
7.	Bahawalpur Raya	RARI, AARI, Bahawalpur	Punjab	2003		Rec.
8.	NIFA Raya	NIFA, Peshawar	NWFP	2003	2004	Rec.
9.	Takwara	ARI, D.I.Khan	NWFP	2004		Rec.
10.	Durr-e-Nifa	NIFA, Peshawar	NWFP	2005		
	Safflower					
1.	Pawari (Thori 78)	ARI, Tandojam	Sindh	1996	1997	Rec.
	Sesamum					
1.	TS 3	ORI, AARI, Faisalabad	Punjab	2000	2004	Rec.
	Soybean					
1.	Faisal	ORI, AARI, Faisalabad	Punjab	1996	1997	Rec.
2.	Malakand 96	ARS, Mingora, Swat	NWFP	1996	1996	Rec.
	PULSES					
	Chickpea					
1.	CM 88	NIAB, Faisalabad	Punjab	1994	1996	Rec.
2.	NIFA 95	NIFA, Peshawar	NWFP	1996	1997	Rec.
3.	Bittal 98	PRI, AARI, Faisalabad	Punjab	1998	1999	Rec.
4.	CM 98	NIAB, Faisalabad	Punjab	1998		Rec.
5.	Karak 98	ARS, Karak	NWFP	1998		Rec.
6.	Balkassar 2000	BARI, AARI, Chakwal	Punjab	2000	2004	Rec.
7.	CM 2000	NIAB, Faisalabad	Punjab	2000	2004	Rec.
8.	Hassan 2K	NIFA, Peshawar	NWFP	2000	2004	Rec.
9.	Lawaghar 2000	ARS, Karak	NWFP	2000	2004	Rec.
10.	Punjab 2000	PRI, AARI, Faisalabad	Punjab	2000	2004	Rec.
11.	Sheenghar 2000	ARS, Karak	NWFP	2000	2004	Rec.
12.	Wanhar 2000	BARI, AARI, Chakwal	Punjab	2000	2004	Rec.
13.	Dasht	PARC, Islamabad	Islamabad	2003	2004	Rec.

14.	Karak 2	ARS, Karak	NWFP	2003	2004	Rec.
15.	Karak 3	ARS, Karak	NWFP	2003	2004	Rec.
16.	Parbat	PARC, Islamabad	Islamabad	2003		Rec.
17.	NIFA 2005	NIFA, Peshawar	NWFP	2005		Rec.
18.	Thal 2005	AZRI, Bhakkar	Punjab	2006		Rec.
	Lentil					
1.	Masoor 93	PRI, AARI, Faisalabad	Punjab	1994	1996	Rec.
2.	Sheraz 96	AZRC, Quetta	Balochistan	1996	1997	Rec.
3.	Masoor 2002	NIAB, Faisalabad	Punjab	2002	2004	Rec.
4.	Masoor 2004	ARI, D.I.Khan	NWFP	2004		Rec.
5.	Ratta Kulachi 2004	ARI, D.I.Khan	NWFP	2004		Rec.
6.	*** Lentil 05**	**NIA, Tandojam**	**Sindh**	**2006**		**Rec.**
7.	NIAB Masoor	NIAB, Faisalabad	Punjab	2006		Rec.
	Mash					
1.	Mash 97	PRI, AARI, Faisalabad	Punjab	1997	1999	Rec.
2.	Chakwal Mash	BARI, AARI, Chakwal	Punjab	2002	2004	Rec.
	Mung					
1.	Khalood (AEM/96)	NIA, Tandojam	Sindh	1996	1997	Rec.
2.	NIAB 92	NIAB, Faisalabad	Punjab	1996	1997	Rec.
3.	Chakwal Mung 97	BARI, AARI, Chakwal	Punjab	1998	2004	Rec.
4.	NM 98	NIAB, Faisalabad	Punjab	1998	1999	Rec.
5.	Karak Mung 1	ARS, Karak	NWFP	2003	2004	Rec.
6.	Swat Mung 1	ARS, Mingora, Swat	NWFP	2004		Rec.
7.	Ramzan	NIFA, Peshawar	NWFP	2005		Rec.
8.	AZARI Mung 2006	AZRI, Bhakkar	Punjab	2006		Rec.
9.	**Chakwal M 5**	BARI, Chakwal	Punjab	2006		Rec.
10.	NIAB Mung 2006	NIAB, Faisalabad	Punjab	2006		Rec.
	RICE					
1.	Khushboo 95	NIA, Tandojam	Sindh	1996	1996	Rec.
2.	Super Basmati	RRI, AARI, K. S. Kaku	Punjab	1996	1996	Rec.
3.	Kanwal 95	RRI, Dokri Larkana	Sindh	1997	1999	Rec.
4.	Dilrosh	ARS, Mingora, Swat	NWFP	1998	1999	Rec.
5.	NIAB IRRI 99	NIAB, Faisalabad	Punjab	1999	1999	Rec.
6.	Basmati 2000	RRI, AARI, K. S. Kaku	Punjab	2000	2004	Rec.
7.	Shaheen Basmati	SSRI, Pindi Bhattian	Punjab	2000	2004	Rec.
8.	Sarshar	NIA, Tandojam	Sindh	2001	2004	Rec.
9.	Fakhre-e-Malakand	ARS, Mingora, Swat.	NWFP	2003	2004	Rec.
10.	KSK 133	RRI, AARI, K. S. Kaku	Punjab	2006		Rec.
11.	*** Mehak**	**NIA, Tandojam**	**Sindh**	**2006**		**Rec.**
12.	*** Shandar**	**NIA, Tandojam**	**Sindh**	**2006**		**Rec.**
13.	**Shahkar**	**RRI, Dokri,**	**Sindh**	**2006**		**Rec.**
	VEGETABLES					
	Bitter Gourd					
1.	Nasarpuri	SHRI, Mirpur Khas	Sindh	1996	1997	Rec.
	Cauliflower					
1.	Good man	ARI, Tarnab, Peshawar	NWFP	1996		Rec.
2.	Early CSS	ARI, Tarnab, Peshawar	NWFP	1996		Rec.
3.	Caperd	ARI, Tarnab, Peshawar	NWFP	1996		Rec.
	Carrot					
1	T 29	VRI, AARI, Faisalabad	Punjab	2006		Rec.
	Eggplant (Bringal)					
1.	Saravan 96	ARI, Sariab, Quetta	Balochistan	1996	1997	Rec.
2.	Dilnasheen	VRI, AARI, Faisalabad	Punjab	2000	2004	Rec.
3.	**Bemissal**	VRI, AARI, Faisalabad	Punjab	2000	2004	Rec.
	Garlic					
1.	Aglioblanco	ARI, Tarnab, Peshawar	NWFP	1996		Rec.

	Okra					
1.	Hazarganji	ARI, Sariab, Quetta	Balochistan	2002		Rec.
2.	Sabz pari	VRI, AARI, Faisalabad	Punjab	1996	1997	Rec.
3.	Sarhad white	ARI, Tarnab, Peshawar	NWFP	2000		Rec.
	Peas					
1.	Dasan	ARS, Mingora, Swat.	NWFP	2003	2004	Rec.
2.	Green sword	ARI, Tarnab, Peshawar	NWFP	1996		Rec.
3.	Koh-e-maran	ARI, Sariab, Quetta	Balochistan	2002		Rec.
4.	Mayfare	ARI, Tarnab, Peshawar	NWFP	1996		Rec.
5.	Samrina zard	VRI, AARI, Faisalabad	Punjab	1990	1990	Rec.
6.	P 267	PRI, AARI, Faisalabad	Punjab	1996	1997	Rec.
	Tomato					
1.	Elum 02	ARS, Mingora, Swat	NWFP	2003	2004	Rec.
2.	Conder	ARI, Tarnab, Peshawar	NWFP	1996		Rec.
3.	Pakit	VRI, AARI, Faisalabad	Punjab	1992	1996	Rec.
4.	Shalkot 1	ARI, Sariab, Quetta	Balochistan	1996	1997	Rec.
	WHEAT					
1.	Perwaz 94	WRI, AARI, Faisalabad	Punjab	1994	1996	Rec.
2.	Pothowar 93	WRS,(BARI), Rawalpindi	Punjab	1994	1996	Disc.
3.	Abadgar 93	WRI, Sakrand	Sindh	1996	1996	Rec.
4.	AZRI 96	AZRC, Quetta	Balochistan	1996	1997	Rec.
5.	Kiran 95	AEARC, Tandojam	Sindh	1996	1997	Rec.
6.	Kohsar 95	WRS, (BARI), Rawalpindi	Punjab	1996	1996	Rec.
7.	Nowshera 96	CCRI, Pirsabak	NWFP	1996	1997	Rec.
8.	Punjab 96	WRI, AARI, Faisalabad	Punjab	1996	1997	Rec.
9.	Shahkar 95	WRI, AARI, Faisalabad	Punjab	1996	1997	Rec.
10.	Sulaiman 96	CCRI, Pirsabak	NWFP	1996	1997	Rec.
11.	Tatara	NIFA, Peshawar	NWFP	1996	1997	Rec.
12.	Chakwal 97	BARI, AARI, Chakwal	Punjab	1997	1999	Rec.
13.	Drawar 97	RARI, AARI, Bahawalpur	Punjab	1997	1999	Rec.
14.	Fakhre Sarhad	NIFA, Peshawar	NWFP	1997	1999	Rec.
15.	Kohistan 97	WRI, AARI, Faisalabad	Punjab	1997	1999	Rec.
16.	MH 97	WRI, AARI, Faisalabad	Punjab	1997	1999	Rec.
17.	Bahawalpur 97	RARI, AARI, Bahawalpur	Punjab	1998	1999	Rec.
18.	Daman 98	ARI, D.I. Khan	NWFP	1998	2004	Rec.
19.	Dera 98	ARI, D.I. Khan	NWFP	1998	2004	Rec.
20.	Durum 97	WRI, AARI, Faisalabad	Punjab	1998	1999	Rec.
21.	Ghaznavi 98	Agri. Univ. Peshawar	NWFP	1998	2004	Rec.
22.	Zarlashta 99	ARI, Sariab, Quetta	Balochistan	1999	2004	Rec.
23.	Auqab 2000	WRI, AARI, Faisalabad	Punjab	2000	2004	Rec.
24.	BWP 2000	RARI, AARI, Bahawalpur	Punjab	2000	2004	Rec.
25.	Chanab 2000	WRI, AARI, Faisalabad	Punjab	2000	2004	Rec.
26.	Iqbal 2000	WRI, AARI, Faisalabad	Punjab	2000	2004	Rec.
27.	Nasir 2K	ARI, D.I.Khan	NWFP	2000	2004	Rec.
28.	Punjnad 1	RARI, AARI, Bahawalpur	Punjab	2000	2004	Rec.
29.	Raj	ARI, D.I. Khan	NWFP	2000		Rec.
30.	Saleem 2000	CCRI, Pirsabak	NWFP	2000	2004	Rec.
31.	Takbeer	NIFA, Peshawar	NWFP	2000	2004	Rec.
32.	AS 2002	WRI, AARI, Faisalabad	Punjab	2002	2004	Rec.
33.	Bhakkar 2002	AZARI, Bhakkar	Punjab	2002	2004	Rec.
34.	Chakwal 2002	BARI, AARI, Chakwal	Punjab	2002	2004	Rec.
35.	SH 2002	WRI, AARI, Faisalabad	Punjab	2002	2004	Rec.
36.	Ufaq 2002	ABRI, AARI, Faisalabad.	Punjab	2002	2004	Rec.
37.	KT 2000	BARS, Jarma, Kohat	NWFP	2003	2004	Rec.
38.	KT 2003	BARS, Jarma, Kohat	NWFP	2003	2004	Rec.
39.	Lakki J03	ARS, Serai Naurang, Bannu	NWFP	2003	2004	Rec.
40.	Manthar 3	RARI, AARI, Bahawalpur	Punjab	2003		Rec.
41.	Marwat J01	ARS, Serai Naurang, Bannu	NWFP	2003	2004	Rec.
42.	Bhittai	NIA, Tandojam	Sindh	2004		Rec.

43.	Haider 2000	CCRI, Pirsabak	NWFP	2004		Rec.
44.	Marvi 2000	NIA, Tandojam	Sindh	2004		Rec.
45.	Pirsabak 2004	CCRI, Pirsabak	NWFP	2004		Rec.
46.	TD 1	ARI, Tandojam	Sindh	2004		Rec.
47.	Zam	ARI, D.I. Khan	NWFP	2004		Rec.
48.	Raskoh 2005	ARI, Sariab, Q uetta	Balochistan	2005	-	Rec.
49.	Fareed 2006	RARI, AARI, Bahawalpur	Punjab	2006		Rec.
50.	**Imdad 05**	**WRI, Sakrand**	**Sindh**	**2006**		**Rec**
51.	***Khirman**	**NIA, Tandojam**	**Sindh**	**2006**		**Rec**
52.	**Moomal 2002**	**WRI, Sakrand**	**Sindh**	**2006**		**Rec.**
53.	***Sassui**	NIA, Tandojam	Sindh	**2006**		**Rec.**
54.	Seher 2006	WRI, AARI, Faisalabad	Punjab	2006		Rec.
55.	Shafaq 2006	WRI, AARI, Faisalabad	Punjab	2006		Rec.
56.	**SKD 1**	**WRI, Sakrand**	**Sindh**	**2006**		**Rec**

*** Conditionally Approved**

ANNEX-XVII
GERMPLASM COLLECTION THROUGH EXPLORATION MISSIONS
Under PTTC

S. No.	Name of Expedition	Year	Areas explored	No. of Accession
1.	Wild Forages	1993	Balochistan	106
2.	Brassica	1994	Punjab	182
3.	Wheat & Barley	1994	NWFP, Punjab	134
4.	Fruits	1994	Northern Areas	156
5.	Lentil & Chickpea	1995	Punjab	163
6.	Fruits	1995	NWFP, Northern Areas	94
7.	Legumes	1996	Punjab	105
8.	Fodder & Forages	1996	Punjab	328
9.	Wheat	1996	NWFP, Northern Areas	349
10.	Mash/Vegetables	1996	Punjab	98
11.	Millet & Sorghum	1996	Sindh	163
12.	Fodder & Forages	1997	Punjab (Cholistan)	21
13.	Maize	1997	NWFP (Kaghan)	43
14.	Seabuckthorn	1997	Northern Areas	38
15.	Wheat & Barley	1999	Punjab	61
16.	Vegetables	1999	NWFP	9
17.	Vegetables	2000	Punjab, NWFP	340
18.	Wheat & Barley	2001	Sindh, Balochistan, Punjab, NWFP, Northern Areas	316
19.	Wheat, Barley & Oilseeds	2002	NWFP, Punjab	286
20.	Vegetables	2002	Punjab, AJK, NWFP, Northern Areas	424
21.	Medicinal Collection	2002	Sindh, Punjab, NWFP, Northern Areas	344
22.	Fruits & Vegetables	2003	NWFP, Northern Areas, Punjab	138
23.	Grapes and Peaches	2003	AJK, NWFP, Northern Areas	083
24.	Medicinal Collection	2003	Sindh, Punjab, NWFP, AJK Balochistan, Northern Areas	926
25.	Sesame and Peas	2004	Punjab	105
26.	Vegetables and Under-utilized crops	2004	Sindh, Punjab, NWFP	269
27.	Vegetables Collection	2004	Balochistan	063
28.	Medicinal Collection	2004	Sindh, Punjab, NWFP, AJK, Northern Areas	210
29.	Grapes Collection	2005	Balochistan	064
30.	Vegetables Collection	2005	Balochistan	087
31.	Medicinal Collection	2005	Sindh, Punjab, NWFP, AJK, Northern Areas	291
32.	Medicinal Collection	2006	Punjab	020
33.	Medicinal Collection	2006	Punjab	100
34.	Maize Collection	2007	NWFP, AJK, Northern Areas	090
35.	Vegetables and Minor species	2007	Punjab, NWFP, Northern Areas	132

Source: PGRI

SUMMARY OF GERMPLASM COLLECTION (VARIOUS SOURCES)

S. No.	Expedition		Donation		Total
	Year	Exploration	Local	Overseas	
1-	1992	6874	1125	1000	8999
2-	1993	106	-	-	106
3-	1994	474	-	321	795
4-	1995	354	1101	1913	3368
5-	1996	952	95	826	1873
6-	1997	60	274	20	354
7-	1998	-	714	-	714
8-	1999	71	696	-	767
9-	2000	342	1002	4	1348
10-	2001	344	355	2	701
11-	2002	352	985	101	1438
12-	2003	450	75	-	525
13-	2004	437	02	238	677
14-	2005	2023	26	-	2049
15-	2006	120	1009	-	1129
16-	2007	222	137	410	769

Source: PGRI

ANNEX-XVIII
STATUS OF GENEBANK AT PLANT GENETIC RESOURCES PROGRAMME

S. No.	Crops	Accessions	Total
	Cereals:		10617
1-	Wheat (*Triticum aestivum*)	2931	
2-	Durum wheat (*Triticum durum*)	270	
3-	Wheat (Wild species)	133	
4-	Barley (*Hordeum vulgare*)	1274	
5-	Oats (*Avena sativa/fatua*)	540	
6-	Rice (*Oryza sativa*)	3032	
7-	Maize (*Zea mays*)	545	
8-	Sorghum (*Sorghum bicolor*)	866	
9-	Millets (*Pennisetum glaucum*)/related spp.	1007	
10-	Buckwheat (*Fagopyrum)esculentum*	19	
	Food Legumes:		5300
11-	Chickpea (*Cicer arietinum*)	2243	
12-	Chickpea (wild cicer)	90	
13-	Lentil (*Lens culinaris*)/its wild relatives	818	
14-	Mungbean (*Vigna radiata*)	643	
15-	Mashbean (*Vigna mungo*)	799	
16-	Cowpea (*Vigna unguiculata*)	212	
17-	Lobia (*Phaseolus vulgaris*)	109	
18-	Vicia species	172	
19-	Moth (*Vigna acontifolia*)	66	
20-	Matri (*Lathyrus speceis*)	148	
	Oilseeds:		3567
21-	Oilseed brassica	1093	
22-	Groundnut (*Arachis hypogaea*)	754	
23-	Soybean (*Glycine max*)	133	
24-	Sunflower (*Helianthus annuus*)	143	
25-	Safflower (*Carthamus Tinctorius*)	362	
26-	Sesame (Sesamum indicum)	073	
27-	Cotton (Gossypium hirsutum)	1009	
	Others:		5271
28-	Fodder & Forages	471	
29-	Fibre Crops	357	
30-	Vegetables	1481	
31-	Fruits	1024	
32-	Medicinal Plants	1938	
		G.Total:	**24755**

Source: PGRI

ANNEX-XIX
GERMPLASM MULTIPLICATION SINCE PROJECT INCEPTION

Crop	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total
Maize	97	25	331	-	-	-	-	-	150				36		639
Mung	-	325	-	720	100	-	72	-	100	50					1367
Mash	-	311	-	623	514	37	65	-	150	120					1820
Cowpea	-	138	-	197	-	191	138	-	100						764
Aegilops spp.	-	43	-	-	-	-	-	-	-						43
Setiaria spp.	-	-	49	50	-	-	-	-	-						99
Peniicitum spp.	-	-	48	-	194	-	-	-	150						392
Wild Chickpea	-	37	-	-	-	-	-	-	10	12					59
Wild Lentil	-	24	30	-	-	-	-	-							54
Wheat	88	1238	367	1271	-	-	-	-	100	200	200	530	200	430	4624
Barley	171	397	504	161	-	-	-	-	80	100	100	100	100	100	1813
Sorghum	79	371	409	449	-	-	-	-	150	50	150	147	36	36	1877
Chickpea	67	222	357	125	500	-	32	-	100	-	50	400	65	15	1933
Rice	544	239	466	-	-	-	-	-	438	200	70	90	267	252	2566
Lentil	-	423	423	200	-	-	-	-	-					20	1066
Brassica spp.	-	-	-	50	-	-	-	80	-				95	173	398
Buckwheat	-	-	-	12	19	-	-	-	-						31
Wild Mung	-	-	-	1	1	1	1	-	1						5
Okra	-	-	-	-	-	-	39	19	21						79
Moth	-	-	-	-	-	-	-	-	62						62
Soybean	-	-	-	-	-	60	-	152	96	120		80	125		633
Peas	-	-	-	-	-	102	89	-	-	255	150	244	120	223	1183
Brinjal	-	-	-	-	-	-	-	-	7						7
Chilli	-	-	-	-	-	-	-	-	6						6
Tomato													84	100	184
Seame														151	151
	1046	3793	2984	3859	1328	391	436	251	1721	1107	720	1591	1128	1500	21855

Source: PGRI

ANNEX-XX
AGRO-MORPHOLOGICAL EVALUATION OF GENETIC RESOURCES

S.No.	Crop	Preserved in Genebank	Evaluated	Number of Traits
1.	*Oryza sativa*	2836	1249	14
2.	*Sorghum bicolor*	860	860	18
3.	*Hordeum vulgare*	1274	933	12
4.	*Zea mays*	544	428	13
5.	*Cicer arietinum*	2243	1004	14
6.	*Triticum durum*	207	192	21
7.	*Brassica spp.*	1002	121	15
8.	*Triticum aestivum*	2767	2042	21
9.	*Glycine max*	133	133	20
10.	*Setaria italica*	121	50	5
11.	*Pennisetum glaucum*	1000	194	20
12.	*Fagopyrum esculentum*	19	19	5
13.	*Lycopersicon esculentum*	92	70	20
14.	*Raphanus sativus*	86	47	23
15.	*Pisum sativum*	350	223	23
16.	*Ablemoschus esculentus*	44	34	33
17.	*Lens culinaris*	806	360	12
18.	*Vigna mungo*	647	550	21
19.	*Vigna radiate*	639	620	18
20	*Vigna unguiculata*	192	173	31

Source: PGRI

ANNEX-XXI
MOLECULAR/BIOCHEMICAL EVALUATION

Crop	**Number**	**Year**	**Technique used**
Rice	15	1994	SDS-PAGE
Aegilops	42	1995	SDS-PAGE
Chickpea	10	1995	Isozyme
Cotton	13	1995	Isozyme
Lathyrus	12	1995	SDS-PAGE
Buckwheat	19	1998	SDS-PAGE
Groundnut	151	2001	SDS-PAGE
Okra	39	2001	SDS-PAGE
Vetch	12	2001	SDS-PAGE
Lentil	166	1995-1997	SDS-PAGE (120), Isozyme (36), DNA (RAPD) (10)
Peas	73	1998-2000	SDS-PAGE
Wheat	273	1994-2001	SDS-PAGE (268), 2-D Protein Analysis (5)
Mash	321	1997-2001	SDS-PAGE (311), 2-D Protein Analysis (10)
Cowpea	138	1999-2001	SDS-PAGE
Soybean	161	2001-2002	SDS-PAGE
Vigna spp.	150	2001-2002	SDS-PAGE
Medicago spp.	168	2003	SDS-PAGE
Wheat	150	2003	SDS-PAGE
Vigna spp.	150	2003	SDS-PAGE
Rice	510	2004 to 2007	SDS-PAGE
Brassica	95	2006 to 2007	SDS-PAGE
Brassica	100	2007	SDS-PAGE
Rice	175	2005 to 2007	RAPD, SSR
Brassica	50	2007	RAPD
Nigella	31	2006	SDS-PAGE, RAPD
Peas	250	2004 to 2007	SDS-PAGE
Peas	45	2007	RAPD
Tomato	101	2006-2007	SDS-PAGE
Tamarind	20	2007	SDS-PAGE
Source: PGRI			

ANNEX-XXII
SEMINARS/WORKSHOPS/TRAININGS ORGANIZED AT PGRI

S. No.	Name of Training Courses	Date/Year
1	Tissue culture and biotechnology.	1998
2	Seminar on "Underutilized crops of Pakistan".	May 22-29, 1998.
3	Seminar on "Medicinal Plants of Pakistan",	December 2-3, 1998.
4	Tissue culture and biotechnology,	1999.
5	Seminar on "Sustainable Utilization of Plant Genetic Resources for Agricultural Production".	December 17-19, 2002.
6	Medicinal Plants: Linkages Beyond Boundaries.	September 7-9, 2004.
7	Production and post harvest processing of medicinal herbs.	2004.
8	Plant molecular genomics.	2005.
9	Production and post harvest processing of medicinal herbs.	2005.
10	Production and post harvest processing of medicinal herbs.	2006.

Source: PGRI

PHOTOGRAPHS

Equipment Required Replacement

PH Meter-Out of Order

Washing Machine out of order

Multichamber –Out of Order

Seed Dryer One light out of order with two lights OK

Dehumidifier Out of order

Cooling Units-Out of order

Computer the only machantorch out of order rather out dated

Distillation Plant-Out of order

Mrdical Refrigerator –Currently being used as store

Equipment working properly (Good)

Centifugal Machine working condition

Microscope OK

Incubator OK

Field Photographs

Germplasm Evaluation (Brassica)

In Vitro Culture (Peach)

Annexure

Third Party Review by External Expert

Overall Statement:

On the request of Government of Pakistan, Government of Japan through JICA established Genetic Resource Preservation and Research Laboratory (1993-1998) at NARC, Islamabad. Aftercare technical cooperation was provided from May 2001 to May 2003.

The project is successful. The project has made significant inputs. The project responded to the demand of both Government of Pakistan & Government of Japan. Crop varieties have been developed and distributed to farmers for general cultivation, yields have been increased. Crop breeders, researchers, post graduate university students & farmers have benefited.

Linkages with local and international institutions have been developed. Technically, institutionally and financially the project is sustainable. The Plant Genetic Laboratory has been upgraded to Plant Genetic Research Institute. Financial support has increased 10 times. No negative influence on the social, culture & environment has been noticed.

The evaluation process was conducted logically and objectively.

The results, conclusion and recommendations are reasonable.

Method of Evaluation

- First of all, documents i.e Bio-data of consultant, terms of reference, main report and evaluation guideline manual were thoroughly studied
- Then each item in the evaluation Performa was compared with the main report and evaluation guideline manual

Example 1

Performa item (1) Time Frame of Evaluation Study was compared with the entries said in Evaluation guideline page 97, which reads

1. Preparatory Period
    - Overall evaluation plan is drawn
    - Selection of evaluation team personal
    - Preparation of evaluation grid
    - Coordination with local personal
    - Questionnaires developed
2. On Site Evaluation Period
    - Data Collection
    - Analysis
    - Discussion conclusion, recommendation
    - Lesson Learned

Keeping in view the entries, report was examined and rating

Example 2

Performa item (2) Data collection & Analysis According to Evaluation guideline page 72, data should be collected as under

- Previewing statistics
- Literature
- Existing data
- Observations
- Questionnaire survey
- Interviews
- Discussion

Keeping in view these criteria, report was examined critically and rating was awarded. Similarly all items of the Performa was examined and rating was awarded

Reasons for awarding "B" to most of the Performa Items

The main goal of the project is to collect, evaluate, multiply and distribute the germless of various crops to the crop breeders so that they can develop high yielding varieties for the farmers. This objective

has been achieved. The germless has been collected, evaluated, multiplied and distributed to the crop breeders and researchers. Varieties have been developed and released to farmers & general cultivation. Crops yields have been increased. Project is sustainable. Scientific manpower has been trained laboratory has been upgraded to plant genetic resource institute. Finance has been increased 10 times. No bad influence has been noticed. Positive ripple effects have been noticed. Therefore almost all items of Performa were rated as "B". Since the cooperation of both the countries i.e. Govt of Pakistan & Govt of Japan was excellent therefore, rating "A" was awarded