Agricultural Innovation Program for Pakistan (AIP)

Semi-annual report:

April 01, 2015 to September 30, 2015

Submitted to USAID on

November 5, 2015

aip.cimmyt.org

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ACRONYMS

AARI	Ayub Agriculture Research Institute
AAUR	Arid Agriculture University, Rawalpindi
AI	Artificial Insemination
AIP	Agricultural Innovation Program
AJK	Azad Jammu And Kashmir
AR Farms	Adaptive Research Farms
AR4D	Agricultural Research for Development
ARI	Agriculture Research Institute
ARS	Agronomic Research Station
ASI	Animal Science Training Institute
ASLP	Australian Sector Linkages Project
ATI	Agriculture Training Institute
AVRDC	The World Vegetable Center
AWD	Alternate Wetting And Drying
AZRI	Arid Zone Research Institute
BARDC	Baluchistan Agricultural Research and Development Center
BARI	Barani Agricultural Research Institute
BLB	Bacterial Leaf Blight
BUITEMS	Balochistan University of Information Technology, Engineering and Management Sciences
CA	Conservation Agriculture
CCRI	Cereal Crops Research Institute
CGIAR	Cumulative Group of International Agricultural Research
CGS	Competitive Grants System
CIMMYT	International Maize and Wheat Improvement Center
COs	Community Organizations
CRI	Citrus Research Institute
DAP	Diammonium Phosphate
DAR	Directorate of Agriculture Research
DG	Director General
DSR	Direct Seeding of Rice
DSS	Decision Support System
DVC	Dairy Value Chain
ETV	Enterotoxaemia Vaccine
FAO	Food And Agriculture Organization of the United Nations
FEAST	Feed Assessment
FGDs	Focus Group Discussions
FMD	Foot and Mouth Disease
FSC&RD	Federal Seed Certification and Registration Department
GB	Gilgit Baltistan
GS	Green Seeker
Ha	Hectares

HEC	Higher Education Commission
HRD	Human Resource Development
HS	Hemorrhagic Septicemia
ICARDA	International Center for Agricultural Research in the Dry Areas
ICI	Imperial Chemical Industry
ICT	Information and Communication Technology
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
ILRI	International Livestock Research Institute
IPM	Integrated Pest Management
IRD	Informal Research and Development
IRRI	International Rice Research Institute
IRS	Internationally Recruited Staff
KP	Khyber Pakhtunkhwa
KSK	Kala Shah Kaku
L&DDD	Livestock & Dairy Development Department
LCC	Leaf Color Chart
LDDDB	Livestock and Dairy Development Department of Balochistan
LSOs	Local Support Organizations
M&E	Monitoring and Evaluation
MEW	Mega Environment for Wheat
MMRI	Maize And Millet Research Institute
MR	Moderately Resistant
MS	Moderately Susceptible
MSF	Mission Strategic Framework
NAC	National Advisory Committee
NARC	National Agriculture Research Center
NARS	National Agricultural Research Scientist
NE	Nutrient Expert^{tm}
NRS	National Recruited Staff
NRSP	National Rural Support Program
NSTHRI	National Sugar and Tropical Horticulture Research Institute
NUYT	National Uniformity Yield Trial
ODK	Open Data Kit
OPV	Open Pollinated Variety
PARB	Pakistan Agricultural Research Board
PARC	Pakistan Agricultural Research Council
PARD	Pakistan Academy for Rural Development
PAU	Punjab Agriculture University, Ludhiana, India
PIASA	PARC Institute for Advanced Studies In Agriculture
PPR	Peste-Des-Petits Ruminants
PVS	Participatory Varietal Selection
QAARI	Quaid-E-Awam Agriculture Research Institute
QPM	Quality Protein Maize
RA	Research Associate
RCA	Roberts Cotton Associates Ltd.
RCBD	Randomized Complete Block Design
RRI	Rice Research Institute
SARS	Summer Agricultural Research Station

SB	Super Basmati
SDS	Sodium Dodecyl Sulfate
SEP	Socio Economics Program, CIMMYT
SOP	Sulfate of Potash
SS	Sorghum Sudan
SSNM	Site Specific Nutrient Management
SSRI	Social Sciences Research Institute
t / ha	tons / hectare
TAC	Technical Advisory Committee
TEVTA	Technical Education and Vocational Training Authority
TMK	Tando Muhammad Khan Seed Corporation
UAF	University Of Agriculture, Faisalabad
UC	Union Council
UC Davis	University of California, Davis
USAID	U.S. Agency for International Development
USDA	United States Department of Agriculture
VG	Vegetable Growers
VO	Village Organizations
WRI	Wheat Research Institute
WRIS	Wheat Research Institute Sindh
ZT	Zero Tillage
ZTHS	Zero Tillage Happy Seeder

Contents

SUMMARY

In this reporting period (April-September 2015) 'Agricultural Innovation Program for Pakistan' (AIP) remained committed to implementing results-based approaches and determined to be more efficient, effective, transparent and accountable. Improving Pakistan's agricultural sector and achieving the targets of 2014-15 work plan, AIP is working to increasing the agricultural productivity and economy.

The project is being implemented across four diverse cross-commodity key themes namely new varieties seeds, new technologies (mechanization), value chain development (durum wheat, rice, vegetables, perennial horticulture and livestock), human resource development and introducing competitive grants system through the creation of provincial Agricultural Research for Development (AR4D) Boards.

The commissioned projects are tranquilly continuing to meet AIPs' objectives i.e. improving agricultural productivity and creating new avenues of livelihoods for the farmers.

More than 1,000 dairy farmers from Punjab province now have direct access to the volunteer farmer dairy model training farms established for sustainable livestock production. In addition to this livestock component is also promoting improved cereal and forage varieties for fodder with increased nutritional value of residues through Village Based Seed Enterprises.

Vegetable component is engaged in identifying and promoting the best varieties and hybrids to extend the open field production season, and expanding the use of integrated pest management (IPM) practices for protected cultivation of vegetables. It is also identifying opportunities to improve mungbean production as part of the existing cropping systems and evaluating postharvest strategies to improve the operations of value chains.

Quality wheat seed of 17 new high yielding and rust resistant varieties was produced through public-private partnerships by using the concept of village-based seed production. This has significantly increased access to wheat seed in food deficit and rural areas in Pakistan. Nearly 27,000 additional farmers can access to new seed varieties in the remote villages through informal seed flow for no extra costs. National Uniform Yield Trial (NUYT) was conducted by AIP with public sector partners at nine locations across Pakistan, which led to the identification of a number of durum wheat lines promising for both rainfed and irrigated areas.

AIP focuses on attaining food and nutritional security. CIMMYTs' germplasms that have proven quality of protein and enriched with pro vitamin-A (beta-carotene) and are being evaluated in Pakistan. Besides this, maize component is successfully managing multi-stakeholder platform and has taken on board ten private and nine public institutions in the maize working group to enhance the maize seed sector in Pakistan.

Rice hermetic storage super bags showed positive results at the experimental station across Pakistan, which has led to the next level evaluation i.e. the super bags are now being evaluated by ten selected progressive farmers in Sindh province.

AIP's National partners were instrumental in conducting field days for farmers to observe conservation agriculture (CA) demonstrations during wheat season. A total of 1470 farmers participated in 15 field days which enabled them to understand the benefits of various improved practice like zero till (zt) wheat, ridge planting of wheat, performance of new seeders and better nutrient management techniques.The socioeconomics component is closely

analyzing the access, availability and adoptability of conservation agriculture technologies among the agricultural communities.

The Perennial Horticulture component has successfully extended the results to a wide range of citrus, mango, guava, pistachio, olive and ber stakeholders.

AIP, under its human resource development component, has successfully sent 14 highly competitive scholars to commence their MS and PhD degrees at 8 difference land grant universities in the U.S.

In the previous reporting period, in response to the call for application of research proposals advertised under the competitive grants system, 349 preliminary proposals were received from all the provinces. Punjab Agriculture Research Board has completed the evaluation and the shortlisted proposals for approval from AIP secretariat. Whereas, in other three provinces the preliminary proposals are still in evaluation phase as the boards are not existent.

In August 2015, AIP highlighted its accomplishments and the latest innovations in its annual conference in Islamabad which focused on improving productivity and economy in the country. The AIP presented the way forward to improve agricultural productivity and make Pakistan economically viable by utilizing the latest technologies and developing value chains for marketing agricultural products. The commissioned projects showcased the innovative trends, modern practices, and new technologies introduced by AIP.

AIP continues to strive to provide technical assistance and support to reduce gender disparities and enhance the capabilities of women working at different levels in the agricultural sector. To contribute to the USAID gender objectives, this has been made part of the new sub-grant agreements. AIP has directly benefitted 4,230 women and 20,712 men during this reporting period.

AIP-M&E prepared a comprehensive strategy to achieve the set targets. An inclusive M&E plan was prepared and also shared with USAID. The quarterly data from all the AIP primary partners was uploaded on USAID's website i.e. PAKINFO. Mission strategic framework (MSF) indicators were refined. Monitoring and Evaluation quarterly meeting was held at CIMMYT office in which different organizations participated.

The external factors and risks, such as volatile security situations, slow administrative processes of the public sector organizations and unfavorable climatic conditions, cause delay in some of the operations, AIP is committed to continue to improve the Pakistan's agricultural productivity and economy.

BACKGROUND

The 'Agricultural Innovation Program for Pakistan' (AIP) works to increase agricultural productivity and incomes in the agricultural sector through the promotion and dissemination of modern practices in the following sectors: cereals (wheat, maize, and rice), livestock and horticulture (fruits and vegetables). Project management is vested in a unique consortium of CGIAR Centers and the Pakistan Agricultural Research Council (PARC), led by the International Maize and Wheat Improvement Center (CIMMYT). AIP aims to foster the emergence of a dynamic, responsive and competitive system of science and innovation that is 'owned' by Pakistan and will catalyze equitable growth in agricultural production, productivity and value. AIP is rooted in the principles of AR4D, with particular emphasis on building partnerships between public research and those it serves, including farmers and the private sector; increasing investments; generating, sharing and making use of agricultural knowledge for development; and demonstrating and building awareness of the development impacts and returns from agricultural innovation.

AIP operates through three Activity Windows: commissioned projects, a competitive grants system and human resource development (HRD). Work within these activity windows addresses complex agricultural systems which is divided into four 'Science Windows' – cereals and cereal systems, livestock, vegetables and perennial horticulture. The key indicator of AIP's success will be the number of smallholder farmers who adopt or benefit from productivity or value-enhancing technologies. CIMMYT is the primary implementing partner and prime grantee; managing and taking overall responsibility for AIP and providing direct oversight of the agronomy, wheat and maize commissioned projects within the cereals and cereal systems science window. Four international partners (the International Livestock Research Institute, or ILRI; University of California, Davis; The World Vegetable Center, or AVRDC; and the International Rice Research Institute, or IRRI) lead on commissioned projects in livestock, tree fruits, vegetables and rice, respectively, while PARC serves as both the hosting partner and the lead on a province-inclusive competitive grants system. Combined, those organizations are CIMMYT's "primary partners."

1. TECHNICAL AND WORKPLAN UPDATE

1.1. COMMISSIONED PROJECTS

1.1.1. Livestock

1.1.1.1. Dairy Value Chain

1.1.1.1.1. Farmer's Field Day to Improve Milk Productivity

After successful completion of the water and feed trial with limited number of animals at farmer's field in Chella village in Jhang district, Punjab province, a farmer's field day was organized on April 4, 2015. The objective of this field day was to create awareness among the dairy farmers on the importance of free access (adlib) to drinking water, balanced feed for improved milk productivity and role of Mott grass in alleviating fodder shortages in lean periods. The field day was attended by 32 farmers.

In addition to this, the issue of seasonal variation in fodder supply was discussed. The farmers benefited by learning the importance of adlib supply of water, balanced feeding and continuous supply of green fodder in improving milk productivity. Five farmers received Mott grass roots slips, a month before the event. The AIP-Livestock shared their observation on the suitability of soil condition, harvesting time, seed rate, fertilizer and irrigation requirements, yield and nutritional value of Mott grass. The availability of green fodder through Mott grass during lean periods is expected to improve farmer's profitability through increase in milk production.

Mr. Abdul Hameed, is a progressive dairy farmer and a participant of the trial, shared observations of adlib water supply and balanced feeding on milk productivity.

Figure 1 Demonstration of adlib water, balanced feeding and Mott grass in Chella village of district Jhang, Punjab province

1.1.1.1.2. Farmer's days on the importance of adlib water availability and balanced feeding on milk production in District Bahawalnagar

On-farm trials were conducted by involving 17 progressive dairy farmers from the district Bahawalnagar at two villages' 67-4-R tehsil Haroonabad and Ahata Mukhian tehsil Bahawalnagar to demonstrate the importance of adlib water availability and balanced feeding on milk production.

As a follow-up, two farmers' field days were organized to create awareness on the impacts of adlib water availability and balanced feeding on milk production. On August 5, in 67-4-R village farmer's field day, 130 farmers from nearby villages namely 28/3-R, 68/4-R, 70/4-R and 37/4-R actively participated in the event.

Figure 2 Demonstration of adlib water and balanced feeding in 67-4-R

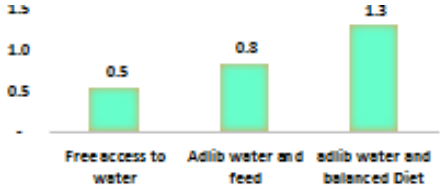
On August 6, a similar field was held in village Ahata Mukhian. A total of 140 farmers including farmer of nearby villages namely Noor Sar and Chak Abdulhah participated in the event. Farmers were interested for having information on the importance of water for milk production and the need for balanced feeding. The AIP-ILRI team explained that 85% of the milk constitutes of water and this has to be supplied mainly via drinking water, and also a proper balance of energy and protein in feed is required for maximizing milk production. The farmers appreciated the responses and realized the need to provide free access to drinking water for their milking animals.

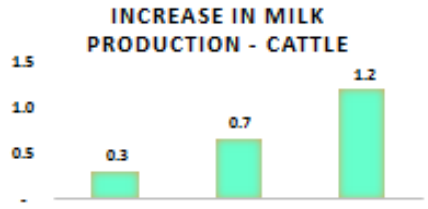
Fact sheets on improved management practices, feeding and breeding strategies, preventive animal health and disease control developed in local language, and these were distributed among 17 farmers, participated in the trials. The fact sheet on the importance of water and milk production increase were distributed to the 270 participants at both sites. Through these fact sheets, AIP-ILRI will continue to help the farmers to improve livestock management on scientific basis.

Figure 3 Demonstration of adlib water and balanced feeding in Ahata Mukhian

In four villages (Chella, 166-JB, Ahata Mukhiaan, 28/3 R) the trials with 49 milking cows carried out, indicate that providing only adlib water and balanced feeding can increase the daily milk production from 0.25 to 1.2 liter/animal. On an average each farmer has three to four milking animals, and this practice can increase dairy farmer's income from US$ 0.43 to 2.08 per day. This will result in improving their annual household income from US$157 to US$759.

According to Livestock Census (Government of Pakistan, 2006) there were ten million milking cows (4 m) and buffaloes (6 m).If we assume 5 million are offered adlib water and balanced feeding, then the estimated revenue can be generated in Punjab province is given below in figure .





	per animal (L/day)	million cows in milk (million L/day)	revenue at province level (million Rs./day)
Adlib water	0.250	1.25	50 (US$0.48)
Adlib water and feed	0.700	3.5	140 (US$1.35)
Adlib water and balanced feed	1.2	6.0	240 (US$2.31)

Figure 4 Monetary benefits of adlib and balanced feed supply

1.1.1.1.3. Volunteer Farmer Dairy Model Training Farms established for sustainable livestock production

Appropriate animal housing is the basic need for excellent health and sustainable animal production which leads to improve rural livelihood. Currently, the existing infrastructure prevailing in the project villages lack sanitation, critical elements for clean milk production, colossal feed wastage and limited access to drinking water to the animals.

AIP-livestock plans to establish three to five model training farms equipped with improved housing, resulting in better (quantity and quality) milk production. In Bahawalnagar and Jhang district of Punjab province, four villages namely Chella, Ahata Mukhiaan, 28/3 R and Noor Sar were selected for model training farms.

Figure 5 Construction of Model farms in district Bahawalnagar

In the first phase, AIP-Livestock team identified 10-15 potential farmers and collected their detailed information using a structured questionnaire. 3-5 farms in each village were selected based on the criteria including attitude, behavior, willing to work in team, provision of access to other farmers, existing physical infrastructure etc. The construction of model farms initiated in May 2015 and is still in progress at some locations and expected to be complete in next quarter

Before After

Figure 6 Construction of Model farms in district Jhang

More than 1000 other dairy farmers in various project villages were directly able to access the model training farms.
The detail list of the model farms that have been completed in different villages in the Appendix 1.

1.1.1.1.4. Improved Forage Seed Distribution to Ensure Fodder Availability

In the focused group discussions held at Bahawalnagar district of Punjab province and Kotli in AJK, the dairy farmers identified the problem of fodder shortage during the lean periods.
AIP-Livestock distributed improved quality fodder seeds including multi-cut forage sorghum, Rhodes grass, Mott grass, cluster bean and stay green maize to farmers to enhance green fodder supply in the study areas.
The involvement of village based seed enterprises in this activity ensured the timely availability of improve variety of seeds within village for all the dairy farmers and viable economic returns. The detail of seed distribution beneficiaries is given Appendix 2.

1.1.1.1.5. Foot & Mouth Disease (FMD) – Awareness and Prevention Campaign

Foot-and-mouth disease (FMD) in small and large ruminants is spread by direct contact with affected animals. The virus may spread by aerosol depending on environmental temperature and humidity. Animals may also become infected from eating (oral) contaminated feed or by contact with contaminated objects. FMD virus can be carried on clothes, shoes, vehicles and even in the nasal passages of people that have had contact with infected animals. The incubation period for foot-and-mouth disease virus has a range between one and 12 days. The disease is characterized by high fever that declines rapidly after two or three days, blisters inside the mouth that lead to excessive secretion of stringy or foamy saliva and to drooling, and blisters on the feet that may rupture and cause lameness. Adult animals may suffer weight loss from which they do not recover for several months, as well as swelling in the testicles of mature males, and in cows, milk production can decline significantly. Though most animals eventually recover from FMD, the disease can lead to myocarditis (inflammation of the heart muscle) and death, especially in newborn animals. Some infected ruminants remain asymptomatic carriers, but they nonetheless carry FMD and may be able to transmit it to others. Thus, resulting in decrease in milk production in milking animals and economic loss.
In 2014. FMD affected 30-40% of the large ruminants in the dairy VC operational villages in Jhang and Bahawalnagar districts.
In the project villages, the death rate of FMD affected calves below 5 months

of age was above 80 % and was 60 % in 5-12 months old calves. Farmers also claimed that last year due to FMD, milk production of the affected animals reduced 75-90 %. Some farmers claim that last year on an average they lost about PKRs 100,000 (US$ 1000) due to FMD.

In March 2015, AIP-Livestock, with the assistance of the provincial livestock line departments, conducted FMD awareness and successfully vaccinated all large ruminants in all six project dairy villages include Chella, 166 JB, 28-3 RAhta Mukian, Noor Sar, 167-R. AIP obtained the vaccine from FAO on a cost sharing basis and vaccinated 7,594 animals including 4,071 cattle and 3,523 buffaloes owned by 890 farmers. The first dose was given in March and booster dose in April and third booster dose will be given in mid-October. AIP-Livestock team is continuously monitoring FMD situation in all of study villages and as of today no case of FMD has been reported. This helps to gain farmers confidence, credibility and the farmers are highly receptive to interventions.

1.1.1.1.6. Baseline Survey to assess the challenges and opportunities in the dairy sector

A bench survey to assess the socioeconomic factors, input-output of dairy sector, small ruminant, rangelands and market aspects was conducted in selected seven villages in Punjab province in April. Chakwal and Bahawalpur districts were selected as small ruminant site whereas district Jhang and Bahawalnagar were selected as large ruminant site. However, data was collected both for small and large ruminants for comparison at all the sites. In total information from 227 dairy farmers were interviewed. The detail of respondents from each village is given in the Appendix 3.

The survey revealed that:

- In large ruminant sites livestock farmer have local and exotic (cattle) animal in higher proportion than in small ruminant sites but small ruminant sites have slightly higher number of cross breed cattle in their herds, implying that local and exotic breed are more popular in large ruminant sites.
- Natural breeding both in cattle and buffalo from own bull is less than 10% at both sites. Data revealed that natural breeding either from own bull or from some other sources is significantly higher in buffalo than in cattle at all study sites.
- The success of artificial insemination (AI) in small ruminant site is 77.8% in first heating period as compared to 67.9% in large ruminant site. This also implies that cost of breeding in large ruminant site is higher mainly due to low success rate and availing higher number of attempts to get success.
- At both areas 65% respondents strongly agree that intake of water effects milk productivity
- Stall feeding is a dominant feeding system at both sites and also in all types of breeds of cattle and buffalo across the seasons. This is mainly due to dominancy of tie system (neck and/or leg) and structure of housing due to limited space.
- Analysis demonstrate that livestock farmers are preferring village at 64.3% and city at 53.3% market for concentrate feeds both in large and small ruminant site, respectively.
- More than 20% farmers reported death of animals annually from diseases at both project sites results in a major economic loss which ranges from PKR 20,000 to 50,000 per farmer.
- A noticeable proportion of female farmers have complete control on livestock income in large ruminant 15.8% and small 17.4% ruminant sites, respectively.
- Slightly higher than 1% farmers have access to extension services either from AI, feed supplier or from some technician.

1.1.1.2. Small Ruminant Value Chain Development

1.1.1.2.1. Multi-stakeholder meetings to discuss the findings of Small Ruminant Value Chain Rapid Assessment and to explore the possible interventions

A two day consultative meeting was organized in Islamabad by ICARDA, ILRI and the Social Science Research Institute (SSRI) from 11-12 May. The objective of the meeting was to discuss the findings of small ruminant value chain-rapid assessment. The findings of the rapid assessment studies were shared and the possible best bet interventions in small ruminant value chain were explored. The meeting was attended by subject experts of small ruminants, feed, fodder and rangelands from PARC, NARC, three universities and extension services of Punjab and Balochistan provinces.

Figure 7 Inaugural session of the consultative meeting held in Islamabad

1.1.1.2.2. Training on Livestock Management Practices for extension workers from Balochistan

Among the major constraints identified in small ruminant production is lack of knowledge on proper livestock management practices and health care. Capacity development need attention at grass root levels. Extension workers are the main linkages between farmers and officials. While learning recent advances in animal production, they can play a tremendous role for improving the existing livestock production practices and improve livelihood of smallholder farmers.

AIP-Livestock in partnership with ICARDA and the Livestock Department Balochistan conducted a training on livestock management practices on June 3-6, 2015 held at the Animal Sciences Institute (ASI), Livestock Department, Quetta, Balochistan province.

The training was focused on low cost appropriate animal housing, feeding, reproduction management, preventive health care and disease control of small ruminants. A total of 75 participants included four women atteneded the training. These participants were extensions workers/ livestock assistants, from six districts of Balochistan namely Pishin, Loralai, Mastung, Rakhni, Khuzdar and Quetta. The training objective was to enhance the technical knowledge of the participants on improved and advance small ruminant's production and to develop linkages of the extension workers with highly technical animal production manpower. The training also focused on the recent advances on animal housing, feeding, reproduction management and health care related to Balochistan agro ecologies.

Figure 8 Glimpse of the training on livestock management practices held in Balochistan province

1.1.1.2.3. Construction of Model Farms

Construction of volunteer farmer model farm on cost sharing (50% by farmers) basis for small ruminant was implemented initially in two villages namely Begal and Dhulli in Chakwal district, Punjab province. This will also be used as field school to extend awareness (housing, feeding, and watering) among other farmers in the village.

Figure 9 Existing animal shed and new model farm under construction at Dhulli

1.1.1.2.4. Lambs/ kids fattening for higher economic return

The fattening production potential of native lambs/ kids for Eid-ul-Azha was assessed at Punjab and Balochistan provinces. Five farmers owned 60 male Shinwar breed lambs from Ahmadun, Quetta, Balochistan province and four farmers owned 30 male mainly beetal breed kids and 16 male Kaghani cross lambs from Chakwal, Punjab province were involved in the fattening experiment (Fig below). All animals were divided into sub-groups and offered five different ration formulations (Appendix 4).

All the lambs/ kids were ear tagged, drenched against internal parasites and vaccinated against Enterotoxaemia. Before the start of experiment all the selected animals were kept off-feed/ water for 12 hours followed by concentrated rations at 500g per animal for 3 days for adoptability. Afterward this ration offered at 1Kg/ day for 30 days (Fig below). Data regarding fortnightly weight gain analyzed at the end of the experiment. The weight gain of lambs/ kids fed the different rations are presented in Appendix 5.

Figure 10 Formulation of experimental rations

The group B lambs at Quetta, fed with ration T2 showed higher average live-weight gain at 2.09Kg followed by group A, fed with T1 at 1.22 kg, while control/ grazing group decreased weight by 0.3 kg. The low live weight gain may be due to low availability of fresh biomass in rangeland.

Comparatively the lambs at Chakwal showed higher weight gain than at Quetta due to higher feed/ fodder availability. At this site, lambs in group A, showed higher live-weight gain at 5.44Kg followed by group B at 4.07Kg and C at 3.81Kg compared with control group at 1.25Kg. The kids in three groups also showed similar increases at Chakwal site.

The sale of fattened lambs/ kids at Eid-ul-Azha returned an average profit of Rs. 7,000/animal that also reached up to Rs. 23,000 fed with different rations. The farmers received profit on each Rupee invested was 0.5 from this fattening operation at Chakwal site. The average profit was lower at Ahmadun site with an average of Rs. 6,000 and profit on each Rupee invested was 0.3. Later these results were shared with fellow farmers at all sites to motivate them to use proper feed for fattening purpose.

1.1.1.2.5. Peste des-Petits Ruminants (PPR) Awareness and Control in Pakistan in Collaboration with FAO

The Peste des-Petits Ruminants (PPR) awareness and control training program was launched at Ahmadun, Ziarat in Balochistan province on August 11-12, 2015, by AIP-Livestock in collaboration with FAO. The farmers were briefed about the clinical signs, diagnosis, prevention of PPR with the help of pictorial presentation and distribution of booklets in local language (Fig below). This event was attended by 51 farmers and 12 officials from Livestock and Forest Department, Balochistan.

Total16 farmers participated in the immunizations program launched against PPR at Ahmadun in Balochistan province. Blood samples of 95 animals prior to PPR vaccination were collected and handed over to FAO for testing PPR titer.

The results confirmed 51.6% animals were positive with PPR virus. However, apparently all the animals were found healthy. Subsequently on August 12-13, 3500 small ruminants including 1096 sheep and 2404 goats owned by 62 farmers were vaccinated against PPR vaccine, strain Nig. 75/1 manufactured by Jordan Bio-industries Center; obtained from FAO, Islamabad.

Figure 11 Awareness program on prevention and vaccination against PPR at Ahmadun, Ziarat

AIP in partnership with FAO, PPR project conducted the PPR awareness program and vaccinated 2500 animals in both villages of Chakwal i.e. Dhulli and Beghal in February 2015. According to farmers' feedback, no PPR clinical symptoms or deaths in animals were reported. In Pakistan, PPR reported with morbidity and mortality rates of 65% and 26%, respectively. Thus, PPR vaccination has saved more than 650 animals, which in monitory terms amounts to about Rs. 9,750,000.

1.1.1.2.6. Manual for Nachi goat breed in Pakistan

AIP-Livestock, in collaboration with University of Agriculture, Faisalabad, is developing a judging and selection manual for Nachi goat bread. This is a unique indigenous goat's breed in Pakistan. The manual will promote conservation and improved utilization of this unique genetic resource. It will serve as a tool for breeders for classifying the beauty standards of this breed and will help the breeders to structurally select correct bucks and does.

1.1.1.2.7. Caprice Mastitis

AIP-Livestock in collaboration with University of Agriculture, Faisalabad is developing standard protocols for milk testing with the aim of developing a vaccine for control of mastitis in goats.

In large ruminants the losses are well documented, however, information on mastitis in goats is scanty. Pakistan has a huge goat population with goat breeds having adequate milk production potential under low input production system. Studies undertaken at University of Agriculture, Faisalabad, indicates that mastitis is prevalent in goat breeds, such as Faisalabadi Beetal, Makhi Cheeni Beetal and Diara Din Panah, with high milk production.

1.1.1.2.8. Capacity Building Training

On September 14-17, 2015, a training on the use of compiled feeding tables for balance ration formulation for small ruminant's production was organized by AIP-Livestock, in partnership with ICARDA and Provincial Livestock Department, Balochistan. A total of 25 staff members including two women from livestock department attended the training from three districts of Balochistan province namely Pishin, Mastung, and Quetta. The training enhanced their technical knowledge and provided a platform to establish linkages between the stakeholders.

Figure 12 Training on the use of compiled feeding tables for balance ration formulation for small ruminant's production held in Balochistan province

Another training on value chain-rapid assessment of small ruminant was organized on September 15-16, 2015 at Quetta. A total of 40 participants from provincial livestock department Balochistan, Sardar Bahadur Khan Women's University**,** Forest department, FAO**,** Center for Advanced Studies in Vaccinology & Biotechnology (CASVAB) and University of Balochistan, participated in the training. Training will help in developing skills of the participants to further help in value chain assessment of small ruminant.

Figure 13 Training on small ruminant value chain-rapid assessment

1.1.1.2.9. Snapshot Survey to identify the challenges by dairy farmers in Balochistan, Sindh, AJK and Gilgit Baltistan

Snapshot surveys were conducted to identify the challenges faced by farmers in dairy value chain in Balochistan and Sindh provinces and AJK, Gilgit Baltistan regions. Based on the results the best-bet interventions related to management and input-output supply constraints will be introduced by AIP. The survey was carried out on 465 respondents (the location wise distribution in appendix 6).

Figure 14 Indicating existing problems related to roofing, flooring and balanced feeding

It was observed that free access to drinking water to animals could be one of the leading factors to improve milk productivity without spending any additional resources. Dairy farmer's management practices could be improved by AIP-Livestock through farmer participatory trials. However, impact of balanced ration supply to milking animals, paved floor with proper drainage facilities and

improvement of immunization through vaccines on milk productivity needs to be quantified through farmer's participatory approach.

Figure 15 Snapshot survey in different provinces is in progress

The following general observations were extracted from the collected data:

- Less than 5% of the farmers have proper housing facilities (feed manger, proper water trough, proper flooring, roofing, milking area, calf pens), leading to poor hygienic conditions, restricted access to water, feed wastage, resulting in both low milk production and milk quality.
- 10-15% of the dairy farmers are landless and rely heavily on purchased feeds (forages & concentrates) and the situation is aggravated due to the shortage of forage feed supply in summer in Sindh province and in winter season in Balochistan province and AJK and Gilgit Baltistan regions.
- 95% of the farmers practice intensive system of management where animals are kept tethered (neck or legs). 100% of the dairy farmers feed water once or twice a day and are unaware of the importance of water for milk production. Milk constitute 85% water which has to be supplied daily either via feed consumed or drinking water, hence farmer collaborated trails and awareness campaigns on importance of unrestricted availability to dairy animals needs to be undertaken.

1.1.1.3. Range, Fodder and Feed

1.1.1.3.1. Farmers field day on improved varieties of fodder at Dhulli in Punjab province

A Farmer's field day to demonstrate improved varieties of fodder was organized by AIP-Livestock, in partnership with the ICARDA, Rangeland Research Institute and Fodder Program, Crop Sciences Institute and NARC, on April 11, 2015 at Dhulli in Chakwal District, Punjab province. The participants visited plots of improved varieties of fodder namely oats, alfalfa and Mott grass. The demonstration also showed improved varieties of NARC hybrid canola, wheat including: NARC 2009, Pakistan 2013 and BARI varieties: Chakwal 50 and Dharabi, planted for seed multiplication to disseminate seeds among other farmers. Total 70 participants including policy makers, scientists and farmers attended the field day. Progressive farmers of adjacent villages and local farmers also participated in this event.

Figure 16 Introduction of PARC Hybrid Canola, high yielding vanities of Alfalfa and Mott grass

Figure 17 Improved wheat varieties of NARC and BARI at Dhulli for having good quality of straw

The rangeland activities initiated on more than 50 acres demonstrating controlled grazing and technologies including like silvo-pastoral plantation of ipil ipil and palatable grasses as winter feed. The introduction of spineless cactus namely *Opuntia ficus-indica* (L.) in fields also attracted the participants.

Figure 18 Capturing rangeland activities

1.1.1.3.2. Demonstrations of Improved Maize Varieties Under Irrigated and Rainfed Conditions in Chakwal District of Punjab Province

In Pakistan, maize is extensively used as animal feed for its high net energy and low fiber content. Major factors limiting the yield includes lack of knowledge, insufficient input use both due to unavailability and financial constraints, inappropriate agronomic practices, and unavailability of improved seed.

AIP-Livestock introduced improved maize variety S-2002 for green fodder on farmers' fields. Free of cost seed was distributed among 17 farmers from rainfed and irrigated lands in Chakwal district of Punjab province.

Figure 19 Maize planation under irrigated (a) and rainfed condition (b)

A comparison of biomass was made between locations and across varieties. Shortly before farmers start cutting maize, biomass of green fodder is determined for all varieties at tassel form, i.e. the time of 50% flowering stage. At this stage, maize is partially matured, its nutritive value is high and taste is preferred by the animals. It is observed that green biomass production is significantly higher at 80 tons ha^{-1} and 23 tons $ha^{-1}$of improved maize variety compared to traditional variety which is at 45 tons ha^{-1} and 18 tons ha^{-1} at both in Dhulli and Begal in Chakwal district in Punjab province, respectively (Figure below). However, production of both local and improved varieties was low at Begal as compared to Dhulli which falls in low and medium rainfall conditions, respectively. High biomass under low rainfall condition was mainly because it has continuous irrigation water supply from ponds while in Begal maize crop completely depends on soil moisture due to rain.

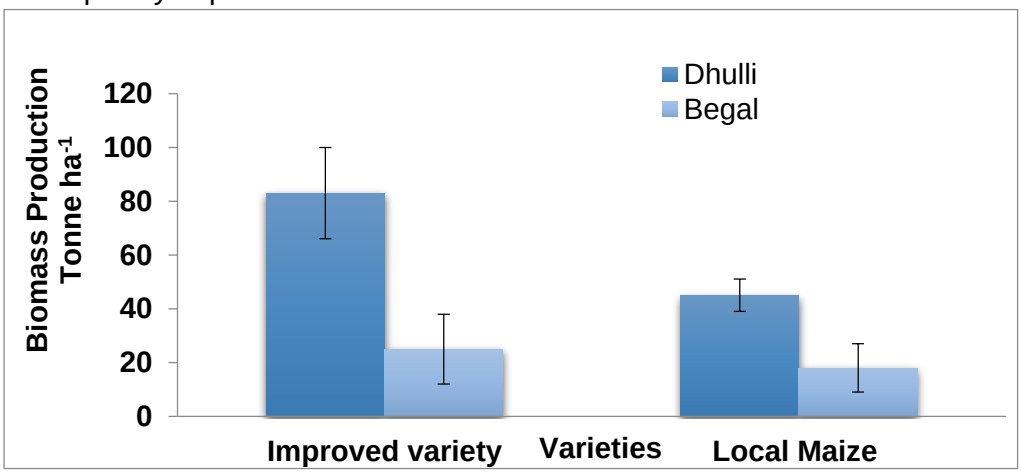


Figure 20 Comparison of biomass production for improved and local Maize varieties at Dhulli and Begal

1.1.1.3.3. Introduction of Alfalfa and Mott grass to provide green fodder in lean periods

More than 16% of the total cropped area in Pakistan is annually planted with fodder crops. To improve the livestock's productivity, it is important to overcome scarcity of green fodder during lean periods i.e. May-June and October-November. Alfalfa is a highly palatable legume fodder that has been grown as livestock feed under irrigated condition. It is valued for its high nutritional quality as it is a rich in protein, essential vitamins, and minerals. Under AIP-Livestock, seed of alfalfa variety Sgd Lucerne was introduced and seed was distributed among nine and four farmers in Begal and Dhulli in Chakwal district of Punjab province, respectively. The area under this variety in Begal and Dhulli was 6.3 acres and 3 acres, respectively.

At both the villages, first time Mott grass also known as *Pennisetum purpureum* has been introduced as new forage which has a potential to provide good quantities of biomass per unit area through multiple cuts. The main objective of this planation was to assure the continuous supply of green fodder during lean periods. Mott grass seed was distributed among two farmers in each village and is cultivated on four acres in each village.

Figure 21 Plots of Alfalfa and Mott grass in Dhulli and Begal village of Chakwal

In three months from April to June, alfalfa produced 86 t ha^{-1} green biomass while Mott grass produced 69 t ha^{-1} green biomass (Figure below). In both villages the farmers were utilizing alfalfa as green fodder for large ruminates for both time and to small ruminants in the evening as a supplemental feed. However, it will be quite interesting to quantify the effect of additional fodder supply on milk productivity. The cultivation of these fodders will be extended to other farmers' fields through demonstration to improve livestock productivity and thereby farmers' income.

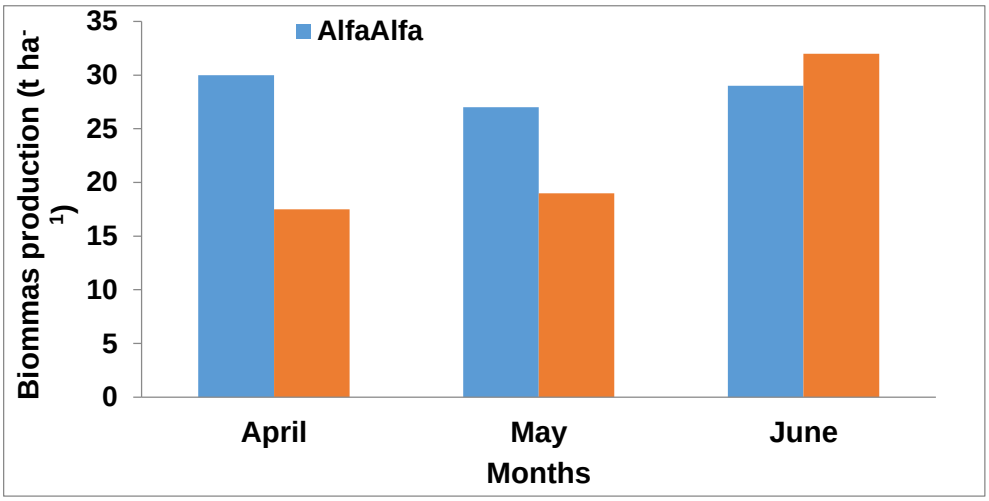


Figure 22 Green biomass production of Alfalfa and Mott grass

1.1.1.3.4. Promotion of improved cereal varieties with increased nutritional value of residues through Village Based Seed Enterprises

.

AIP-Livestock in partnership with ICARDA and National Agricultural Research Center (NARC) distributed improved varieties of wheat, oat and barley seed to progressive farmers in Dhulli and Begal villages in Chakwal district in Punjab

province. This activity was done to initiate village based seed enterprises. The NARS scientists continuously supervised the farmers in relation to management and agronomic practices for quality control. In seed multiplication trials at Dhulli, pre planting irrigation was done at sowing time in order to obtain uniform establishment while at Begal the planting was done in the conserved moisture which was attained from the monsoon rain and water runoff in the field.

Figure 23 NARC Oat variety planted at Begal and Oat Seed Production plot at Dhulli

Planting of NARC Oat was done in mid-November 2014 at the fields of three progressive farmers. Introduced Village Based Seed Enterprise (VBSE) in the target sites and trained farmers for informal seed production of NARC-Oat and wheat varieties including Chawkal-50, Dharabi and NARC-2013. At Begal, one farmer has sold 1.7 tons of oat seed at Rs. 47.50/Kg which is more than Rs. 73,000 (US$ 730) in total, 0.9 tons Barley seed at Rs. 35/Kg which is Rs. 28,500 (US$285). His total household income has improved by 20%. At Dhulli one farmer has sold 1 ton oat seed at Rs. 60/Kg having income of Rs. 54,431 ($544). The farmers will sell the improved varieties of wheat at the end of October 2015.

During the seed production process at village based enterprise it is observed that performance depends on skills, farmers' management capacity, technical support and funding from the public sector. AIP-Livestock will attempt to establish link between producers and seed traders to make Chakwal a successful story of seed enterprise.

1.1.1.3.5. Effect of rotational grazing on rangeland and livestock productivity in the arid/ semi-arid areas of Pakistan.

The gross rangeland area is 34.72 million ha in Balochistan province which is 78.9% of the total area. The productivity of rangelands is a dynamic attribute and varies greatly depending on climatic conditions specially low and high rainfall seasons, human management i.e. community participation and defining property right of these resources. Under AIP-Livestock, in March 2015 a plan was developed to rehabilitate the existing rangeland of Chakwal district in Punjab province and Balochistan province through community participation. The initiative was taken to educate the farmers on grazing management to improve their livelihood. Improved fodder varieties were introduced in Dhulli and Begal in Chakwal district. The Forest and Wild Life Department and local herders are being involved province to replicate similar activities in Balochistan. Since the protection of a rangeland area in Chakwal from grazing in September 2014, the biomass production was monitored. Vegetation sampling was conducted in May and August 2015 at both research sites. The 100 meter line transect method was used to estimate cover and species composition at an interval of 10 meters. The biomass was estimated using the $1m^2$ quadrate. All the species were clipped at stubble height. The palatable species were separated and weighed again to find out their proportion in the overall biomass. Samples were dried in oven for 24 hours at 80^oC and weighed again for dry

matter.

The data revealed that in May 2015 after winter rains (Fig below) the total biomass in protected area was 774 and 669 kg ha^{-1} and in the unprotected area 350 and 286 kg ha^{-1} at Dhulli and Begal sites, respectively. Biomass was measured again in August during monsoon and found that the total biomass in protected area was 1476 and 780 kg ha^{-1} and in the unprotected area 480 and 310 kg ha^{-1} at Dhulli and Begal sites, respectively.

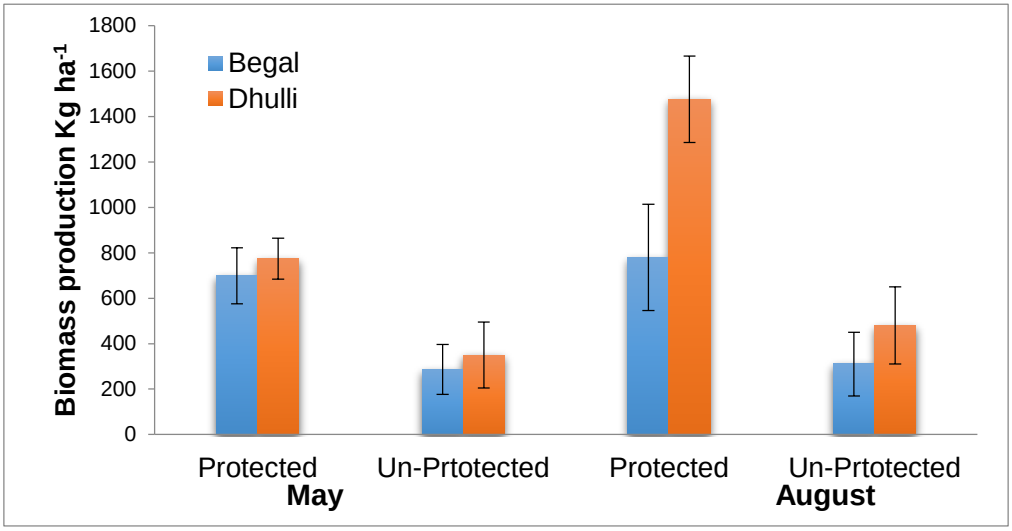


Figure 24 Comparison of vegetation biomass in protected and unprotected rangelands at Dhulli and Begal sites during May and August 2015

1.1.1.3.6. Impact of rotational grazing on animal weight in Chakwal

In Chakwal district of Punjab province, experiment to assess the impact of rotational grazing on animal weight was carried out at two sites; at medium rainfall zone in Begal and at low rainfall zone of Dhulli. At both the sites, the protected area from last year were divided into three blocks of 8 ha each. The stocking density was kept six small ruminants per ha for both sites. The animals were dewormed and tagged and were allowed to graze in block 1 for 8 hours for 10 days. Then the animals were moved to block 2 for the same period of time and lastly to block 3. Live weight gains were recorded regularly before shifting across the pasture blocks. Besides the rotational grazing blocks, a parallel control group of animals were also kept and monitored on un-protected area grazing at each site. The live-weight gain data of these two groups were compared.

Figure 25 Reflecting deworming of animals, tagging and grazing in the field

Before monsoon, i.e. mid July, in protected area, it was observed after 10 days average increase in daily weight was 30.0-84.5g/ animal while in un-protected area average daily weight varied from -16.5 to 50.8 g/animal (Appendix 7). After monsoon i.e. September, the biomass has almost doubled and now stocking density is maintained at 16 animals/ ha and the experiment is underway.

1.1.1.3.7. Cactus (Opuntia ficus indica) Plantations

In continuation of cactus planation in Chakwal during the reporting period cactus has been planted on more than 20 acres owned by to eight farmers. Before plantation of cactus, land was ploughed and farm yard manure (FYM) was properly mixed. In the first week of May, single cactus pads were planted at a distance of 1x1m and the distance between rows was 2 meter. After planting, each pad was irrigated with approximately 10 liter water. Trials on cactus feeding is planned to show the farmers about cactus utilization as animal feed.

Figure 26 Cactus planation as crop (a) and planation on marginal lands (b)

1.1.1.3.8. Conservation of Rangeland Resources in Balochistan Province

In April 2015, AIP- Livestock held discussions on conservation and utilization of the rangeland resources in Balochistan province with provincial ministry and the Forest Department and Livestock Departments. These discussions led to the allocation of land in Ahmadun, Ziarat for rehabilitation of rangeland trials.

The situation in Ahmadun warrants to exercise grazing management through active participation of the local communities. Moreover, the local communities should be encouraged to improve the condition of their rangelands through sowing and planting of forage species with water harvesting techniques. In this way, local rangeland stakeholders will be demonstrated on forage availability to livestock and rehabilitation of rangeland areas. The main objective of this activity was conservation and utilization of the rangeland resources by introducing improved management practices, increased production and incomes, and human resource development.

In this regard, 50-hectare demonstration site was prepared to demonstrate a water harvesting configurations for shrub planting. Crescent-shaped micro-catchments were developed on land slopes of 1-8% with variable soil depth except shallow soils.

1.1.1.3.9. Establishment of Stock Water Pond in Balochistan Province

In arid areas, surface water is the main source of water for purely pastoral livestock. In rainy seasons, precipitation over limited catchment basins runs off and concentrates in natural ponds where the soils are sufficiently impervious to prevent leaking. Most of these ponds dry out a few weeks after the end of

the rainy season due to the combined effect of evaporation and seepage. Keeping in view of above issues, two stock water ponds were established at Ahmadun, Ziarat, in Balochistan province (Fig 27). Each pond has the capacity to store 13,160 ft^3 (372.42 m^3) water. The main purpose of surface water development was to increase the storage capacity of stock water ponds to extend their period of utilization, and to create reservoirs for better the rangeland resources.

Figure 27 Stock water pond at Ahmadun, Ziarat

Also with the consensus of the community, *Atriplex lentiforms* and *Acacia victoria* were chosen for introduction to the site (Fig 28).

Figure 28 Rehabilitation of rangeland with Atriplex lentiforms and Acacia victoria

1.1.1.3.10. Seminar on Rangeland Management in Pakistan

A seminar on rangeland management in Pakistan, was held at Bahudin Zakariya University Multan in Punjab province on April 29-30, 2015, organized AIP-Livestock in partnership with ICARDA, PARC and Rangeland Research Institute of NARC. This seminar focused on the current status, potential and opportunities in rangelands and solutions for possible improvement. The seminar was attended by 130 participants including 57 women belonging to line departments, NGO, universities teachers and rangeland/ forestry students. The objective of the seminar was to present and discuss the state of rangeland ecosystems and its services in each province and to identify research, policy and capacity gaps in managing rangeland ecosystem goods and services for local livelihoods, nutrition and food security.

Figure 29 inaugural session of the rangeland symposium

1.1.2. Vegetables

1.1.2.1. Protected Cultivation of Vegetables

1.1.2.1.1. Identify and Promote the Best Varieties of Crops Commonly Grown under Protected Cultivation

In Pakistan, the varietal development process is relatively very slow due to lack of germplasm, the capacity of the local public sector research institutes and the focus of the private seed sector on seed trading rather than breeding. The farming community largely depends on old varieties and imported commercial hybrids, which are being used on-farm without adequate evaluation. AIP-Vegetables is working on variety improvement and on-farm performance appraisals. Advanced lines, were imported from AVRDC, Taiwan, are being tested on station and on-farm across Pakistan. After adaptability trails and selection process farmers will have wider choice of varieties. The varietal trial work is being done in three ways: (a) On-station validation trials under protected cultivation in Pakistan and India, (b) On-farm validation trials under protected cultivation in Pakistan, and (c) Natural off-season open field trials across Pakistan. In the latter case, such crops are grown in frost-free areas and could directly compete with crops grown under protected cultivation. It is important to understand the yield potential of both systems in order to assess their relative economics.

The crops chosen for study have now been narrowed down to tomato, cucumber, sweet pepper, chilli, bitter gourd and vegetable marrow following the first year of trials, more feedback from farmers and expanded trials being conducted by Punjab Agriculture University (PAU), Ludhiana.

1.1.2.1.1.1. On Station Validation Trials

Advanced lines of tomato, pepper, onion and bitter gourd was provided by AVRDC headquarter to AIP for testing, which were distributed across Pakistan (Appendix 8)

1.1.2.1.1.1.1. Tomato

Protected cultivation of tomato between October and May is losing popularity in Pakistan because of narrow choice of commercial hybrids, timely availability, relatively high cost of imported hybrid seed and initial cost of the structures. AIP-Vegetables is providing technical and financial assistance to commercialize low cost improved public sector hybrid lines. A total of 14 determinate public advance lines/ hybrids were evaluated with two checks namely commercial hybrid T-1359 and the variety Naqeeb under walk-in tunnels at the VRI, Faisalabad. The yields of three hybrids namely AUT-318 at 39.6 t/ha, AUT-305 at 36.7

t/ha and AUT-309 at 36.5 t/ha) were statistically significantly higher than the top yielding commercial check: T-1359 (32.3 t /ha) and the variety Naqeeb (18.9 t/ha). These findings will be validated on-station during the spring, 2016. In another multi-location study 10 public institute's hybrids/ varieties including four from NIAB, Faisalabad with two checks were evaluated by VRI, Faisalabad at three sub-stations in district Sheikhupura, Faisalabad and Multan. The top performing hybrids at all three sites were NBH-2, NBH-25, NBH-7 and NBH-3 and results confirm those found in multi-location trials in 2014.

- Faisalabad: Yields of 24.6 to 28.6 t/ha compared to the local check Naqeeb (17.1 t/ha).
- Sheikhupura: Yields of 22.8 to 26.0 t/ha compared to the check T-1359 (18.1 t/ha).
- Multan: Yields of 21.7 to 25.1 t/ha compared to checks T-1359 (19.1 t/ha) and Naqeeb (17.5 t/ha).

Further testing in farmers' fields for two more years of these public sector hybrids is needed before it goes for Variety Evaluation Committee (VEC) or Provincial Seed Council. Selection of these public sector hybrids will benefit farmers with pure and cheap source of hybrid seed.

1.1.2.1.1.1.2. Chilli

Protected cultivation of green Chili has recently become popular due to its market demand in Punjab province, and commercially available Chili cultivars/hybrids need to be screened for their performance under plasticulture growing conditions. In 2014 seventeen chili varieties / hybrids along with the local check (P-6) were evaluated under plastic tunnels at the Vegetable Research Institute, Faisalabad. Advanta 623 F1 was the top yielder with a fresh green fruit yield of 46.8 t/ha, followed by "Hot-708" and "Hot-711" with yields of 41.5 and 41.1 t/ha, respectively. Of the 17 lines tested only eight were selected for further evaluation in 2015 and these were planted at ARI, Mingora-Swat. Chili 06 was the top performer with 23.5 t/ha, followed by Chili-01 (21.7 t/ha) and these will be further evaluated in the coming spring.

Advanced international lines of chili are also being evaluated. This year 15 advanced chili lines are being tested at the National Agricultural Research Center, Islamabad. Out of 21 accessions of chilies / sweet pepper received from AVRDC, only 15 (11 hot and 3 sweet pepper) germinated. These were sown in November 2014 under cover, transplanted in the open field during late March 2015 and then covered in an isolation tunnel prior to flowering. There were not enough seed for a replicated trial, so plants were grown for seed multiplication and to record morphological data on fruit length, width, weight and pungency. Selfing of plants was done, off type plants were rouged out and seed from true to type plants were retained for planting in next spring season.

1.1.2.1.1.1.3. Sweet Pepper

Sweet pepper cultivation is gaining popularity in Pakistan. Colored varieties of capsicums are widely grown under protected cultivation and harvested at the immature green stage. There is need to introduce those varieties/hybrids that are meant to be harvested green to increase the yields of the crop. Five hybrids / varieties which includes Coral,

Alina, Super Globe, Capino and Astra-II were evaluated under tunnels at the Vegetable Research Institute, Faisalabad. The maximum fresh green fruit yield of 28.9 t/ha was attained by Coral, followed by Alina and Super Globe with yields of 28.3 and 25.3 t/ha, respectively. Super Globe showed susceptibility to root rot. These findings will be validated for high yield and good quality in the next spring season.

1.1.2.1.1.1.4. Onion

Onions are widely grown in Pakistan, but only five local varieties (Phulkara, Nasarpuri, Chiltan-89, Saryab Red and Swat-1) have been the mainstays of the local consumption and export for many years. Producing onion seed takes two seasons. Seed of 10 AVRDC advanced onion lines which includes AVON 1073, AVON 1301, AVON 1013 AVON 1037, AVON 1028, AVON 1027, AVON 1067, AVON 1016, AVON 1056 and AVON 1014 were received from AVRDC HQs Taiwan and planted in December 2013 in the vegetable area, NARC, Islamabad. Seeds were germinated in an incubator and seedlings were transplanted into the field in March 2014 for bulb production along with three locally cultivated onion varieties; Swat-1, Phulkara and Dark Red. Bulbs were small (30-40 g) due to the short growing period, only 10 to 60 plants were harvested from each entry in June, 2014. These were replanted in the field under cloth cages to prevent cross pollination in October, 2014. Honey bees were introduced in each cage to assist with pollination, but only a small quantity of seed (2-4 g) was produced, as bees in these cages did not work properly All these varieties will be planted in isolation at a distance of 1000-15000 m to avoid any cross pollination. An onion nursery will be raised and transplanted in February 2016 for varietal evaluation and multiplication. After adaptability trails these advance lines will be an addition to the existing onion varieties.

1.1.2.1.1.1.5. Bitter gourd

Bitter gourd is an important vegetable used as food based selection for diabetics and only two to three local high yielding varieties are available in Pakistan. AIP-AVRDC in collaboration with six public sector research institutes; the Agriculture Research Institute Mingora, the Arid Zone Research Institute, DI Khan, the Vegetable Program, NARC-Islamabad, the Vegetable Research Institute, Faisalabad, the Arid Zone Research Institute (AZRI), Umerkot and the Balochistan Agriculture Research Center, Quetta are testing six advanced lines of bitter gourd across the country. So far only three partners have provided trial data. Of the six AVRDC advanced lines, only AVBG-1323 (17.0 t/ha) was at par with the local check (19.7 t/ha), while AVBG-1324 and ABG-1334 yielded lower with averages of 14.6 t/ha and 13.9 t/ha respectively (5% probability of difference) at Umerkot, Faisalabad and Islamabad. These AVRDC advance bitter gourd lines will be further tested for adaptability at multiple locations in spring 2016.

1.1.2.1.1.2. Variety / hybrid evaluation under protected cultivation at PAU, Ludhiana, India

Promising lines of indeterminate tomato, cherry tomato, bell pepper, hot pepper, leafy vegetables, cucumber and French bean out of 124 only 22 promising advance lines have been identified in trials under polyhouse / polynet over recent years. In 2014/15 these trials continued with an extended selection of new lines. These covered production conditions are different to those under the plastic tunnels normally used in Pakistan, and will provide advance advice of the varieties that are most likely to succeed under these growing structures once such structures are more widely

adopted in Pakistan.

1.1.2.1.1.1.6. Tomato

Past trials of indeterminate table tomatoes in PAU have resulted in recommending Punjab Gaurav and Punjab Sartaj (from PAU, Ludhiana) and hybrid G-600 (from Golden Seeds Pvt. Limited). These remain the top recommendations, but an additional 25 lines were evaluated in the 2014-15 season.

Yield data collected included total fruit yield per plant, early fruit yield, average fruit weight, number of clusters per plant, number of fruits per cluster, fruit shape, pericarp thickness and number of locules per plant. In addition, quality traits were also assessed including TSS and dry matter percentages, lycopene content (mg/100g of fresh fruit weight), carotene content (mg/100g of fresh fruit weight), acidity (g/100ml of fruit juice) and vitamin C (g/100ml of fruit juice). Lines E-9111, PAU 2374, S-2413, S-321, S-211 and YT-211 have been identified as promising and have been promoted to second year trials in 2015-16 for wider adaptability and availability.

1.1.2.1.1.1.7. Cherry tomato

Punjab Red Cherry has been the best performing cherry tomato in past trials, but in the 2014/15 season a total of 30 lines were evaluated for early planting and total yield (kg/plant), average fruit weight, number of clusters per plant and number of fruits per cluster; and quality traits such as TSS (%) and lycopene content (mg/100g of fresh fruit weight). Lines CR-4, CR-31, ACT-33, ACT-44 (all red), Punjab Yellow Cherry and Punjab Orange Cherry have also been identified as promising high yielding lines.

1.1.2.1.1.1.8. Hot pepper

A total of 50 genotypes and 20 F_1 hybrids were evaluated for fruit yield per plant (kg), fruit length (cm), fruit width (cm) and fruit weight (cm) during 2014-15. Lines PP 402, PLS 1, SL 461, AC 102, FL 201, DL 161, IS 261, US 501, YL 581 and ML 342 were identified as promising and have been promoted to second year testing in the spring season,2015-16.

1.1.2.1.1.1.9. Bell pepper

Indra, Orobelle and Bomby hybrids of bell pepper (from Syngenta Seeds Pvt. Limited) have performed best in past trials and are recommended for sowing in Punjab. However in 2014/15 a total of 19 open pollinated varieties and 10 F_1 hybrids of bell pepper were tested under poly house conditions. Observations were recorded on yield, fruit and quality traits. The lines PAU SM-1, PAU SM-2, PAU SM-3 and Royal Wonder were identified as promising and have been shortlisted for further trials during 2015-16.

Additional crop recommendations based on previous trials

In addition to those recommendations listed above, long term trials by PAU have identified the best varieties of cucumber for protected cultivation to be Multistar (RizkZwaan Pvt. Limited) and KUK-9 (Namdhari Seeds Pvt. Ltd.). The best varieties of pole bean for protected cultivation are Contender (IARI, New Delhi) and Falguni (from Seminis Seeds Pvt. Limited).

1.1.2.1.1.3. On Farm Adaptability Trials

1.1.2.1.1.3.1. Protected Cultivation

1.1.2.1.1.1.9.1. Tomato

Thirteen tomato hybrids were evaluated under protected cultivation

at Mingora-Swat, Haripur and DI Khan in Khyber Pakhtunkhwa; Muzaffarabd in Azad Jammu Kashmir; Rawalpindi, Shiekhupura, Gojra-Faisalabad, NoorpoorThal, Bahawalpur in Punjab and Quetta, Dhadar in Balochistan. The best performers at different locations are shown in Appendix 9. The performance of hybrids was different across locations in Pakistan due to diverse climatic conditions, so it is difficult to make any generalized recommendations. This may be due to different climatic conditions or management practices used by the farmers. The commercial hybrid Sahil was top or second top yielder in six of the 11 trial sites, but the top yields for this hybrid varied from a high of 89.9t/ha in Quetta to a low of 20.5 t/ha in NoorpurThal. The variety Danar was top or second top yielder in three sites while Anna and Sallar also were the top or second top yielders in two sites each.

Figure 30 A happy farmer with a tomato basket produced under Protected cultivation at Kallar Saidan-Rawalpindi

Figure 31 The first ever tomato crop produced under a bamboo-framed tunnel at NoorpurThal- Khushab

1.1.2.1.1.1.9.2. Cucumber

The current yield potential of cucumber open pollinated varieties is low and there is a need to introduce high yielding varieties and hybrids. Three public sector research institutes; the Vegetable Research Institute-Faisalabad, the Agricultural Research Institutes-DI Khan and Mingora have been evaluating cucumber hybrids in farmers' fields in the Faisalabad, Sheikhupura, DI Khan and Mingora areas. A total of 17 hybrids namely Cu-2833, Nobel, Ujala, Jalal, Saver, Yousaf, 5555, Saeed, Nine ring, Ramzan, Waleed, Termossos, DS-97-86, Kandil and Ozbek were evaluated (Appendix 10). The yield of hybrids was high in Sheikhupura, followed by Faisalabad and Mingora while it was low in DI Khan. There were no consistent top performers across farmer trials in different locations and the top yields varied considerably between locations. This may have been due to the number of pickings and varying management practices. The highest overall yields were in Sheikhupura where the hybrids Waleed and Ramzan yielded two to five times higher than the best performing varieties at all other locations.

Figure 32 Cucumber crop produced under tunnels at Gojra-Faisalabad

These farmers at Sheikhupura followed the instructions of a visiting expert from PAU, Ludhiana who visited Pakistan in first week of March 2015 and suggested removing lateral cucumber shoots from the bottom 1-2 feet for better production. Farmers obtained very good results with minimum attack of downy mildew as compared to other hybrids. This suggests that promoting improved management practices may be even more

Figure 33 Cucumber plants after removal of lateral shoots at Bhikhi-Sheikhupura

important than introducing new varieties for many farmers.

1.1.2.1.1.1.9.3. Sweet Pepper

Three sweet pepper hybrids (Orobelle, Extra 2 and Bonus) were evaluated under protected cultivation in Shiekhupura and Gojra-Faisalabad. The hybrid Extra-2 gave a yield of 77.9 t/ha, followed by Bonus (74.0 t/ha) at Sheikhupura while Orobelle yielded 22.5 t/ha at Gojra-Faisalabad. The yields of hybrids was more than double at Sheikhupura as compared to Gojra-Faisalabad. This may be due to greater use of improved management practices by farmers in Sheikhupura and salinity issues in the Gojra-Faisalabad area.

1.1.2.1.1.1.9.4. Chili

The narrow choice of low yielding cultivars limits farmer options. The average national dry chili yield is 2.3 t/ha (Fruit, Vegetables and Condiments Statistics of Pakistan, 2013-14). Two years of trials with six green chili varieties have now been conducted in the arid temperate highlands region of Quetta, Balochistan. This year the variety Red Revil gave the highest yield of 11.3 t/ha followed by Temble (8.0t/ha) and PBC-1356 (7.7 t/ha). These results are similar to those found last year, but will need further confirmation on-station and on-farm in the coming season. This year, five Chili hybrids (P-6, P-428, P-410, Revival and Tejal) were also evaluated inGojra-Faisalabad and Shiekhupura. Trials are progressing well and plants

are flowering heavily. However, due to rain and hail storms late flower setting has delayed fruit setting in Bhikhi- Sheikhupura. The hybrid P-6 yielded well at Sheikhupura with a yield of 44.7 t/ha, followed by P-428 (40.7 t/ha) but P-6 yielded poorly in Faisalabad (26.3 t/ha). This may be due salinity problems in the field there as well as the hail storm at the fruiting stage that damaged the overall crop in the area.

Figure 34 A smiling farmer with a good chili crop at Bhikhi-Sheikhupura

1.1.2.1.1.1.9.5. Bitter Gourd

A limited choice, low yields and the different taste of improved hybrid/varieties have affected bitter gourd cultivation in the country. Seven bitter gourd hybrids (Palee, Parachi, TS-222, BG-485, BG-888, Bejo and BJ-034) and a local variety (Kala Karela) were evaluated in Shiekhupura, Gojra-Faisalabad and DI Khan. In Sheikhupura, BG-888 gave the highest yield of 102.9 t/ha followed by BJ-034 (62.8 t/ha). In Faisalabad Palee gave the highest yield of 57.2 t/ha, followed by BG-888 (52.6 t/ha). However in DI Khan the overall yields were much lower, but Palee was also the top performer with41.2 t/ha followed by BG-485 (23.0t/ha).

Figure 35 Bitter gourd hybrid "Palee" with hanging structure at DI Khan

1.1.2.1.1.1.9.6. Vegetable Marrow

Vegetable marrow is a relatively new crop with a narrow choice of low yielding varieties. Therefore, the evaluation of seven vegetable marrow hybrids (Farid, Sanam, Liza, Ezra, Zarra and Charisma, Jalal and Starex) was carried out in Mingora-Swat and DI Khan. The highest yield of 85.4 t/ha was obtained from Charisma, followed by Ezra (81.5 t/ha) in Mingora. Yields were much lower in DI Khan with Jalal yielding 20.5 t/ha followed by Starex (16.9 t/ha). These hybrids will be tested for adaptability at multi-locations in the spring 2016.

Figure 36 A heavy fruit bearing crop of vegetable marrow at Mingora-Swat

1.1.2.1.1.3.2. Natural Off-Season

There are vegetable-producing pockets that are frost-free in different part of the country. The growing season is the same for crops grown under protected cultivation and natural off-season production. The crops tested in 2015 were narrowed down to tomato, cucumber, sweet pepper, chili, bitter gourd and vegetable marrow based on performances in 2014 and feedback from farmers and industry.

1.1.2.1.1.1.9.7. Tomato

Tomato is cultivated on a large scale in these pockets due to the favorable environmental conditions. Local varieties are low yielding and susceptible to disease. Farmers prefer to cultivate determinate hybrid tomatoes to minimize their losses. Ten tomato hybrids/ varieties (T-1359, T-1757, T-786, Supper, Ayusman, F1-176, Savera, Sahil, Kimia and Local) were evaluated in farmers' fields at Muzaffarabad-Azad Jammu Kashmir, Thoamehram-Talagang, Soon Valley and Katha Saghral-Khushab in Punjab and in Badin in Sindh.

A determinate hybrid T-1359 performed best at three locations namely Muzaffarabad in AJK and Talagang and Soon Valley in Punjab while Supper and Sahil were the best varieties at the other two locations i.e. Khushab in Punjab and Badin in Sindh province. Despite its good overall performance, the yields of T-1359 varied greatly across locations, and it suffered from bacterial wilt and blight in Katha Saghral-Khushab and in the Badin-Sindh area.

The hybrids Sahil and Kimia are indeterminate and were grown on vertical structures at Katha Saghral where they yielded better than T-1359 and the local control. Good agronomy may be even more important than varieties there since the parasitic weed "Orobanche" has existed in the area for many years, and can only be controlled through improved agronomic practices.

1.1.2.1.1.1.9.8. Cucumber

Two improved varieties were compared against popular local cultivars in Mingora-Swat and in DI Khan. In Mingora Swat, the local variety with a yield of 56.3 t/ha outperformed Nine ring (53.1 t/ha). In DI Khan, Hybrid 22 yielded 35.4 t/ha compared to the existing variety Badshah (26.3 t/ha).The fruit yields of cucumber were again low this year due to water scarcity in the area. The highest yield of 8.2 t/ha was recorded in Beithalfa and this was closely followed by Cus-080 and Gharib Nawaz with fruit yields of 7.2 and 6.1 t/ha, respectively. These hybrids / varieties will be further evaluated on-station for at least two more seasons due to the highly variable results.

1.1.2.1.1.1.9.9. Sweet Pepper

Three hybrids; Early Morlen, Royal Wonder and Ganga were evaluated in Mansehra and the Soon Valley. The yields were much higher in the Soon valley, possibly due to a prolonged season, accompanied by a greater number of pickings in the area. In the Soon Valley, Ganga yielded 86.2 t/ha, followed by Royal Wonder (71.2 t/ha) while Early Morlen yielded 10.9 t/ha in Mansehra.

1.1.2.1.1.1.9.10. Chili

Seven hybrids/varieties (PusaJawala, China Jaifen, BSX001, PS, Meraj Diamond and F1-Captain were evaluated at Muzaffarabad and Mansehra. The highest yields were in Muzaffarabad, where hybrid BSx011 yielded 67.2 t/ha followed by Pusa Jawala. In Mansehra, Diamond (52.6 t/ha) yielded better than PS (44.5 t/ha).

1.1.2.1.1.1.9.11. Bitter Gourd

Bitter gourd trials were conducted in Mingora-Swat, Gojra-Faisalabad and DI Khan. Eight hybrids (Prachi, Palee, BG-485, BG-888, Winner F1, Kala Karela, Bejo and Durga) were evaluated for yield and quality and the yields are shown in Appendix 12.Palee performed best at two locations and the hybrid Prachi gave a highest overall yield of 57.2 t/ha while it has the disadvantage of spines that make it difficult to market.

1.1.2.1.1.1.9.12. Vegetable Marrow

A total of eight vegetable marrow hybrids were evaluated at Mingora-Swat and DI Khan. These were Sanam, Liza, Jalal, Starex, Fareed, Charisma and Zara and were planted by a group of farmer beneficiaries. The overall yields were higher in Mingora-Swat compared to DI Khan. In Mingora, Charisma (57.6 t/ha) was the top yielder closely followed by Fareed. In DI Khan, Jalal was the top yielder (20.5 t/ha) followed by Starex with a yield of 16.9 t/ha.

Overall conclusions after two years of trials

The wide variety of ecological zones within Pakistan make it difficult to select hybrids / varieties that are top performers over a wide range of environments. The range of crops being tested has been reduced to six priority vegetables: tomato, cucumber, sweet pepper, chilli, bitter gourd and vegetable marrow. There are some common patterns emerging in hybrids / varieties that may be better adapted to a wide range of conditions – e.g. tomatoes that performed well on-farm under cover are Sahil, followed by Denar, and T1359 in natural off-season locations. Multi-location trials on-farm and on-station over the next year will confirm these emerging findings for tomato and other crops.

1.1.2.1.2. Improved Insect and Disease Management to Reduce Pesticide Use in Protected Cultivation

Growing vegetables under plastic cover provides partial climate control that avoids frost and low night temperatures during winter between mid-November to mid-February. However, these dates can be changed according to the local environmental conditions. In Punjab province of Pakistan, climatic conditions appear to have changed over the last decade. From the start of January, foggy days, usually decrease the temperature, which remains for three to four weeks and humidity level increases up to 80 percent inside the plastic tunnel. This is a very favorable environment for diseases like downy mildew and powdery mildew to attack plants. Fungicide applications are needed to avoid loss of the crop. Due to a lack of scientific knowledge, farmers apply an indiscriminate amount of fungicides and pesticides to control diseases and insects without knowing the health implications involved. This also increases the cost of

production beyond the reach of smallholder farmers.

As a solution, integrated pest management techniques were demonstrated to vegetable growers in Punjab. To encourage large scale adoption, the AIP Program organized 11 trainings on healthy vegetable production, off-season vegetable production and control of diseases using IPM techniques (Appendix 13) Table 1.2.1.

IPM Key Informant Survey

Farmers usually practice indiscriminate use of high doses of toxic pesticides especially for off season vegetables. It is important for farmers to understand the use of pesticides and the process of its application. Therefore, a key informant survey on pesticide usage and IPM Practices was conducted at six different locations with the support of a team of experts for off-season vegetable production. These surveys were conducted at the Haripur, RWP/ICT, Gojra-Faisalabad, Bhikhi-Sheikhupura, Katha Saghral and Noorpur Thal-Khushab clusters. Findings of the survey shown that farmers were applying 15-20 sprays in a short period. Training is needed in pest scouting skills and the use of IPM techniques to avoid the excessive use of pesticides. The farmer's practices and proposed training in IPM Techniques are described in Appendix 13 and 14.

The IPM strategy proposed aims to minimize the cost of pesticides and fungicides using an environmental friendly approach to get maximum yields. The first approach to IPM is to identify the insect pests and diseases, then to use different practices to minimize the damage. The different practices include cultural physical, biological and chemical control. The idea of FFS (Farmer Field Schools) can be adopted to train the farmers by increasing their personal capabilities in pest scouting identification and adoption of best practices to control the attack of insect pests and diseases.

Need-based farmer training has to be developed to popularize desired practices. Therefore, it is important to demonstrate integrated pest management techniques to vegetable growers. For large scale adaptation, the AIP Vegetables Program organized eight trainings on Healthy vegetable production, Off-season vegetable production and Control of diseases using IPM techniques. A total of 189 farmers which includes 40 women farmers were trained in collaboration with partner research institutes (Appendix 15). The training contents included lectures and practical demonstrations on nursery bed preparation, tunnel constructions, layout for different vegetables, identification of diseases, insect & pest and IPM techniques to avoid their spread, suitable fungicides, insecticides and fertilizer requirements of the vegetables at different stages.

Figure 37 Field demonstration of the importance of seedling trays during "Healthy Vegetable Seedling Production and IPM" at Naushera-Soon Valley, Khushab (Punjab)

Figure 38 Hands-on training to female farmers on "Healthy Vegetable Seedling Production and IPM" at Hatian (Azad Jammu Kashmir)

Figure 39 Group photo of the training particpants at ARI Mingora, Swat, KP

Figure 40 A group of nursery raising trainees visiting a Healthy vegetable seedling demonstration produced at Badin (Sindh)

1.1.2.1.3. Evaluate and Identify Summer Crops for Protected Cultivation with Higher Economic Returns

In Pakistan, plastic tunnels are used from October to April to produce off-season vegetables such as tomato, cucumber, and sweet pepper by keeping the crops warm in cold weather. Although farmers make a significant investment to construct the tunnels, which remains unutilized from May to September. To maximize the use of tunnel structures year-round and to increase the supply of fresh vegetables, three crops namely bunching onion, spinach and coriander were studied at three locations in Faisalabad and Bahawalpur in Punjab and Islamabad in 2013-14. Crop productivity from the bunching onion and coriander crops were not encouraging while spinach proved to be a winner. Spinach is largely cultivated in the winters in Pakistan while in summer normally spinach does not grow due to hot weather. However, by swapping the plastic covers of tunnels with green shade net, winter crops can be kept cool during the summer. This year, the Agricultural Engineer from AIP-AVRDC visited 6 locations namely Haripur in KP, Sheikhupura Faisalabad, Noorpur and Bahawalpur in Punjab and Islamabad to get the measurement of tunnels to be able to procure sufficient green nets for covering trial crops of spinach and coriander at 18 different locations in Khyber Pakhtunkhwa and Punjab. Both the crops; spinach and coriander were planted in mid-May in tunnels having an average area of 255 m^2 (10 Marla).

The results show that spinach yielded higher than coriander while in terms of economic return coriander is a more promising crop due to higher market prices than for spinach (Appendix 16.). Ramses, an improved hybrid was introduced which had a good germination percentage in summer. This had broad leaves, a nice aroma and produced 48 percent more biological yield (23.7 t/ha) as compared to the local varieties Qandhari or Irani with 16.0 t/ha. The introduction of spinach and coriander under shade net is ensuring the profitability with increased yield and economic return of farmers and beneficiaries.

Figure 41. Spinach under green net during

Figure 42 Improving off-season coriander in Swat

summer in Faisalabad and Soon Valley

Complementary trial work on summer leafy vegetables in PAU, Ludhiana

Based on the previous year's results, three promising spinach varieties; Supriya, Mulayam and Punjab Green have been identified. These three Spinach varieties and three coriander lines namely PD 5824, PD 6820 and Punjab Sugandh are being evaluated this summer season and the trials are in progress.

1.1.2.1.4. Identify and Promote Improved Protected Cultivation Systems

In continuation of the previous season's trials, five demonstration drip irrigation systems were installed; two at Research Institutes and three in farmers' fields under-cover in KP and Punjab provinces. The combination of drip irrigation system with mulching sheet is helping farmers to reduce the time and resources spent on weeding/hoeing. Farmers are very happy with the results and benefits in shape of savings and the uniform distribution of water and fertilizer. They are not only interested in extending their drip irrigation systems but also want to install foggers for raising healthy nurseries.

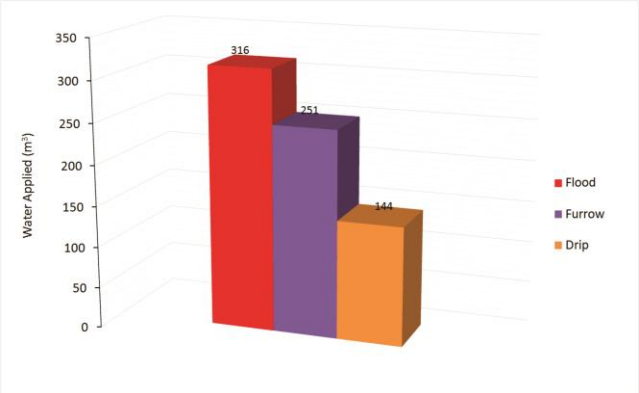


Figure 43 Computation of water utilization for improved cultivation system

Balochistan is a major producer of onion and tomato, but farmers are irrigating their fields by flood or furrow methods as they are not aware of drip irrigation systems. The ground water level in Quetta is very low and they have to draw water from 600 to 800ft down through tube well that requires a lot of energy and they do not have any option to minimize the water usage except to adopt drip irrigation systems.

The AIP-AVRDC Agricultural Engineer visited Quetta and installed a demonstration drip irrigation system in an open field area of 1340 m^2 at the Agriculture Research Institute, Quetta. The field of 4050 $m^2$was divided in 3 zones, and tomato and onion were planted and irrigated by flood, furrow and drip irrigation methods to evaluate the differences in water and fertilizer application rates. More than 100 farmers visited the drip irrigation demonstration site and commented that it is a blessing for the farmers of Balochistan that will help them to cut down the usage of water and fertilizer (Fig 44.).

Figure 44 Onion crop raised with drip irrigation system at Quetta, Balochistan

During the season, data were collected and it was found that drip irrigation saved 42% of water compared with flood irrigation and 54% compared to furrow irrigation.

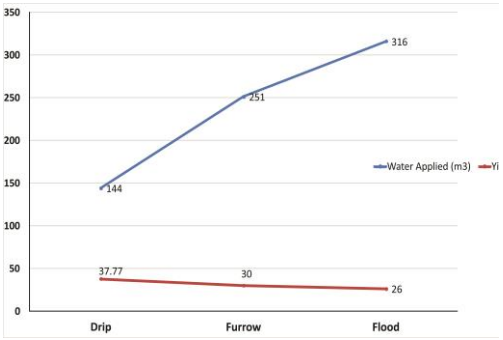


Figure 45 Onion yield and water usage under different irrigation systems

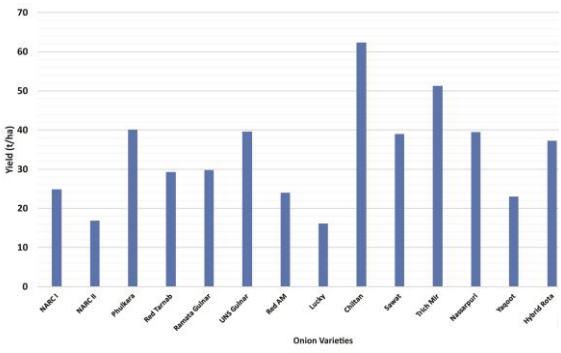


Figure 46 Onion varieties performance with drip irrigation system

The onion yield produced by drip irrigation system was 20% higher than that with furrow irrigation and 31% higher than with flood irrigation. The graphical representations of the results are given in Figures 43, 45 and 46.

Market Potential of Off-Season Tomato

In Pakistan, the normal off-season production of tomato under plastic tunnels starts in November and ends in May. By using a plastic cover in late November or early December, an early crop of tomato can be obtained to fetch good prices. With this practice, farmers can market tomatoes at least two to three weeks before the normal crop picking reaches its peak. Early production of tomato under plastic has very promising effects on farmer net returns. Earlier supply of products improves the market price during April to June as shown in Figure 47. The rate was high and it gradually decreases towards the normal off season prices in Rawalpindi whereas in Sheikhupura the start of the market was not as promising, but the graph showed an increasing trend. This may be due to selection of market and weight of the first picking. The nearest markets to Sheikhupura and Gojra are Lahore and Faisalabad, respectively. Those vegetable growers using protected cultivation systemsare getting high yields with good quality fruit, and are fetching good prices through early marketing.

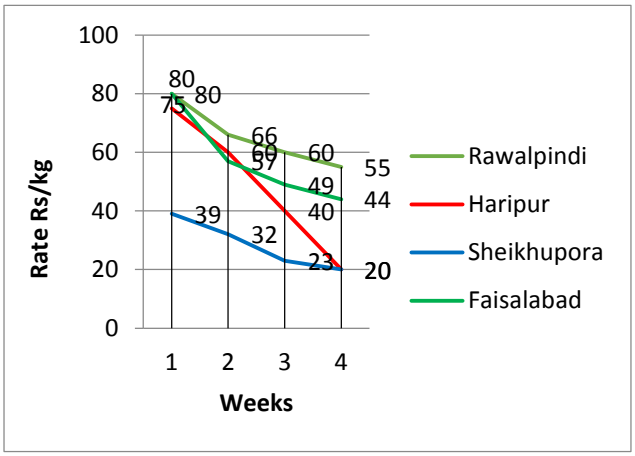


Figure 47 Price per kg of tomatoes at different markets from April 2nd week to May 3rd week

1.1.2.2. Improved Mungbean Production

The main objective of this sub project is to improve mungbean yields and to expand the area of the crop in existing mungbean growing areas as well as in new production areas. This involves introducing mungbean into various cropping systems, as well as intercropping in sugarcane and citrus. Six provincial and national institutes participated in various project activities at different geographical locations. The complete list of participating institutes is given in Appendix 26 A. For double-cropping, NARC, Islamabad in the Pothwar region of Punjab, Pakistan participated in this activity. For the rice-wheat cropping system in Punjab and Sindh, one partner institute worked in each of these provinces. These were AARI (Faisalabad) in Punjab and QAARI (Larkana) in Sindh. The responsibility for testing mungbean intercropping with sugarcane was shared by AARI (Faisalabad) in Punjab and NSTHRI (Thatta) in Sindh province. The Citrus Research Institute, Sargodha (Punjab) participated in intercropping mungbean with citrus on a 0.2 ha demonstration area. AZRI (Bhakkar) worked in the traditional mungbean production area of Pakistan in the Thal region of Punjab province that accounts for more than 90% of Pakistan's mungbean production. An updated summary of the clusters and direct beneficiaries is attached (Appendix 26 B), and a summary of major activities under each priority is given below.

1.1.2.2.1. Identification of opportunities to improve mungbean production as part of the traditional and rice-wheat cropping system as well as through inter-cropping (irrigated); and double cropping in wheat-fallow areas of the Pothwar region (rainfed)

This is the most important activity of mungbean sub-project and the interventions were carried out in four different cropping systems:

1.1.2.2.1.1. Mungbean production in the traditional area

This sub-activity was carried out by AZRI, Bhakkar in the traditional mungbean area where it is a major crop. Demonstration plots of both high yielding varieties NM-11 and AZRI-6 were planted in six clusters involving 58 farmer beneficiaries. The long-term average yield of the area is 600 to 700 kg/ha (Ag Statistics of Pakistan). The use of improved production practices including line sowing, use of *Rhizobium* + PSB (Phosphorus Solubilizing Bacteria), post-emergence chemical weed control and IPM to control insect pests led to a significant increases in yields and farmer incomes. The mean yield was 1143 kg/ha with a range of 970 to 1375 kg/ha

and a net profit of Rs. 54,000/- to 94,500/-. This was lower than last year's mean yield of 1362 kg/ha and income. Up until podding the crop looked much better than last year, but high rainfall and other un-favorable environmental conditions at maturity caused late crop damage, resulting in 10-15% yield and income loss to the farmers (Appendix 17 and Fig 48).

Figure 48 (Right) Mungbean farmer's field in Darya Khan, Bhakkar, in Punjab province showcasing improved agronomic practices and high yields (left). The field on the right shows traditional farmer practices with a crop full of weeds and a poor plant population

1.1.2.2.1.2. Mungbean production in rice-wheat cropping system

This sub-activity was carried out by AARI, Faisalabad in Punjab and QAARI, Larkana in Sindh province. This was the second year for the farmers to grow the crop. A total of ten farmers got the seed and other recommended inputs in time and this resulted in much better yields and net profits compared to last year. The yield ranged between 594 to 1297 kg/ha and the net revenue gain from PKR 19,550 to 72,275/- per hectare. This is additional income for this cropping system and indicates the success of the innovation. However, there is a lot of room for improvement in the crop management practices including line sowing, use of *Rhizobium* + PSB (Phosphorus Solubilizing Bacteria), post-emergence chemical weed control and IPM to control insect pests particularly, in Sindh. The soil of Larkana district is too heavy with poor drainage and low mungbean yields, however, with the passage of time growing mungbean as a catch crop in this system will improve the soil nutrient status, water absorption capacity and the soils will become more productive for all crops (Appendix 18 and Fig 49).

I

Figure 49 (Left) The mungbean variety NM-11 planted in May 2015 in the rice-wheat cropping system in Nankana district. (Right) A happy farmer Abdul Razzaq from Larkana, Sindh with his bumper crop of mungbean planted after wheat harvest

1.1.2.2.1.3. Mungbean production through intercropping with sugarcane and citrus

Two institutes, NSTHRI, Thatta in Sindh and AARI, Faisalabad in Punjab were involved in mungbean intercropping with sugarcane, and CRI, Sargodha in Punjab was involved in intercropping with citrus. The mean yield was in the range of 190 to 667 kg/ha, and a net profit/ha of PKR 19,277/- to 55,018/- per hectare was achieved. This year, sowing operations were timely and yields were much better than last year. The high yielding variety, NM-11 was widely used in Punjab and Sindh. In addition, two other varieties, AZRI-06 and NCM-13 were also tested in Sindh. The major difference of yield in the two provinces was due to soil types. The Punjab soils were much more productive than Sindh soils where mungbean was intercropped. Furthermore, the crop management of Punjab farmers was relatively better than that of the Sindh farmers. All farmers were satisfied as it was an additional crop for them that did not affect their long duration crops of sugarcane and citrus. The citrus growers indicated that the citrus trees needed less irrigations where mungbean was intercropped. (Appendix 19 & Fig. 50-52).

Figure 50 A happy and satisfied farmer in his mungbean field intercropped with sugarcane in T.T. Singh district (Punjab).

Figure 51 Mungbean intercropping with sugarcane in Sajawal district (Sindh).

Figure 52 Mungbean intercropping with citrus Sargodha district (Punjab). In the background, there is no crop in citrus field which is a normal practice of the farmers of this area.

1.1.2.2.1.4. Mungbean production through double cropping in Pothwar region

The Pulses Program, NARC is involved in this sub-activity. There are five districts of Pothwar region with low (<300 mm rainfall) to high rainfall (>450 mm rainfall) areas. Under this activity, only medium (350 mm rainfall) to high rainfall areas are being targeted for mungbean cultivation under rainfed conditions. Last year experience of the farmers was successful and the number of farmer beneficiaries increased this year. At the time of reporting, the crop was in the field and yield data were not available. However, medium to bumper crops close to pods have been produced. It is a great success for this innovation, and in some places, harvesting is in progress. It is expected that the fields will be fully harvested by the end of September, 2015. It will provide sufficient time for moisture conservation for wheat planting under rainfed conditions (Fig 53).


Figure 53 (Left) Mungbean crop at maturity at medium rainfall area in Attock district, Punjab province. (Right) mungbean crop at the vegetative stage at high rainfall area in Rawalpindi district, Punjab province.

1.1.2.2.1.5. Complementary pre and post emergent weed management research conducted in India

Weeds can be controlled by hand weeding/hoeing and using pre-emergence herbicides. However, manual weed control is very expensive and not easily available during the critical crop-weed competition period. Pre-emergence herbicides are also often not very effective due to low soil moisture at the time of application or are not applied within the recommended time of 1-2 days prior to sowing. Consequently there is a great need to explore the use of post-emergence herbicides in mungbean for effective weed management.

Trials were conducted by Punjab Agricultural University at Ludhiana. Among the 12 treatments imposed, the highest seed yield (1221 kg/ha) was obtained with pendimethalin 0.45 kg/ha PE + 1-hand weeding, which was statistically on par with two hand weeding (20-25 + 35-40, DAS) compared to other treatments. Among the different herbicide treatments, application of Pendimethalin 30 EC + imazethapyr 2% (Ready mix combination) 1.0 kg/ha PE recorded the lowest weed population and weed dry weight. An experiment is also underway in the Kharif season to compare the results with the previous (summer) season.

1.1.2.2.1.6. Complementary selection for abiotic stress tolerance in mungbean in India

In Indian Punjab mungbean is grown during the summer as well as the kharif season and the growing conditions are similar to those in Punjab Pakistan. Mungbean grown during the spring/summer season in between wheat and rice crops is exposed to high temperatures (>39°C), during the reproductive stage. A continuing drop in the level of irrigation water is also exposing more irrigated crops to saline water. Improving the tolerance of mungbean to heat and salinity tolerance can improve its adaption to summer production and fitting into the irrigated rice-wheat crop rotation.

1.1.2.2.1.6.1. Screening lines for salinity tolerance

A total of 42 elite mungbean accessions were evaluated for salinity stress tolerance at Punjab Agricultural University (PAU), Ludhiana, and at the University of Agricultural Sciences (UAS), Bangalore.

1.1.2.2.1.6.1.1. A plant level evaluation

45 mungbean accessions (including 2 checks) planted for salinity screening in both pots (PAU, Ludhiana) and field conditions (RRS, PAU, Bathinda) were harvested. All pertinent traits (under saline and non-saline) related to growth and yield were recorded. Leaves were sampled for biochemical assays.

On the basis of the results, 14 entries showed tolerance to salinity at 80 mM and 120 mM salt treatment out of 45 accessions. 2 local

check varieties i.e. SML 668 and SML 832 also showed salinity tolerance. While the overall growth of tolerant entries was also affected compared to untreated controls, the response of these accessions to different concentrations of salinity was acceptable. There is a scope to use these accessions for further investigation to develop saline tolerance lines using them as donors.

Figure 54Overview of salinity experiment (under polyhouse) with 3 treatment levels

1.1.2.2.1.6.1.2. A field level evaluation

The results suggest that out of 45 entries (which includes 2 local checks), 6 accessions showed tolerance to salinity. The growth and yield response of these entries was less affected to salinity compared others. Intrinsically, these accessions have an ability to withstand saline irrigation water. These may be promising accessions to be used for further investigation to develop saline tolerant mungbean lines under the growing conditions of Punjab.

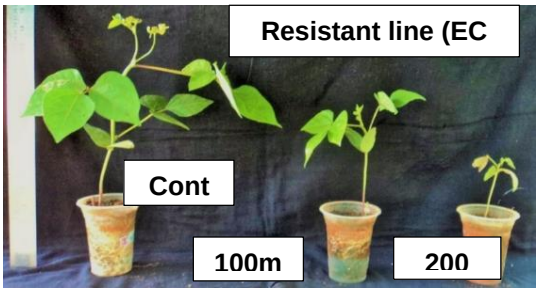


Figure 55 Genotype variations in plant growth in response to NaCl stress

1.1.2.2.1.6.2. Effect of Heat Stress on growth, phenology and yield of mungbean accessions

Mungbean accessions were screened for heat tolerance at the vegetative and reproductive stages and the mechanisms governing heat tolerance/sensitivity were explored.

A total of 45 mungbean accessions were evaluated for heat tolerance at the Panjab University, Chandigarh, where the growing temperatures exceeds 38°C and may even reach 45°C. Seeds were sown in last week of March 2015 for normal-sown situation and also sown in last week of April 2015 (late sown), to impose heat stress at reproductive stages. A replicated (3/accession) trial was conducted and the relevant data were recorded at different vegetative and reproductive stages along with yield attributes and the final yield.

In late-sown condition, accessions EC 693358, EC 693360, EC 693369, ML 1299, PDM 139, MASH1-1 could produce pods even during high temperature periods (>40˚C), thus seemed to be promising ones

for further in depth investigation. There would be a scope to exploit them to gain useful information on heat tolerance mechanisms.

A large amount of data were collected on the performance of all lines (Fig 56).

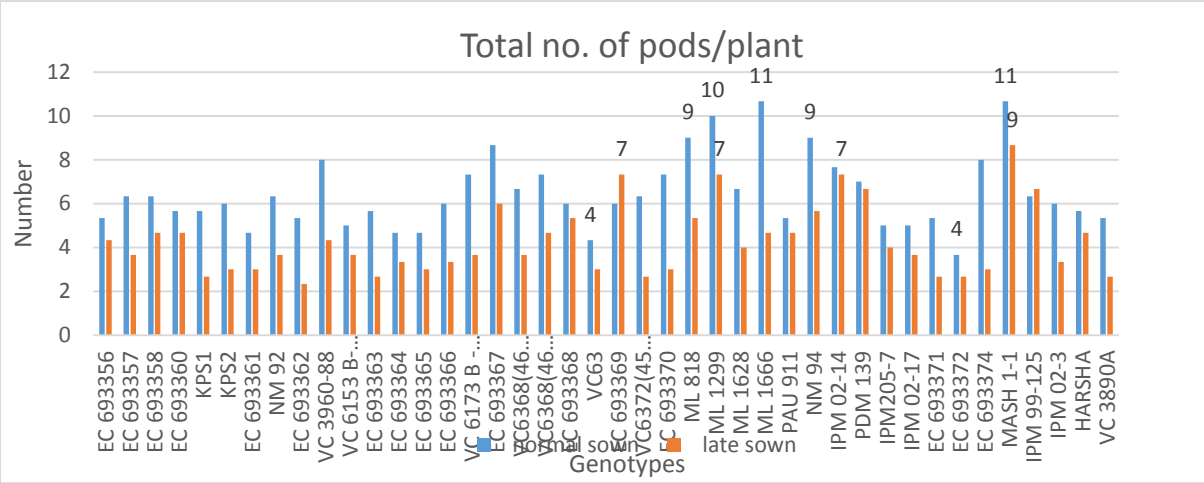


Figure 56 Total number of pods per plant in normal and late-sown mungbean genotypes

1.1.2.2.2. Evaluate the efficiency and effectiveness of the national seed supply system and assess the opportunity to develop "seed villages" for production of high quality seed of improved varieties

AZRI Bhakkar is located right in the center of the traditional mungbean production area of the country and is a suitable location for this activity. Therefore, 28 tons of quality seed of the two main high yielding varieties, AZRI-06 and NM-11, was produced this year by partners. Both varieties (NM-11 and AZRI 06) had an almost equal share in the total seed produced with the value of PKR 2.8 million (Appendix 22). A linkage was also developed with a private seed company (Mumtaz Seed Company Ltd.) and they have produced 500 tons of seed of three varieties (AZRI-06, NM-11 & NM-15). It means that more than 1300 tons of quality seed will enter the market during the 2015-16 cropping season and will be sufficient for planting more than 43,000 ha. Furthermore, at the moment, NARC has 13 ha of seed blocks to maintain the purity of these varieties. This area is expected to produce at least 13 tons of high quality pure seed of the major varieties which will also be available during the 2015-16 cropping season.

1.1.2.2.2.1. Evaluate methods including resistance breeding for improving postharvest storage to reduce bruchid damage

Training of the beneficiaries to minimize postharvest storage losses

All the six partner institutes were assigned responsibility for this first sub-activity. The six field days and training activities were held by five institutes for 550 direct farmer beneficiaries, against the target of 500 farmers. Activities focuses on how to reduce post-harvest losses through sun drying

of seeds, using clean or pest free bags and the use of fumigation with phostoxin in the stores (Fig 57 and 58).

Figure 57 Training for fumigation process at one of the farmer's sites in Bhakkar district

Figure 58 Mungbean crossing block for bruchid resistance breeding at NARC

1.1.2.2.2.2. Development of bruchid resistant lines through strong breeding program at the institute level (long-term)

1.1.2.2.2.2.1. Breeding for bruchid resistance in Pakistan

For the second sub-activity, NARC, Islamabad took on this task of breeding work due to their strength in this area. Bruchids can be controlled by fumigation, but a resistant cultivar is preferable due to reduced risks to health, the environment, and a reduction in the cost of insecticides.

1.1.2.2.2.2.1.1. New crosses

The crossing block was planted on 8th August, 2015 in a tunnel at NARC. The crossing block consisted of 3 bruchid resistant lines and 4 high yielding, well adapted but susceptible cultivars. The following 12 cross combinations will be made (Appendix 23).

1.1.2.2.2.2.1.2. Advancement of Segregating generations

Eight F_1 crosses, seven F_2 and seven F_3 populations were planted during summer, 2015 for generation advancement (Appendix 24).

1.1.2.2.2.2.1.3. Back Crossing

F_1 plants will be backcrossed with locally adapted parents during summer, 2015 to improve grain quality (Appendix 25).

1.1.2.2.2.2.2. Bruchid resistance breeding in Taiwan and in Hyderabad

Populations were established from crosses between bruchid-resistant lines V02802, V02709 and V02164 with bruchid-sensitive cultivar 'NM94.' F3 to F7 families of these populations were generated and submitted for bruchid resistance testing. Populations of V02802 × NM94 and V02709 × NM94 showed segregation for resistance, and a few F3 families were 100% resistant against the pest. Resistance testing of NM94 × V02164 F3 families is ongoing. Currently, 143 F7 families are available for cross V02802 × NM94, and 1k49 F6 families of cross V02709 × NM94. After repeated exposure of these populations to bruchids, AVRDC identified 52 F7 lines derived from V02802 with resistance. Bruchid resistance has been tentatively mapped in V02802 × NM94 to four loci on chromosomes 2, 3, 4 and 5. The resistance locus on chromosome 5 overlaps with previously mapped bruchid resistance loci from V. radiata ssp. sublobata. Validated molecular markers

associated with bruchid resistance in V02802 will be recommended for use in marker-assisted selection.

1.1.2.2.3. Identification of opportunities for adoption of IPM practices in mungbean cultivation

1.1.2.2.3.1. Training activities in Pakistan

All the six partner institutes were assigned with responsiblity for this activity. Six field days were held by five institutes for 350 farmer beneficiaries, against the target of 300 farmers. They were made aware of the use of IPM practices and the potential for yield increases of over 20%. Practices involved pest scouting and the monitoring for parasites, parasitoids and predators. Farmers were involved in the identification of insect pests and controlling the sucking pest complex of thrips, white flies and jassids using imidacloprid 15ml /15 L of water, applying detergent with water and spraying Chlorfenapyr (Squadrin) @ 500ml/ha. Armyworms were controlled with Match (Lufenuron) 25ml, field crickets with Lorsban (Chloropyrophos) 4 ml/L of water and mixing in 5kg wheat flour for application. Lambda cyhalothrin (Silk) at 620 ml/ha was sprayed for the control of Helicoverpa and pod borer. Post-emergence herbicides were also used and farmers were provided with a complete training program.

Figure 59 Hands on training to the farmers and scientists for IPM practices at one of the farmer beneficiary sites in Nankana district, July 2015

1.1.2.2.3.2. Complementary research activities in India to screen varieties for tolerance to thrips

Bean thrips, *Megalur othripsdistalis* (Karny) is the major insect pest of summer mungbean. This sucking pest causes shedding of flowers leaving few pods per plant. A severe incidence may result in total crop failure. Therefore, short duration mungbean accessions which is developed by the breeding team of PAU were evaluated for relative tolerance to thrips. Result showed that the incidence of thrips on the test entries ranged log-transformed values from 2.00 to 9.33 thrips/ 20 flowers compared to 13.00, 10.33 and 16.66 thrips/ 20 flowers on checks SML 668, SML 832 and the Infester, respectively. Entries SML 1807 and SML 1814 recorded least incidence of thrips. Full details are shown in Appendix X.

1.1.2.2.4. Assess the opportunities for mechanical harvesting of mungbean

1.1.2.2.4.1. Demonstrations in Pakistan

A lack of suitable combine harvesting technology in Pakistan is the only hurdle in mechanizing the harvesting of mungbean. This is attractive to farmers as a way of avoiding heavy yield losses during manual harvesting. If some adverse environmental conditions occur, both quality and quantity are affected. Last year testing of a small combine harvester for harvesting of desiccated mungbean was initiated at NARC under AIP, AVRDC-

Pakistan. After fine tuning of the technology and getting initial success, a large commercial wheat combine harvester was used with tremendous success. This year, on August 27, 2015, a combine harvesting operation was performed at village Daggar Rohtas (Bhakkar) on farmer beneficiary's field that was sprayed with the chemical desiccant paraquat five days before. The crop dried down well and a successful combine harvesting operation was performed. It was a great success and many farmers were interested to observe the operation, and it will have positive impact on future production of mungbean in the area. Crops were also combine harvested at two more farmer beneficiary sites in Bhakkar district and three in Layyah district making six sites against the target of one site (Fig. 60-62).

Figure 60 Desiccated (front) and non-desiccated (back) mungbean fields. It is essential to desiccate the crop at 90% maturity before combine harvesting on Aug. 27, 2015

Figure 61 Mungbean combine harvesting operation at Daggar Rohtas, Bhakkar on Aug. 27, 2015

Figure 62 AVRDC and AZRI teams with farmers celebrating historical succesful mungbean combine harvesting operation at Bhakkar on Aug. 27, 2015

1.1.2.2.4.2. Complementary testing in India

If mungbean can be successfully sown into standing wheat it makes it easier to reach crop maturity in time for rice planting, but there may be problems with harvesting such a crop. So a small study was undertaken in collaboration with BISA (Borlaug Institute of South Asia; a joint CIMMYT – ICAR, initiative) at Ludhiana between March-June 2015 to test the combine harvesting of spring mungbean in a standing wheat crop sown as twin rows. A seed drill modified with greater height sowed mungbean variety SML 668 into standing wheat 12-15 days prior to harvest (Fig 64). Mungbean established on residual moisture. When the mungbean crop reached 80-85 % pod maturity, the crop was desiccated using Gramxone (Fig 64). Harvesting was done a week later in June 2015 (Fig 65). Only a few wheat seeds contaminated the mungbean seed lot, and there were few split seeds. It was estimated that the overall harvest loss was 3-5%, but this needs to be further confirmed, and harvesting methods refined to minimize seed splits.

Figure 63 Mungbean sown in standing wheat crop

Figure 64 Desiccated mungbean crop

Figure 65 Combine harvesting

1.1.2.2.4.3. Evaluation of advance breeding lines for yield, maturity period and suitability to mechanical harvesting in India

The productivity of mungbean is very low in many countries due to the inherently low yield potential of existing cultivars and their vulnerability to many foliar diseases particularly, mungbean yellow mosaic diseases (MYMD). Quick varieties that are disease resistant and suitable for mechanized harvesting will also be helpful in popularizing and boosting mungbean cultivation.

Experiment 1: Performance of inter specific mungbean genotypes in Final Yield Trial (FYT):

Result: Final Yield Trial (FYT) of 12 entries including two checks - Yield data showed that three entries namely SML 1781 (1500 kg/ha), SML 1813 (1546 kg/ha) and SML 1817 (1597 kg/ha) gave significantly higher yields than the best check, SML 832 (1301 kg/ha). Days taken to 50% flowering and maturity ranged from 35 to 45 and 66 to 69 respectively. 100 seed weight was maximum in SML 1781 (6.5 g) and minimum in SML 1817 and SML 1818 (4 g)

Experiment 2: Performance of inter specific mungbean genotypes in Advance Yield Trial (AYT):

Result: Yield data showed that four entries namely SML 1836 (1716 k/ha), SML 1837 (1796 kg/ha), SML 1838 (1685 kg/ha) and SML 1841 (1753 kg/ha) significantly out yielded the best check, SML 832 (1463 kg/ha). Days taken to 50% flowering and maturity ranged from 36 to 46 and 63 to 74 respectively. 100 seed weight was maximum in SML 668 (6.5 g) and minimum in SML 1841 & SML 1843 (4.0 g)

All the entries tested in both the above trials showed top bearing pods with synchronous maturity that would enable for effective mechanical harvesting.

1.1.2.3. Vegetable Value Chains

During the reporting period, seed production and linking value chain actors were the focus in the seed value chain component. Seed production targets have been exceeded while several workshops and consultations were conducted to initiate linkages between seed producers, seed dealers, private sector seed companies, and seed markets. In the fresh value chain component, more technology generation activities were done including an inventory of postharvest technologies and R&D works to adapt and optimize selected technologies. Some technology promotion activities were conducted using available technologies and best practices.

1.1.2.3.1. Increased national vegetable seed production to improve supplies and reduce prices to farmers

1.1.2.3.1.1. Baseline study and seed value chain analysis of onion, tomato, chili, peas and okra

This activity has been completed and the final report has been published by AIP-AVRDC.

1.1.2.3.1.2. Conduct workshop to validate survey findings, establish a start-of-project baseline, identify major bottlenecks, and set priorities for interventions including suitable vegetables and locations for seed production

The first draft of the Consultant's final report has been submitted. The report consolidated and summarized the findings of the four validation workshops

conducted in Faisalabad, Quetta, Kunri, and Swat in the previous reporting period and the last validation workshop conducted in Islamabad in this reporting period. The report is being evaluated.

1.1.2.3.1.3. Conduct evaluation trials for improved varieties of at least 3 major vegetables (onion, chili and tomato)

This activity is reported under Activity 1.1.2.3.2.1.

1.1.2.3.1.4. Building capacity and provide technical backstopping on improved seed production, processing, packaging, storage and marketing

A training program on chili seed production technology was conducted in Kunri, Sindh, on April 24, 2015 in collaboration with AZRI for 29 farmers. Training on onion seed production technology was conducted on April 29, 2015 in collaboration with ARI for 24 participants. Both trainings involved more hands on activities on integrated crop management particularly variety selection, planting method, seed production, diseases and insect pest control, threshing, drying and storage. The farmers found the trainings to be very useful and recommended continuous hands on training on seed production and management. Periodic visits to project sites and consultations were conducted to provide technical advice and guidance to project partners and beneficiaries including linking with markets (see also 1.1.2.3.1.6).

1.1.2.3.1.5. Facilitate seed production of improved varieties of at least five major vegetables on 40 ha of land to meet the seed requirement of 2,000 ha production for seed, fresh market and/or processing

A total of 7.7ha land was used for seed production of tomato, chili and okra while in the previous reporting period, 7.9 ha were used for seed production of onion and peas. The year's total of 15.6 ha of seed production exceeded the target of 10 ha i.e.onion-3 ha, peas-2 ha, tomato-0.5 ha, okra-2.5 ha and chili-2 ha (Appendix 26). The partner research institutes (Appendix 26 A and B) produced basic seeds of onion, peas, okra, tomato and chili for bulking up by farmer-cooperators. They also produced seeds on the institute's farms while private sector partners worked through their contract seed growers. The seed production program involved 52 farmers.
From 15.6 ha of land, 8.12 tons of seeds were produced (Appendix 27). The chili crop is not accounted for yet because harvesting will start at the end of September 2015 and end in December 2015. The Federal Seed Certification and Registration Department through their regional offices has been involved in the certification of seeds of approved varieties. Arrangements have been made for proper packing and marketing of the produced seeds through seed dealers in the country. The demand for seeds from the farming community was so high that all seeds produced were sold out.

1.1.2.3.1.5.1. Onion

An area of 4.9 ha was planted with onion across the country. Climatically suitable and adopted varieties were used; Chiltan-89, Saryab Red, Phulkara, NasirPuri and Swat 1 in the districts of Quetta, Mastung, Khunzdar, Qilla Saifullah and Pishin of Balochistan; Mirpurkhas and Umarkot districts of Sindh; Swat and Buner (Fig 66 and

67) districts of Khyber Pakhtunkhwa (KP); and Rawalpindi and Attock districts of Punjab.

Figure 66 Onion seed crop at ARI, Mingora-Swat, KP

Figure 67 Onion seed crop at Shuga-Buner, KP

Throughout the growing season, the seed plots at all the locations were in good conditions, except for that in the NARC campus which was severely affected by consecutive rains at the time of flowering and the crop was infected by downy mildew and purple blotch diseases. Fungicide sprays using Ridomil Gold, Score and Success did not mitigate the disease problem. The crop in Sindh was also adversely affected by temperature fluctuations in early spring. A total of 1,725 kg seed was produced and packed in attractive pouches (Fig 68 and 69). All seeds produced have been sold out at a price ranging from Rs. 2500 to 4000 per kg depending on the region.

Figure 68 Minister of Population and Welfare, Govt. of Sindh observing packaged onion seed at AZRI, Umerkot

Figure 69 Packaged onion seeds showcased in Quetta, Balochistan

1.1.2.3.1.5.2. Peas

Peas for seed production were grown on 2.95 ha of land in the districts of Swat and Buner in KP and Pakpattan, Chiniot and Tandlianwala-Faisalabad in Punjab, using Meteor, Climax and Peas-2009 varieties. A total of 4,008kg seeds were produced; 193kg by ARI Mingora, 2,115kg by VRI Faisalabad and 1,700 kg seeds by ARCO Seeds, Gujranwala (Fig 70). The seeds, except those of Peas-2009, have already been committed for marketing. The Climax variety was suitable in the mountainous areas of KP while Meteor variety is best suited to the plains of Punjab. Peas-2009 is a new entry in central Punjab introduced by VRI-AARI, Faisalabad. It is a medium stature, mid-season and high yielding variety. Seed packing is being developed.

Figure 70 Threshed and cleaned peas seed is being dried at Tandianwala, Faisalabad, Punjab province

1.1.2.3.1.5.3. Tomato

Half a hectare of land in Tandlianwala- Faisalabad, Punjab was used for tomato seed production. The variety used, Naqeeb, has recently been approved and released by VRI-AARI, Faisalabad for general cultivation in Punjab due to higher yield compared to the imported variety Rio-Grande. A total of 18kg of seeds were produced, which has already been committed for marketing. Farmers were reluctant to produce tomato seeds due to tough competition in the market with hybrids, which produced better quality and higher priced fruit, as well as the low price at Rs. 9000/ kg of locally produced seed.

1.1.2.3.1.5.4. Chili

The chili variety, Loungi (dandicut), was planted in April 2015 on a one hectare of land for seed production in KotGhulam Muhammad-Mirpurkhas and Pathanabad-Umerkot, Sindh. Loungi (Fig 71) is an old local variety, which is commonly used in Sindh and is popular because of its unique taste, but its yield has been declining over the years due to the poor quality seed used. The present crop had an excellent stand and is in the fruiting stage. Harvesting will start at the end of September 2015 and will be completed by December 2015.

Figure 71 Dandicut variety of chili in the field at Umerkot, Sindh

1.1.2.3.1.5.5. Okra

Two varieties of okra; Swat Green (Fig 72) and Sabzpari, were planted for seed production on 5.2 ha of land by ARI Quetta, Balochistan; ARI Mingora, KP; VRI Faisalabad; NARC Islamabad; and ARCO Seeds Gujranwala, Punjab. A total of 2,367 kg seed were produced, excluding the crop in Balochistan as harvesting has yet to be completed. Seed packing methods will be developed.

Figure 72 Seed dealers checking uniformity of seed crop stand at the workshop held at ARI, Quetta, Balochistan

1.1.2.3.1.6. Linkages of farmer-seed producers with key private seed companies, seed markets, technology providers and business development services for increased profitability and sustainability

Workshops, consultations, a conference, demonstrations and coordination activities were conducted to link farmer-seed producers with the seed dealers, private seed companies, and AVRDC and its partners as technology providers (Appendix 2**8** Fig 72). The importance of local seed production and marketing, suitable technologies, and the mechanism of cooperation among seed value chain actors were emphasized.

1.1.2.3.1.7. Establish seed villages in Punjab, Sindh, Balochistan and KP provinces

Establishing Seed Villages in the country could motivate the farming community to grow vegetables for seeds and the dealers to buy locally produced seeds. This could later catalyze the establishment of larger seed companies that involve small farmer-seed producers. As an initial activity, a meeting was held with members of Shuga Seed Growers Association, Gokand Valley-Buner on September 13, 2015 to present the idea of establishing seed villages and to declare Shuga as a seed village. All the Association members positively responded to the initiative and recommended to strengthen their capacities through:

- Trainings on seed production technology of major vegetable crops.
- Provision of seed threshers particularly for onion and okra, small packing machines, and cultivating machines such as rotator and small hand tractors.

1.1.2.3.1.8. Consultation with Government line agencies involved in seed production & supervision and policy makers in public sector, seed producers and seed companies in private sector for making seed policies and regulations favorable to farmers

A consultation meeting on September 16, 2015 at Islamabad gathered all partner institutes as well as the Director of the Federal Seed Certification and Registration Department (FSCRD), Peshawar Regional Office, KP, and the FSCRD Deputy Director of the Balochistan Regional Office. The Director of FSCRD Peshawar briefed the participants about the modified Seed Act 2015 which has been approved by the Government of Pakistan as well as the Plant Breeder's Rights Act, which has not yet been enacted by the Federal Law Division. The Seed Act 2015 is farmer-seed producer-friendly but tough to those who are doing seed business without following the rules and regulations of the country. The seed act provides policies for implementation with the help of provincial departments.

1.1.2.3.2. Evaluate value chains for major horticultural crops to assess and promote improved post-harvest and value adding technologies

1.1.2.3.2.1. Value chain surveys for at least two priority vegetables (chili, tomato, onion) conducted in one major growing area in each of the four provinces and major constraints and priorities for intervention identified

This activity has been completed and the final report is published by AIP-Vegetables.

Validation workshops

The first draft of the consultant's final report has been submitted for evaluation. (See also 1.1.2.3.1.2)

1.1.2.3.2.2. Postharvest and value adding technologies for the priority vegetables developed (At least six)

1.1.2.5.2.2.1. Identify and introduce new varieties of at least two major crops for testing for improved quality, shelf life and processing attributes

Field trials for advanced lines of tomato and chili from AVRDC and exotic varieties of onion were by partner institutes. These trials followed AVRDC's guidelines in conducting variety trials and the recommended cultural management practices.

1.1.2.5.2.2.1.1. Tomato

At ARI, Mingora, 11 AVRDC advanced lines of tomato were transplanted in the first week of April 2015in the open field conditions (Appendix 29; Fig 73). Fruit yields, total soluble solids (TSS), water content and shelf life differed among the entries. Most promising lines were AVTO-1288 and AVTO-1289 because of their higher yields and TSS with intermediate shelf life of 5-6 days compared to the other entries. However, AVTO-1288 had much higher water content than AVTO-1289 which is a negative factor if the fruit is to be processed into dried or sauce product.

Figure 73 Field trials of AVRDC advanced tomato lines at ARI, Mingora-Swat, KP

AVTO-1418 and AVTO-1429 were the other high yielders but their TSS contents were significantly lower than that of AVTO-1288 and AVTO-1289 and they lasted in storage at ambient for only 4-5 days. The long shelf life tomato lines, which is 7 days, were AVTO-9708 and AVTO-1420 but their yields and/ or TSS content were lower than that of the two most promising lines.

The same advanced lines of tomato were evaluated at AZRI, Umerkot, Sindh, and at NARC, Islamabad. At AZRI, the plants were transplanted on August 18, 2015 and data gathering is ongoing. At NARC, the plants

were transplanted in May 2015. Due to consecutive heavy rains, early and late blight diseases became a major problem. Some of the lines wilted completely. Also, insect pests such as armyworm and fruit borer infested the crop. It was decided to forego the experimentation and to extract seeds from surviving plants. Small quantities of seeds were obtained from AVTO 1429, AVTO 1288, AVTO 1418, AVTO 9708 and AVTO 1455 for future use.

Figure 74 Onion bulbs stored for shelf life determination at ARI, Mingora-Swat

1.1.2.5.2.2.1.2. Chili

In AZRI, Umerkot, Sindh, 13 AVRDC advanced chili lines namely C04878, TC06050, TC06472, AVPP 9701, AVPP 9704, AVPP 9804, VI059328 C05573, AVPP 0506, AVPP 0705, AVPP 0903, AVPP 1236, AVPP 1346 and PBC 518 C05650 were sown in the nursery on June 7, 2015 and transplanted in the open field on July 10, 2015. All plants were at the flowering and fruiting stage.

1.1.2.5.2.2.1.3. Onion

In ARI, Mingora-Swat, 9 land races and exotic onion varieties namely Swat 1, Saryab Red, Chiltan 89, Phulkara, NARC-1, NARC-2, Brown Spanish and River Hunter were transplanted in December 2014 and harvested in June 2015. After taking the yield data, the bulbs were stored in a common ventilated store at ambient for shelf life determination (Fig 74). Key findings are presented in Appendix 30.

Based on yield and shelf life data, the most promising variety was NARC-2, followed by NARC-1. Swat-1 had the longest shelf life of 34 days but its yield was significantly lower than that of NARC-1 and NARC-2.

In ARI, Quetta, 13 land races and exotic varieties of onion namely Chiltan-89, Saryab Red, Quetta Red, Swat 1, Phulkara, Nasarpuri, Trich Mir, NARC-1, NARC-2, Tarnab Red, Yaqoot, Lucky and Rota were transplanted in March 2015 and harvested in September 2015. Out of 13 varieties, the bulbs of10 varieties namely; Chiltan89, Saryab Red, Swat 1, NARC-1, NARC-2, Tarnab Red, Trich Mir, Lucky, Phulkara and Nasarpuri were stored in a replicated trial in ventilated store at a room temperature on 11-09-2015 with the objectives to select a suitable variety for longer shelf life, least sprouting and rotting.

1.1.2.5.2.2.2. Review postharvest and value adding technologies available locally and from other countries and assess their applicability to local/provincial situation

This activity has been started in the previous reporting period and the literatures obtained were used as basis of research to adapt technologies and develop new technologies. Some literatures on best

practices were used as training content. Accessing related literature will continue, particularly to support the findings of ongoing research.

1.1.2.5.2.2.3. Build R&D capacity of partners on postharvest research; develop HRI postharvest lab with basic apparatus

The postharvest R&D capacity of the Horticultural Research Institute (HRI) and Food Processing and Product Development Institute (FPPDI) of NARC, Islamabad, and Postharvest Research Center (PHRC), AARI, Faisalabad, were assessed in August 2015 by the Postharvest Specialist of AVRDC South Asia Regional Office. Overall, HRI had no dedicated postharvest laboratory, though it has some basic postharvest apparatus such as refractometer, penetrometer, titration system and pH meter. A room was identified to be developed into a postharvest lab and some small equipment were programmed for procurement. Some R&D activities for fresh produce to support the AIP project were also identified, such as modified atmosphere packaging and low-cost cooling methods. The lab will also support the quality measurement needs of breeding and production researches. On the other hand, FPPDI and PHRC were well equipped with capable manpower. FPPDI will be tapped in processing research and training programs while PHRC has been commissioned by the AIP/AVRDC project to conduct fresh and processed vegetable research.

A national postharvest workshop with 30 participants from partner institutes (ARI-Tarnab, Peshawar; VRI and PHRC-AARI, Faisalabad; ARI Quetta; HRI and FPPDI, NARC, Islamabad; and university representatives) was conducted on August 28, 2015 in Faisalabad, to know the strengths of each partner and what they can deliver best, review the technology generation and promotion activities to be done, and develop the work plan for each partner (Fig 75). The workshop established the role, work plan and deliverables of each partner. AVRDC South Asia Regional Director and Postharvest Specialist presided over the workshop.

Figure 75 National postharvest workshop at Faisalabad.

Furthermore, the AIP-Vegetables' Team Leader, Socio-economist and Vegetable Value Chain Coordinator participated in the annual review of the AVRDC/USAID Postharvest Program on August 31-September 1, 2015 and the following AVRDC Theme Consumption Meeting on September 2-3, 2015 in Dubai. This has widened the Pakistan team's knowledge and understanding on postharvest project delivery in a value chain setting.

1.1.2.5.2.2.4. Adapt and optimize available low-cost postharvest technologies and develop new technologies including fresh produce handling (e.g. packaging, storage) and processing (dried product/powder, sauce, juice)

R&D activities were conducted to adapt and optimize selected postharvest technologies for inclusion in the technology promotion component. To backstop the R&D works in Pakistan, research was conducted at AVRDC South Asia headquarters in India (AVRDC-SA).

1.1.2.5.2.2.4.1. Solar dryers

At the Postharvest Research Center (PHRC), AARI, Faisalabad, a simple solar dryer with transparent polyethylene film cover and adjustable drying chamber was developed (Fig 76). Drying trials on chili and onion showed faster drying producing more hygienic product than that under open sun drying but browning of the dried product was a problem (Fig 77).

Figure 76 Solar dryer with adjustable drying chamber and polyethylene film cover

Figure 77 Dried chili and onion product and powder showing discoloration

At AVRDC-SA, solar drying trials for tomato, onion and chili were conducted. Two types of solar dryers – a solar dryer with a rotary ventilator (SDR) and tunnel type solar dryer with transparent polyethylene film cover (SDT) (Fig. 78) - were tested for tomato (var. 'Arka Saurabh') and onion (var. 'Bhima Kiran').Higher temperatures and lower relative humidity (RH) were maintained in the two solar dryers than in open sun drying (Appendix 31). As a result, drying was faster in the two solar dryers compared to that in the open sun (Appendix 31). The color of the dried product measured in terms of colorimetric lightness values did not significantly differ with drying treatment. The

color of the dried tomato was darker (lower lightness values) than that of fresh fruit while that of dried onion was similar to that of fresh produce.

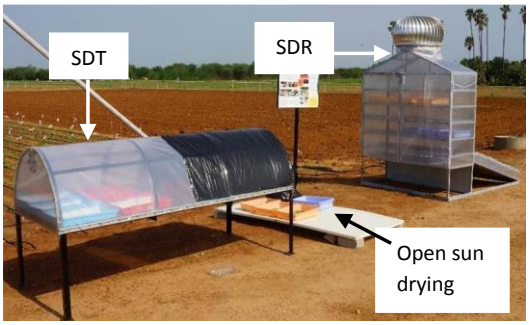


Figure 78 Two types of solar dryer and open sun drying

The rehydration ratio; a measure of the amount of water absorbed to increase the yield of the reconstituted product, was higher in the dried onion product from the two solar dryers. However, the two solar dryers resulted in a higher loss of vitamin C content in dried onion than the open sun drying treatment (Appendix 32). In dried tomato, the drying treatments had no significant effect on vitamin C content which was about 22-32% lower than that of fresh fruit.

In chili, four types of solar dryers were compared to open sun drying treatment: SDR, SDT, tunnel type solar dryer with black polyethylene film cover (SDB) and greenhouse solar dryer with black plastic film lining of the polycarbonate roofing (GSD) (Fig 79). Drying temperatures were highest in the GSD and lowest in open sun drying (Appendix 33). RH was lowest in the GSD and highest in open sun drying. As a result, drying was fastest in the GSD (4 days) and slowest in open sun drying (9 days). Color of dried product seemed to be better maintained in the SDR and SDB.

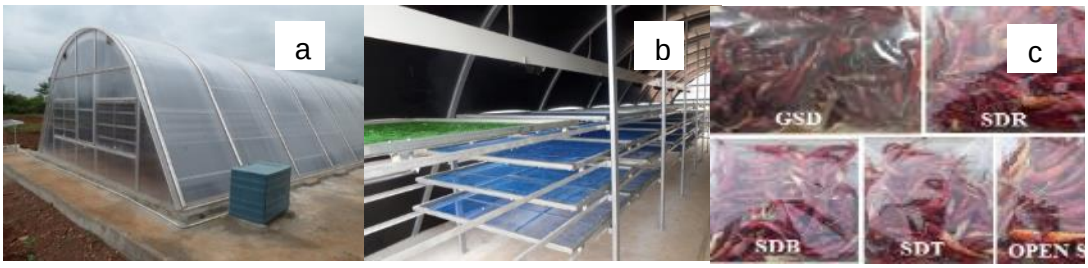


Figure 79 (a) Greenhouse solar dryer (GSD) with solar panel and battery storage to power the ventilation system;
(b) a black plastic sheet roof lining and layered drying trays;
(c) chili dried using the GSD, SDR,SDB, SDT and open sun drying

The greenhouse solar dryer has great potential for drying commercial volumes of produce and could be adopted by smallholder farmer groups. However, the present design is costly, about USD 13,100 and the maximum temperatures exceed 70^{o}C. Arrangement with the engineer-fabricator has been done to simplify and reduce the cost of the dryer, such as replacing the solar-powered ventilation system with rotary ventilator and the use of simple drying trays. This type of dryer can be adapted to Pakistan.

1.1.2.5.2.2.4.2. Tomato sauce processing

Tomato sauce production was optimized at PHRC, AARI Faisalabad. The process involved selection of red ripe fruit, cleaning, slicing and removing seeds, cooking the pulp to remove water and concentrate the sauce to about 25^{o} Brix soluble solids, mixing the flavor formulation,

pasteurization at 100°C for 60-90 minutes, and packing and sealing in bottles or plastic bags when sauce temperature decreased to 65°C. Figure 80 shows the finished tomato sauce product in a labeled bottle and plastic bag produced by PHRC.

Figure 80 Tomato sauce in bottle and plastic bag and also the dried chilies dehydrated through direct sun and solar drier at PHRC, AARI, Faisalabad

1.1.2.5.2.2.4.3. Non-invasive technologies for tomato quality and storage evaluation

Destructive quality parameters such as firmness, total soluble solids (TSS), acidity, dry matter content and starch breakdown require cumbersome, laborious and time-consuming measurements which are performed on only a small sample of produce that may not fully represent the variability within batches. Non-invasive quality evaluation can be carried out more quickly on much larger sample sizes, with the added advantage of repeat analysis over the same samples to follow over time the evolution of quality. The use of a differential absorbance (DA) meter for the rapid, non-invasive assessment of quality parameters, and the use of a hardness tester for non-invasive firmness measurement were examined in a series of trials at AVRDC-SA.

In tomatoes at different ripening stages, the DA index was strongly correlated with a* values (reddening), destructive and non-destructive firmness, and vitamin C content (Appendix 34). The non-destructive and destructive measurement of firmness was also strongly correlated (R^2 = 0.88). These results indicate the potential of the DA meter and hardness tester for measuring quality non-destructively.

In mature-green tomatoes from three varieties (two AVRDC lines ‘DET-56’ and ‘CH-151’, and one commercial variety ‘Arka Saurabh’) stored at ambient (29°C) and chilling temperatures (7°C), the use of the DA meter and hardness tester to assess quality changes was trialed. Fruit stored at ambient turned red and lost weight faster than those stored at chilling temperatures. Fruit reddening did not differ with variety during chilling storage; the fruit turned red (a* >20) after 23 days of storage or 11-15 days earlier than ambient-stored fruit (Fig. 3.18). At ambient, the AVRDC line ‘DET-56’ turned fully red after 8 days of storage or 4 days earlier than the two other varieties. Weight loss differed with variety at both temperatures, with var, ‘Arka Saurabh’ losing less weight than the two AVRDC Lines. The TSS of the three varieties was almost similar at the mature green stage (4-5°Brix). With storage and ripening, TSS increased at a faster rate at ambient than at chilling temperatures. The two AVRDC lines had higher increases in TSS than var. ‘Arka Saurabh’. The DA index decreased with storage and was not detected when the fruit

lost green color after 8-12 days at ambient and 20-24 days at chilling temperatures. Linear regression models revealed a strong correlation (R^2 = 0.84-0.96) between the DA index and a* values for the three varieties at ambient temperatures, while at chilling temperature a high correlation (R^2 = 0.75) was obtained only in AVRDC line 'DET-56' (Appendix 35).

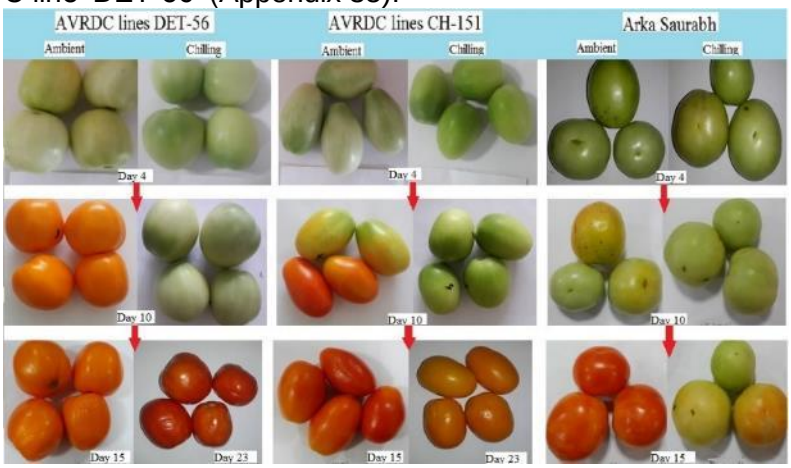


Figure 81 Fruit color changes in three tomato varieties during ambient and chilling storage

The DA index and weight loss were strongly correlated (R^2 = 0.71-0.93) in the three varieties at both storage temperatures. For TSS, a strong correlation with DA index was obtained only in AVRDC line 'CH-151' at ambient. Firmness loss due to softening with ripening was expectedly more rapid at ambient than at chilling temperatures detected as decreases in destructive and non-destructive firmness values. Penetrometer and non-destructive firmness values were strongly correlated in the three varieties regardless of storage conditions (R^2 = 0.82-0.97) (Appendix 36). The digital firmness tester did not produce consistently strong correlation with the non-destructive firmness values. Lower correlation coefficients were obtained for the two AVRDC lines at chilling temperatures and for Arka Saurabh stored at ambient.

Vitamin C content of 'Arka Saurabh' fruit decreased more rapidly at ambient than at chilling temperatures (Fig. 82). Ambient-stored fruit lost about 18% vitamin C after 16 days while chilled fruit lost about 14% after 24 days of storage. The results demonstrate the benefits of low temperature in preserving quality. Quality parameters can be measured using the non-invasive tools but further optimization studies are needed to verify the inconsistencies in the correlation of non-destructive and destructive measurements.

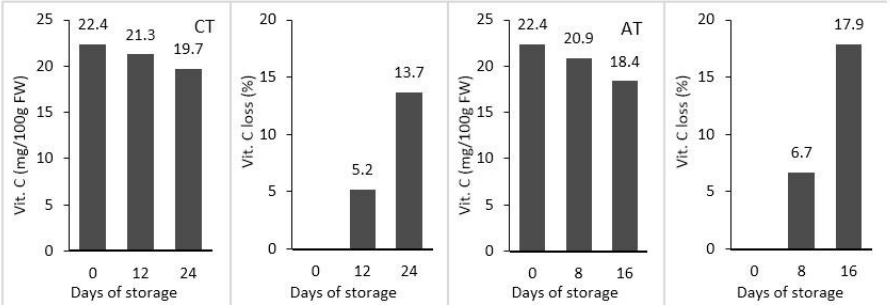


Figure 82 Vitamin C content and loss in tomato var. 'Arka Saurabh' during storage at chilling temperature (CT) and ambient (AT).

1.1.3. Cereal and Cereal System – Wheat

1.1.3.1. Increasing Wheat Production through Rapid Diffusion of new High Yielding, Rust Resistant Wheat Varieties

Gaps identified by three participatory wheat seed value chain workshops during 2014-15 were systematically addressed through a range of activities during the wheat growing season of 2014-15 with the following results:

Creating new innovation platform, developing partnership and networks

Network of partners developed in AIP-Wheat has already been reported in the last six monthly report i.e. October 2014 to March 2015. This report highlights results obtained through that innovation platform.

1.1.3.2. Fast tracking deployment of wheat varieties for buffering possible incidence of wheat rust

A total of 297-ton seeds of 17 new high yielding and rust resistant wheat varieties were deployed to more than 9000 farmers across the parts of 63 districts using a number of activities, which includes participatory varietal selection (PVS), informal research and development (IRD), diamond trial, village level seed production. Majority of farmers obtained each of a 25kg bag[1] seed of one of the 17 varieties included in the project to plant next his or her most widely grown wheat variety. This simple paired plot comparison is called as informal research and development (IRD). Nearly 9000 farmers participated in these informal paired plot comparisons. An analysis of results from a randomly drawn sample of farmers indicated considerable gains in wheat yields (Figure 83) and considerable contribution to various dimensions of livelihood support.

These would offer several benefits to farmers and to wheat production systems at large. Some of those are;

- Informal varietal evaluation by farmers identified most appropriate wheat varieties for the specific regions. For example, Pakistan 13 has been liked in Barani areas in Punjab, Baluchistan, KP and Gilgit Baltistan. Lalma showed excellent performance in KP and Gilgit-Baltistan areas. Shakar 13 was liked in Baluchistan and Gilgit-Baltistan. Punjab-11, AAS-11, Millat-11 and Lasani performed equally well in rainfed as well as partially irrigated conditions. NIA-Amber, NIA-Sundar, NIA-Sunhari and NIA-Sarang also performed well in various parts of Sindh particularly in low input agriculture. Benazir performed better than Nuclear Institute of agriculture (NIA) varieties but was not seen as a superior variety over TD-1.
- Extensive paired plot comparison created knowledge and demand for new varieties in the villages across Pakistan.

[1] The size of the seed bag for Gilgit-Baltistan and hilly areas of Khyber Pakhtunkhwa was 13 kg.

- Findings from the paired plot comparison-IRD and participatory varietal selection trials indicated that increase in grain yield ranged from 23% to 113% and highest yield advantage was observed in Barani areas (Fig. 83). This helped close the huge yield gap in wheat production systems in Pakistan as official data indicate national average yield of around 30 *maunds* per acre (3 t ha^{-1}), while farmers in rainfed areas are just harvesting around 15 *maunds* per acre (1.5 ha^{-1}).
- This efforts has significantly increased access of new high yielding, rust resistant wheat varieties in food deficit and rural areas of Pakistan directly contributing to improve household food security and by replacing old and obsolete varieties by new ones.
- By a conservative estimate, 300 tons of wheat seeds deployed this season can produce more than 9,000 tons of seeds. Considering that only 50% of this is available for seed, it will cover more than 35,000 ha by new seed varieties in the rural remote areas that are generally grown with farm saved seeds of old and obsolete varieties that are the recipe for wheat rust epidemics.
- Informal flow of new seed varieties in the villages through a farmers-to-farmers network. Assuming that each farmer gives out seeds to 3 fellow farmers, nearly 27,000 additional farmers can have access to new seed varieties in the remote villages through informal seed flow for no extra costs.

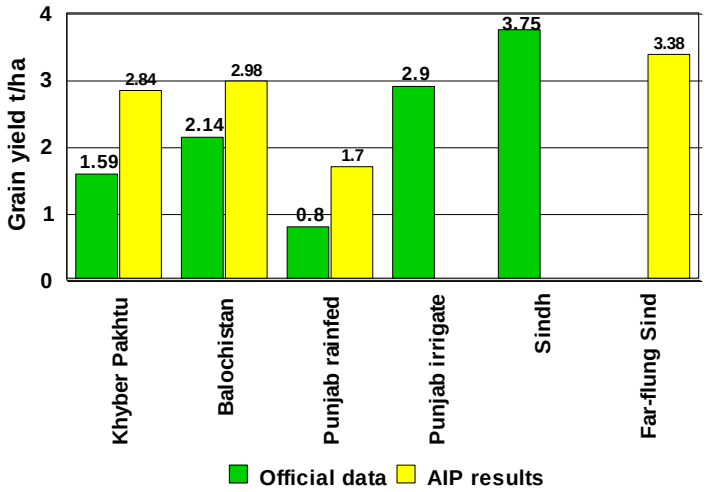


Figure 83 Grain yield performance of new, high yielding rust resistant wheat varieties in various parts of Pakistan in paired plot comparison-IRD implemented by 9,000 farmers during 2014-15 wheat season

Findings from the follow up survey on a random sample of collaborating farmers of PVS and varietal deployment through IRD indicated overwhelming acceptance for new wheat varieties. More than 87% respondents (n=603) were willing to grow and each of them have saved on average 265kg seeds of the new variety they received last year (Fig 84).

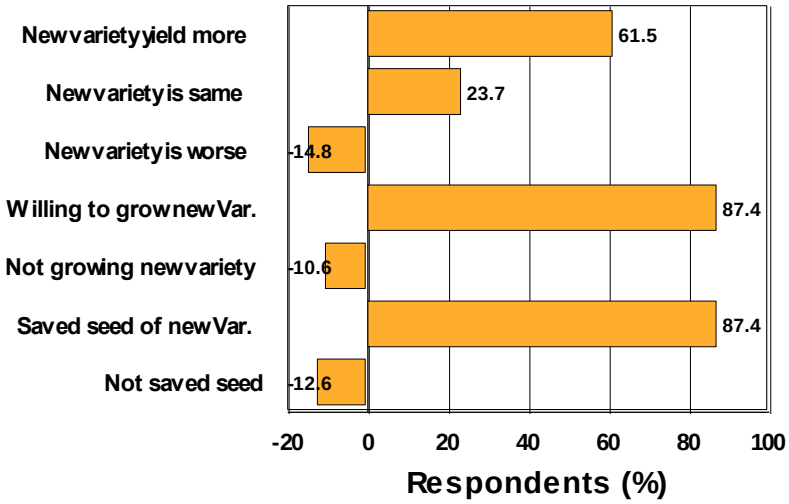


Figure 84 Acceptance and possible uptake of new wheat varieties by collaborating farmers of several of PVS & IRD during 2014-15

These activities offer excellent opportunity for achieving wheat varietal diversification across many districts of Pakistan by fast tracking deployment of new high yielding and rust resistant wheat varieties. These initiatives have been instrumental to contribute to household food security in addition to contributing to other dimensions of livelihoods.

Diamond Trial

There is a huge yield gap between experimental yield and the actual wheat yield realized by the farmers in particular by smallholder farmers in Pakistan. One of the major reasons for this is genetic gains incorporated by wheat breeders are not transferred to the needy farmers quickly. Due to various reasons, new varieties reach to farmers after 6-7 years of release. A simple but powerful on farm experiment was conducted by Wheat Research Institute (WRI) Faisalabad to demonstrate the value of growing new varieties over the old and obsolete ones. The results from a 2x2 factorial experiment are summarized in Appendix 38.

- Benefits of using certified seeds range between 7-11% and higher benefits of certified seed are seen with old varieties.
- Yield advantage of using new varieties over old are in the range of nearly 54-80% with or without the use of certified seeds.
- Even farm saved seeds of new variety gave nearly 54-68% higher yield over old irrespective of the certified or farm saved seed (Appendix 38).
- The message is clear; focus on varietal replacement not merely seed replacement of old varieties.

1.1.3.3. Strengthening Wheat Seed Systems through Seed Multiplication

During 2014-15, quality seeds of a 17 new high yielding and rust resistant varieties was produced through public-private partnerships by using the concept of village-based seed production. Majority of these activities were focused in far-flung areas and using the concept of decentralized seed production and marketing. 900tons of quality seed was produced (Fig. 85) against a preliminary estimate of over 1,300tons. The difference in the production was mainly caused due to adverse weather during harvesting and threshing period. Significant proportion of wheat crop was rendered unsuitable for seed purpose.

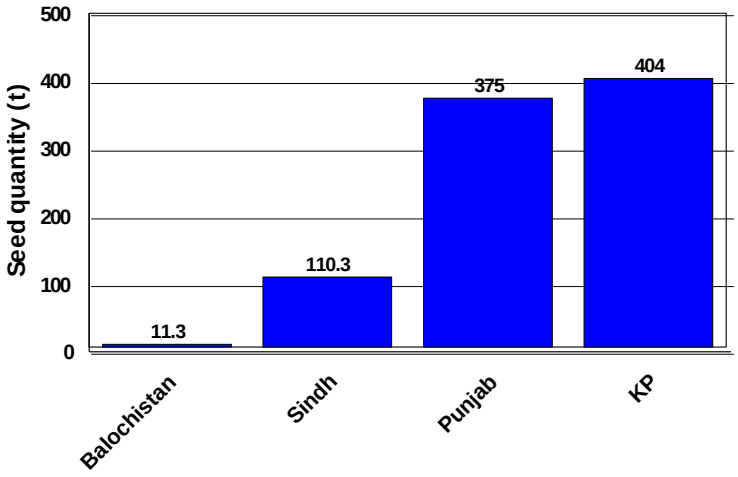


Figure 85 Summary of wheat seed produced in AIP project during 2014-15

Seed growers were enthusiastic about the concept of decentralized seed production and marketing.

1.1.3.4. Effective Fungicides Introduced, Evaluated and Registered for Controlling Wheat Rusts

Two seed dressing fungicides, e.g. Hombre and Raxil and four spray fungicides namely Amistar, Folicur, Nativo and TILT, approved by US Federal law for crop protection, were evaluated at six locations during 2014-15 season. These locations include Cereal Crop Research Institute Nowshera in KP province and Crop Diseases Research Institute (CDRI), NARC in Islamabad for stripe rust, Regional Agricultural Research Institute (RARI) and WRI Faisalabad for leaf rust, CDRI Karachi and WRI Sakrand for stem rust.

Since, the study was done under natural inoculum pressure, and overall wheat rust incidence was lower this year, variable results were obtained as influenced by the level of disease pressure. A glimpse of the results have been presented in Figure 8.

Effect of TILT in reducing yield loss was almost uniform both for yellow rust and leaf rust but this was not the case with rest of the three fungicides (Figure 8). For leaf rust, Natiovo and Amistar followed by Folicur were better alternatives compared to TILT. This research will be repeated for one more season for more conclusive results.

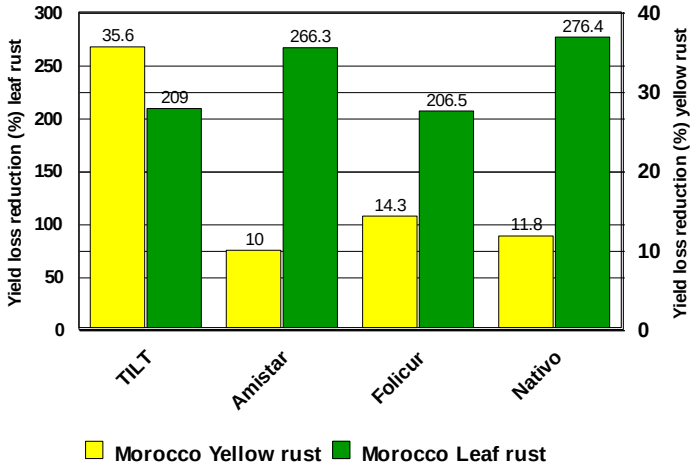


Figure 8. Extent of yield loss that could be protected with the spray of various fungicides for Morocco, a universasusceptible wheat variety to rusts, 2014-15

1.1.3.5. Development of durum wheat value chain

National Uniform Yield Trial (NUYT) was conducted in 9 locations across Pakistan. These locations cover both rainfed and irrigated locations and include ARI and BARDC Quetta, CCRI and NIFA KP, NARC Islamabad, BARI, WRI Faisalabad and RARI Bhawalpur and WRI Sakrand. A number of durum wheat lines were found promising both for rainfed and irrigated areas (Fig 86). Most promising genotype with their relative ranks are given below (Appendix 39) based on the analysis of genotype by genotype and environment interactions analysis (GGE).

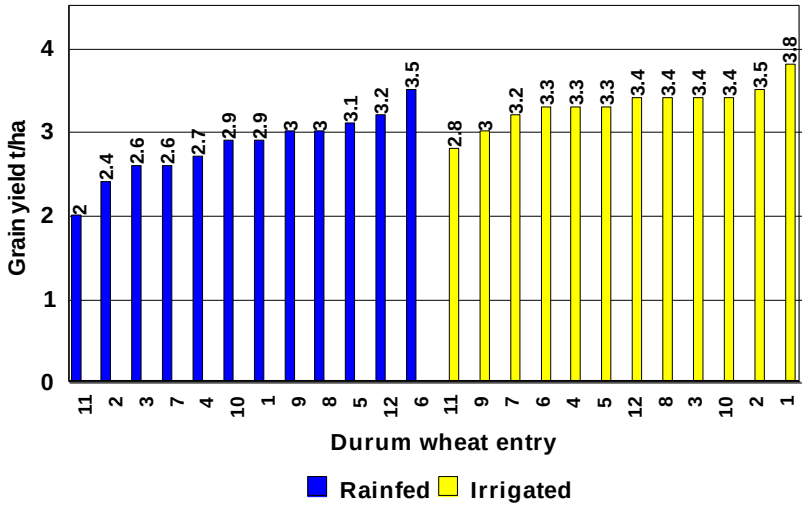


Figure 86 Yield performance of various durum wheat varieties evaluated in NUYT, 2014-15

1.1.3.6. Training and Capacity building

A number of training and capacity building initiatives were done in AIP wheat engaging nearly 3000 beneficiaries (Fig.87). A listing of the training is given below;

- Training on on-farm research methodology
- Training seed growers on wheat seed quality management
- Training private sector companies on producing high quality wheat seed through public private partnership
- Wheat Grain Quality Training

First three training were already summarized in the last six monthly reporting period while a brief account on the fourth training is given below. During this reporting period, training on wheat grain quality was organized by CIMMYT from 6 to 11 April 2015. First part of the training event was organized at Food Science and Product Development Laboratory, National Agricultural Research Centre (NARC), while the second event was organized at Grain Quality Laboratory at WRI jointly with WRI with financial support from USAID. Dr Roberto Javier Pena, ex CIMMYT Scientist and renowned Cereal Chemist was the trainer for this training. Such training was for the first time organized in Pakistan. Over 50 Scientist benefitted from the training. In addition to cereal chemists and food technologies, wheat breeders, agronomists, socio-economists and research managers also participated in the training. Meeting shifting consumer demands will require more rigorous and specialized grain quality analysis and applying it earlier in the breeding process than just prior to a variety's release, as has been the case to date.

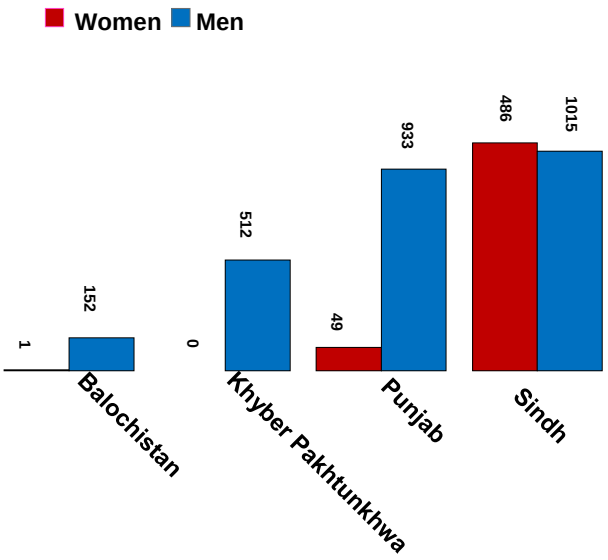


Figure 87 Number of men and women participants for various training and capacity building for various AIP training initiatives, 2014-15.

1.1.4. Cereal and Cereal System - Maize

1.1.4.1. Development or introduction of climate resilient maize:

Agricultural production and productivity are being challenged by climate change globally. Its effect is more pronounced in developing countries where farmers have limited resources to adapt. The diverse nature of climate change ranging from extreme temperatures, erratic rainfall, heavy floods and scarcity of ground water among others poses a threat to global food security. Developing and deploying crop varieties that show resilience to climate change are among the strategies where farmers can mitigate its impact.

CIMMYT's maize breeding program developed germplasm with improved tolerance to drought and water stress and several maize varieties are available that can withstand high temperatures (>45^{0}c) at critical growth stage of the crop. The AIP maize component is introducing such materials to Pakistan where maize growing farmers faces problem of acute water shortage and thermal heat in the pick months of May-July. The availability of such climate smart varieties both hybrids and OPVs will enhance maize productivity and improve livelihood of resource poor farmers.

During the reporting period the evaluation of the following climate resilient variety/hybrid trials were completed:

- Evaluation of 396 white maize climate resilient hybrids sourced from CIMMYT's Latin America and Southern Africa regional offices (Mexico and Zimbabwe).
- Evaluation of 30 white maize climate resilient open pollinated varieties (OPVs) sourced from CIMMYT's Southern Africa regional office (Zimbabwe).
- Evaluation of 49 yellow maize climate resilient hybrids sourced from CIMMYT's Latin America regional offices (Mexico and Colombia).
- Seed micro increase of 137 elite parental inbreds introduced from CIMMYT regional offices (Mexico, Colombia and Zimbabwe).
- The above list of spring trials were grouped under 50 sets and evaluated in KP, Punjab and Sindh provinces. The following table shows the description of the trials evaluated during spring season:

The data from these trails will be analyzed and interpreted to help identify best

performing entries and suitable seasons for future commercial production. In addition, the performance data from the trails will be combined and analyzed with previous season data to further check entries continued performance across seasons and years in comparison with local checks.

Figure 88: Women planting AIP maize spring trials at Ali Akbar Seeds farm, Bhawana

Figure 89: Women planting AIP maize spring trials at Jullundur Pvt farm, Arifwala

1.1.4.1.1. Maize travelling seminar (spring 2015)

The AIP maize program in collaboration with Pakistan Agricultural Research Council (PARC) organized a maize travelling seminar for the first time after it was discontinued for more than 10 years for lack of funds and other reasons. The objectives of the travelling seminar were among others:

- To create synergies among the AIP maize partners in maize evaluation and deployment
- To share experiences and lessons in field trial management and data recording
- To identify and justify best performing entries across the different sites

The evaluation which mainly focused on spring maize in the Punjab province was conducted on June 15-17, 2015 and experts comprised from twelve public and private institutions including seed companies, agricultural universities and public research institutions evaluated the performance of the AIP maize spring trials across the different sites in the Punjab province.

Apart from the evaluation, the event created a good opportunity for stakeholders to share experience in trail management and field data recording. Participants appreciated CIMMYT and PARC for creating such a unique platform where stakeholders open their gate for visitors to show case their activities and discuss and share information how AIP maize germplasm perform across the different sites. When CIMMYT first introduced the range of maize hybrids and OPVs in the beginning of 2014 it was not sure how the performance would be particularly in harsh environments where temperatures often exceed 40^0C and at an elevation about 100 meters above sea level. However, this travelling seminar proved that the AIP maize program has much to offer to the needs of Pakistani partners not only in their effort to produce hybrid seed locally for seed self-sufficiency but also to enhance local maize breeding program by enriching their maize genetic pools. The travelling seminar also helped partners to identify and select good performing entries which will be allocated to them by CIMMYT after evaluation of company's performance. Participants also requested the continuation of the activity in other provinces and in the Kahrif season as well. Below are the summary of the recommendations or suggestions by the participants from the travelling seminar:

Recommendations/Suggestions:

- To incorporate temperate maize germplasm for spring season trails
- To plant trials in their ideal sites based on their days of maturity
- To give more attention in promoting and testing white maize varieties in KP and other hilly areas of Pakistan
- Evaluation and deployment of competent yellow maize varieties suitable for spring season planting in Punjab province to provide farmers with alternative maize varieties
- Promotion of white biofortified maize varieties in KP and hilly areas of Pakistan
- In future to include the visit of seed processing facilities and the wet milling industry
- Travelling seminar to be organized in Kharif season including visits in KP provinces

The following trials were evaluated by the participants during the travelling seminar. Appendix 41 shows the list of participants and their respective institutions and Appendix 42 feedback from the participants of the travelling seminar.

- Early/extra early white maize hybrids
- Advanced white maize QPM hybrids
- Yellow kernel QPM hybrids
- Tropical yellow maize hybrids
- Tropical/subtropical three way cross yellow/white maize hybrids

Figure 90: partial view of maize travelling seminar participants

Figure 91 : Field evaluation at Zamindara Seeds Pvt (L) and at 4B group farm (R)

1.1.4.1.2. Selection of climate resilient maize varieties for registration

After testing the introduced maize varieties for the last three consecutive seasons, AIP maize partner shortlisted best performing entries based on field performance and analyzed data. The shortlisted varieties showed a 20-50% yield advantage over the local check varieties. The AIP maize partners requested CIMMYT for the allocation of the selected varieties for further testing and registration process. Appendix 43 shows the number of AIP maize varieties selected by partners until spring 2015.

The appendix44 that both public and private institutions are interested to take further the maize germplasm from the AIP program. Some of the varieties (hybrids/OPVs) were selected by more than one partner, which requires proper procedure for allocation. CIMMYT's maize program has set criteria to streamline a fair and equitable product allocation to partners. The following are among the guiding principles for product allocation to partners:

- Investment made so far by the applicant in hybrid testing, and potential investment in hybrid seed production and commercialization
- Likelihood that seed will become widely available to smallholder farmers

- Likelihood that seed will become widely available as soon as possible
- Relative importance of a variety in the variety portfolio of the applicant

Based on these and others criteria the seed of the allocated hybrid is provided to the partner for testing to meet regulatory requirements and to enable the institute to begin seed scale-up. The process of product allotment is underway and will be completed before the end of the year for the above requested varieties.

Figure 92 Good germination and seed bed establishment of AIP maize spring trails at ICI Pakistan (top) and at Tara Crop sciences (bottom), private seed company trial stations in Sahiwal, Punjab.

1.1.4.1.3. Introduction of low soil nitrogen stress tolerant maize varieties

Small holder farmers do not have enough resources to apply chemical fertilizers for crop production. Low soil nitrogen is one of the limiting production factors for yield reduction in maize under small holders farming condition. Varieties that can perform well in the limited/scarce condition of soil nitrogen will help farmers to get reasonable harvest from their farm as well as reduce inorganic inputs to soil environment. Reduced use of inorganic fertilizer has positive impact on the environment and enhances quality of agriculture.

Under the AIP maize program CIMMYT introduced low nitrogen (low N) stress tolerant open pollinated maize varieties from the International Institute of Tropical Agriculture (IITA) for evaluation in Pakistan. A total of ten low N stress tolerant maize varieties are being evaluated in Kharif 2015 season along with two local check varieties. Three public research institutes (CCRI, MMRI and NARC) are hosting the trials. The trials are managed by not applying nitrogen fertilizer (UREA) and data of relevant traits will be recorded. As it is the first time to evaluate such trials, partners' needs to have proper low N stress screening sites and skills to gather relevant information for selection of varieties. Based on the data from the current trials, development of ideal low-N sites and appropriate management practices will be facilitated under the capacity program of AIP maize in the upcoming seasons. Further trails will be included in next seasons to compare different nitrogen fertilizer regimes against low N trials. The list of the low-N stress tolerant maize varieties are presented under Appendix 51. Further to the evaluation process of these varieties, partners will get benefit by enriching their maize gene pool by using the seeds from these entries.

1.1.4.1.4. Evaluation of drought tolerant maize inbred lines

Pakistan is among the water scarce countries of the world and farm production is heavily dependent on the availability of enough surface water during the important growing stages of a crop. Maize is generally considered as water intensive plant; however, maize scientists have developed germplasms that can withstand water scarcity and perform well in the arid and semi-arid

ecologies like Pakistan. Introduction and evaluation of such water efficient maize germplasms in Pakistan not only promotes climate resilience farming systems but also increase the competitiveness/profitability of the maize commodity by reducing water and energy which in turn contributes in many ways to the national economy.

Under the AIP maize program, CIMMYT introduced 31 maize inbred lines developed for drought (water stress) tolerance from IITA for evaluation in Kharif 2015. The inbred lines are white grain and help to develop varieties widely acceptable in KP and hilly areas of Pakistan where farmers use maize as food crop. The technical evaluation of the inbred lines which are planted at CCRI, MMRI and NARC includes withholding of water (irrigation) two weeks before flowering which is a critical water stress growing stage for maize. Inbred lines that showed good adaptability at this stress condition will be selected for further testing and formation of new varieties locally. Based on the data of this season further trials will be arranged particularly in spring season to avoid unwanted rain during flowering. Appendix 52 shows the list of drought tolerant inbreds introduced to Pakistan:

1.1.4.1.5. AIP maize candidate varieties under National Uniformity Yield Trial (NUYT)

In the current season of Kharif 2015, 46 candidate maize varieties have been included for the first to be tested under the national uniformity yield trial (NUYT) in Pakistan. The NUYT is a coordinated activity run by Pakistan Agricultural Research Council (PARC) and is part of variety registration process to get nationwide release/production of maize varieties. Under NUYT candidate varieties are tested in 10-15 locations across the country and the data will validate the stability and repeatability in performance of the candidate varieties. The data from NUYT together with previous three season's data will give clear indications on the varieties performance across sites and seasons. The NUYT data is solely compiled by PARC's cereal systems coordination office and trails are coded before dispatch to different testing stations to avoid bias or errors in data recording. Some of the entries included under NUYT are also being evaluated on farmers plot as demonstration and the detail is presented under the seed sector activities of this report. Shortlisting good performing varieties and including them under NUYT in just less than two years can be considered as one of the achievements of the AIP program, otherwise this practice would have taken more than four years in a normal course of action. The Appendix 71 and 72 show summary and list of the maize varieties included under NUYT during Kharif 2015.

Figure 93 Farmers orientation on maize farming practices in Balochistan

1.1.4.1.6. Creating synergies with other USAID climate resilient maize project

Heat Tolerant Maize for Asia (HTMA) is another project funded by USAID's Feed the Future (FTF) program. It is a public-private CIMMYT led alliance consisting of Purdue University, Pioneer Hi-Bred, seed companies, and South Asian public sector maize programs. It is implemented in four south Asian countries viz Bangladesh, India, Nepal and Pakistan. In Pakistan the maize and millet research institute (MMRI) is an implementing partner.

The MMRI in collaboration with CIMMYT Pakistan office organized HTMA field day on 04 June 2015. More than 35 participants from public and private research and development institutions and seed companies attended the field day that included HTMA hybrids visit at MMRI Yusafwala and at Zamindara Seeds Plc. at Dipalpur. Selection of good performing heat stress tolerant maize hybrids was among the objectives of this field day and the AIP maize project will help in facilitating the delivery of the selected hybrids to partners based on hybrid allocation criteria and promote the deployment process in Pakistan.

Figure 94 Partial view of the participants of HTMA (USADI's FTF project) field day at MMRI Yusafwala

Figure 95 Participants visiting HTMA hybrids at Zamindara seeds Plc in Dipalpur

Figure 96 Photo showing tassel burning due to extreme heat and heat tolerant maize line from HTMA program

1.1.4.2. Development or introduction of biofortified maize

Biofortification or the breeding of staple food crops to increase their micronutrient density is widely viewed as a valuable strategy for sustainably improving the nutritional status of some malnourished populations. Successful biofortified varieties must be agronomically competitive with the best available local varieties, acceptable to consumers for all intended uses, including home consumption and marketing, and must be able to improve nutritional status of the target consumer (K. Pixely et al., 2013, Biofortification of maize with provitamin A carotenoids).

According to the global hunger index of 2013 developed by the International Food Policy Research Institute (IFPRI), Pakistan is among the countries where food and nutritional security is at a serious level. The rate of stunting among children under the age of five is about 43% in Pakistan which is one of the highest in the world. Attaining food and nutritional security is one of the main targets of AIP in general and that of the maize component in particular. CIMMYT germplasms that have proven quality of protein and enriched with provitamin A (beta-carotene) are being evaluated in Pakistan to reduce the widely prevalent undernourishment and related health complications.

1.1.4.2.1. Evaluation of biofortified maize during spring and Kharif seasons

The AIP maize program is evaluating protein enriched maize varieties particularly those with enhanced level of Lysine and Tryptophan, which are among the essential amino acids where humans have to get them from external food sources (like eggs, meat, milk and milk products). However, animal derived protein sources are not easily affordable by resource poor farmers and children and women are the most vulnerable.

A total of 60 white and yellow kernel quality protein maize (QPM) varieties were evaluated during the spring and 24 vitamin A enriched hybrids and 60 white kernel QPM hybrids are being tested during Kharif season. Out of the total tested biofortified hybrids two QPM hybrids were included under the NUYT during spring season. These two hybrids have completed the wide adaptability test and expected to be official released in 2016 for large scale commercial production. The QPM hybrids are being evaluated and multiplied by National Agricultural Research Center (NARC) and the varieties will be the first released maize varieties from the AIP program and they will be the first QPM hybrids in Pakistan. Appendix 53 shows the list of biofortified maize varieties evaluated in Pakistan. Appendix 54 list of biofortified maize varieties evaluated in Pakistan (spring and Kharif, 2015).

Figure 97 child carrying yellow maize at Chichawatni from his father's demo plot in Punjab

1.1.4.2.2. Prerelease demonstration and seed production of QPM hybrids

Prerelease on-farm demonstration of the two QPM hybrids has begun during the spring season. The pipeline hybrids were planted in Kaghan in KPK; Rawlakot and Danna Kacheely areas of AJK provinces. The selection of the sites was based on the food habit of the community where maize is the staple food and in many cases the principal source of protein for the resource poor farmers. The farmers demo were planted in $100m^2$ area along with local check variety so that the yield and advantaged can be compared. The demo at Rawlakot is harvested and at Kaghan the crop is approaching maturity.

To ensure the seed production capacity of the parental lines of the QPM hybrids locally, the seed multiplication of the two QPM hybrids is in progress in two isolated fields at NARC in a total of 0.63 acre. The seed micro increase will help to identify proper row orientation and planting pattern of the inbred lines which is one of the important aspects of hybrid seed production. Detasseling (removing the tassel of the seed parent) and removing off type plants from the seed field are being conducted to maintain the quality of the seed. As hybrid seed production requires proper follow up and capacity to meet seed quality standards, NARC needs capacity enhancement in proper seed multiplication

planning, seed processing and conditioning, seed delivery and marketing and on other technical skills in the seed value chain. Furthermore, the nutritional quality of biofortified varieties will be lost if proper protection measures are not set in place. Hence, CIMMYT is planning to give practical training in November 2015 on monitoring and maintaining the grain nutritional quality of QPM and Vitamin A maize varieties.

Figure 98: Showing female (de tasseled) and male rows from the QPM hybrid seed production field at NARC

Figure 99 Removing off type (doubtful) plants from hybrid seed production field at NARC

1.1.4.2.3. Introduction of specialty maize

Maize is one of the extensively utilized cereal crops of the world. One of the reasons for its wider adoption is the availability of maize variants for food, feed and industrial use. Baby corn, sweet corn, popcorn, purple (blue) corn, waxy corn and others are among the different types of maize known for their culinary, dye and health benefits. Among these specialty maize sweet corn and popcorn varieties have been introduced by the AIP maize program for planting during the kharif season.

Two sweet corn open pollinated varieties (yellow and white kernel) and one popcorn variety known for its popping quality were introduced from IITA. These specialty maize varieties are being tested for their adaptation at CCRI, NARC and ICI-Pakistan Ltd. Once their adaptation is confirmed the seed multiplication will continue to avail the products particularly for urbanites where the potential demand for such maize is high. In addition, the germplasm can be used to extract valuable inbred lines for possible formation of the hybrid version in the future.

1.1.4.2.4. Aflatoxin in the spotlight

Food quality and safety issues resulting from aflatoxin contamination present a serious obstacle to programs designed to improve nutrition and agricultural production that link farmers to markets. Aflatoxins are highly toxic, cancer-causing fungal chemicals that suppress the immune system, retard growth, and cause liver disease and death in both humans and domestic animals. Aflatoxin exposure thus provides a challenge in efforts to improve people's health, especially women and children (www.iita.org). Aflatoxin is a poison produced by a fungus, Aspergillus flavus, residing in soil and dead/decaying matter in the field and attacks grains of maize, ground nut, rice and root crops like yam and cassava among others.

Although the problem of aflatoxins is known in Pakistan, there is no a coordinated effort in protecting maize or other crops from its serious consequences. The AIP maize program in collaboration with relevant stakeholders including the industry initiated a project discussion to develop safe and effective ways (including biological method) of controlling maize aflatoxins in Pakistan. During its first meeting, 07 April 2015, experts addressed issues on best ways of controlling aflatoxin primarily in maize and further identify the role of stakeholders in the value chain. During the consultation process stakeholders raised the following issues/suggestions/recommendations:

- The level of aflatoxins in the food/animal products is found above the standards of foreign countries particularly in EU which prohibited export of commodities
- Farmers' wider practices of drying maize cobs on the open field/soil found to be the major source of aflatoxin contaminations in maize
- To initiate biological control of aflatoxin by introducing naturally safe fungal types into the soil. To learn from aflatoxin mitigation projects in Africa which are also funded by USAID and USDA among others donors
- To establish aflatoxin controlling and testing lab facilities under the Borlaug Innovation Platform, a process under discussion between CIMMYT-Pakistan and USAID mission in Islamabad
- To further explore potential stakeholders (local and international) and to engage the private sector in owning the project though co-funding and other support

Based on these and other recommendations, a concept note will be developed to outline implementation framework and funding strategies. It is planned to hold a national aflatoxin workshop in consultation with USAID and other stakeholders to enable the kickoff this project in Pakistan.

Figure 100 Consultative meeting on maize aflatoxins 7th April 2015

Figure 101: Stakeholders' discussions on aflatoxins

Figure 102: drying of maize cobs on soil is one of the causes of aflatoxin contaminations in maize

1.1.4.3. Development or introduction of biotic stress tolerant maize

Pests and diseases cause major loss on maize productivity. In some cases maize stalk borer only can cause a 40% yield loss and such loss will not only reduce total maize production and quality but also affects the livelihood of small holder farmers. During the current Kharif season, AIP-maize is evaluating 13 stem borer tolerant open pollinated maize varieties against two local checks. The OPVs are developed through conventional method by the International Institute of Tropical Agriculture (IITA). The varieties are planted at CCRI, MMRI and NARC and currently at milk stage. These trials are managed by not applying pesticides on the trials and relevant data are recorded to identify the most tolerant entries at natural condition. In subsequent seasons the trials will be compared with under protected condition by releasing stem borers to the trials.

Best varieties from these trials will help farmers to save their produce from pest attack and reduce production cost by avoiding chemical spray. Avoidance or reduction of chemical spray to control maize stem borer will have positive environmental impact. A customized training on mass rearing of maize stem borer and related techniques is planned for December 2015. Maize entomologists will have a chance to gain knowledge from subject matter specialists who will be invited from CIMMYT regional offices in China and Kenya. The introduced varieties will also serve as source population to enhance local gene pools and for the development of hybrid maize varieties in future.

Figure 103: larva of maize stem borer on leaf and inside stem (most damaging stage)

1.1.4.4. Enhancing the Maize Seed Sector

Access and availability of quality seed is the most important factor to enhance agricultural productivity. In this regard, the Pakistan maize seed industry is not robust enough to mitigate the high demand of maize seeds. More than 85% of the hybrid seed is imported annually which makes the unit price of the hybrid very expensive to the smallholder farmers. As a result farmers are forced either to recycle or to use substandard seeds available in the market. Resolving the maize seed issue related to price and quality through the participation of public and private institutions will help to unlock the potential of maize productivity in Pakistan. AIP maize is a public-private alliance to enhance local capacity in the provision of affordable quality maize seeds in Pakistan (Appendix 44).

Currently, ten private and nine public institutions are directly involved under the AIP maize activities and part of AIP maize working group team. Three multinational companies also occasionally share their experiences under the AIP maize network (Appendix 46). It is one of the AIP maize successes to manage such multi stakeholder platforms. Members of the AIP-MWG meet at least once in a year to plan upcoming activities, update progress, share experiences and discuss way forward.

1.1.4.4.1. Taking the seeds to the farmers: *on farm demonstration*

For the first time under the AIP maize program farmers start evaluating candidate varieties in their own field. During Kharif 2015 the seeds of 11 maize varieties were distributed for on farm demonstration. Out of the eleven three are hybrids and eight are white grain open pollinated varieties. The main purpose of the on farm demonstration is to popularize the variety at its future potential marketing area and also to gather performance data based on farmers management who are the ultimate user of the candidate varieties. In addition, the AIP maize also supported promotion of locally developed hybrid from MMRI at 10 farmers' sites to make popular the variety among farmers. The information

from farmers will help for future promotion strategies of the candidate varieties. List of the demonstration sites are presented under Appendix 47.

Figure 104: De-tasseling (removal of the female flower) at NARC's hybrid seed production field

1.1.4.4.2. Support to AIP maize partners (Sub grants)

During the reporting period a total of $62,066.63 has been granted to 17 AIP maize partners to help execute the different commissioned projects. Until the compilation of this report 16 partners have signed the Sub Grant Agreement (SGA) that will be applicable until March 2016. The public sector received 73% of the sub grant and the private sector 27%. The list of the sub grant distribution is presented under Appendix 48 and the distribution of funds based on commissioned projects under Appendix 49. Part of the AIP maize sub grant is the support of IT equipment for field data recording and compiling activities. The equipment support will help to ensure data precision in field operations which in turn increase expected deliverables from partners. Appendix 49 shows equipment support given to AIP maize partners.

Figure 105 Partners using grain moisture meter provided by AIP maize equipment support program

The above equipment were dispatched after the signing of the SGA and partners were requested to send signed acknowledgment/receipt form and government institutions proof that the items are registered in the fixed asset book of the organization.

1.1.4.4.3. AIP maize working group (MWG) meeting

The meeting was held from 8-9 April 2015 in Islamabad. A total of 47 participants attended this annual event that aims partners to share their annual progress regarding the AIP maize activities, lessons learnt and way forward. Participants diagnosed the major bottlenecks of the maize seed sector based

on their working area. The major points identified by stakeholders during the value chain analysis of the maize seed sector in Pakistan Below are.

1.1.4.4.3.1. Challenges indicated by the AIP-MWG Participants

- Lack of availability of temperate maize germplasm
- Provision of access to the public sector maize germplasm
- Enforcement of Plant Breeders Rights in the country.
- Ensuring plant breeders rights to enhance Research and Development in private sector
- Lack of flow of hybrid cultivars from public sector
- Public sector institutes should work on CIMMYT model of Material Transfer Agreement (MTA) and Standard Material Transfer Agreement (SMTA) to avail their hybrids/varieties to the private sector
- Breeding institutes should give a seed road map of commercialization at the time of variety approval
- The limit of 10kgs seed import for testing purpose should be increased
- Multinational companies should produce seed locally and there should be adequate law enforcement for violators.
- Federal Seed Certification & Registration Dept. needs to be strengthened. High penalties for those involving in the illegal seed business.

1.1.4.4.3.2. In breeding and variety release

- National Seed Council (NSC) should be activated and decisions should be made at national level for variety approval for different ecologies and provinces
- Variety Evaluation Committee (VEC) and National Seed Council NSC should have representations of private sector companies
- VEC and NSC should have representation from private sector crop experts for spot examination.

1.1.4.4.3.3. Suggestions for Establishment of Seed Company

- At the time of registration the role/activities of seed companies should be identified either breeding or marketing company or both.
- For companies who breed seed locally minimum one breeder must be necessary for each target crop
- There should be a notified calendar of activities for VEC for each crop
- Fixed schedule for company registration
- Interest free loans for professionals who want to establish a seed company
- Seed importing national and multinational companies should be given a time limit to start local seed production and ultimately stop importing
- Legislation for Interest free loans for development of processing facilities and infrastructure including proper storage and drying facilities.

1.1.4.4.3.4. Seed Marketing

- Claiming for compensation by famers in case of any incidental loss should be restricted to the price of seed only
- Informal seed sector should be discouraged and banned (this is to mention those farmers/others who are selling seed by the cover of informal seed. This doesn't include the age old tradition of seed exchange among farmers)
- Un-registered companies, groups or individuals should be treated as per law on sale of seed.

1.1.4.4.3.5. Problems identified for under developed areas such as AJK, Gilgit Baltistan, Sindh, and Balochistan

The under developed areas are characterized by

- Lack of resources (Capital, land and expertise, almost no mechanized farming.)
- Absence of research institution, no laboratories and field equipment
- Poor extension services
- Lack of market system, no intervention from private seed companies in those areas.
- Capacity building is utmost important for improvement in agriculture in these area.
- Adoptability trials should be conducted, area specific varieties should be introduced
- Farmer to farmer exchange of seed /technology should be promoted.
- There should be a sustainable local seed system for seed production, quality maintenance and dissemination of improved seed and production technology.
- Timely availability of seed at affordable prices.
- Promotion of maize production technology, using field days, seminars, print media, and demonstration plots etc.

Figure 106 Maize farmer Muhammed Sadeeq Tahir inside AIP's biofortified maize demo plot in Rawala Kot, AJK

Figure 107 AIP maize working group meeting April 8-9 2015, Islamabad

Figure 108 Handing over ceremony of equipment to representative of Gilgit Baltistan

1.1.5. Cereal and Cereal System – Rice

1.1.5.1. Breeding Program for Improved Indica and Basmati Rice

1.1.5.1.1. New Generation of High-Yielding, Stress-Tolerant, High-Quality Indicia and Basmati Varieties and Hybrids

Scientists at IRRI HQ were involved in developing/ selecting rice lines having different stress tolerant traits (Biotic-BLB, abiotic-submergence). During this reporting period, the following were accomplished.

A backcross observational yield trial (OYT) was conducted during both the 2015 dry and wet seasons at IRRI Hq. This included putative IR6-Sub1 lines with the recipient and donor parents and other advanced backcross lines. New IR6-Sub1 lines were screened under field submergence condition and 21 lines had shown strong submergence tolerance at 4, 7 and 15 days after de-submergence. Of the 21 lines tested 5 lines had scores of 3 or 5; 9 lines had scores of 7 and the remaining 7 lines were scored as susceptible (9). The best lines, with scores of 3 or 5 which were comparable or better than the Sub1 check varieties included in the trial, were IR105469:43-51-16, IR105469:72-22-1, IR105463:30-13-6, IR105469:81-3-1 and IR105469:74-3-1 (Figure 2).

Figure 109 Showing strong submergence tolerance in controlled flooding experiment at IRRI of new IR6-Sub1 lines developed for Pakistan (August 2015)

Figure 110 Submergence tolerance testing under controlled flooding at RRI, Kala Shah Kaku

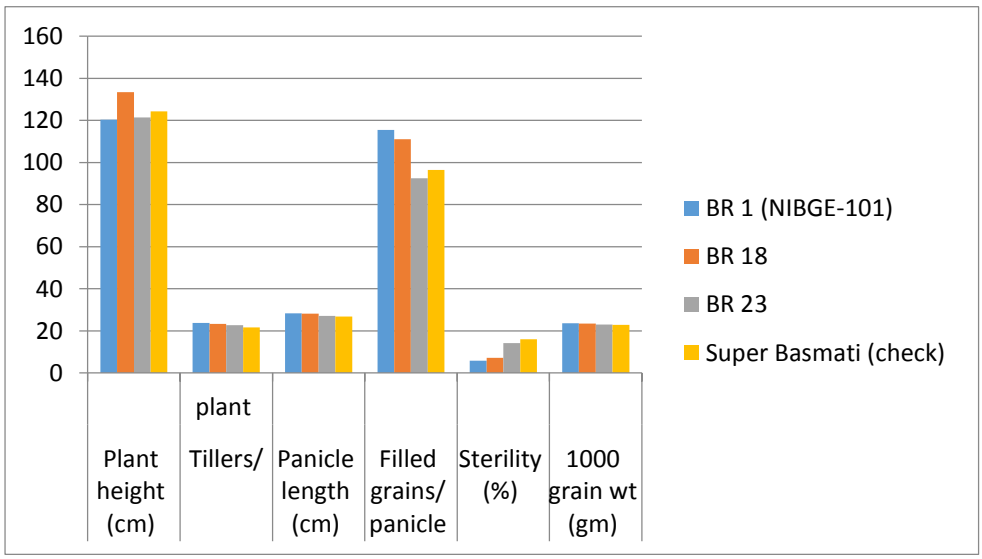
144 bacterial leaf blight (BLB) resistant lines (Super Basmati x IRBB23) with (Xa23) gene and 133 lines (Super Basmati x IRBB27 with (Xa27) gene were also developed. In addition, 154 elite breeding lines with putative Xa resistance genes were also screened against 14 races of Xanthomonas at IRRI. The same material is also being evaluated in Pakistan.

More than 1,172 advanced rice lines having various traits were acquired from IRRI and distributed to 11 institutions throughout the country in public and private sectors for evaluation against biotic i.e. BLB and abiotic such as submergence, drought, salinity and heat tolerance, yield potential and grain quality (Appendix 67). In addition, 224 rice lines were also being tested for salinity and drought tolerance at Soil Salinity Research Institute, Pindi Bhattian, Punjab province. Germplasm sets for specific traits are being tested in appropriate field locations for the relevant stress. The selections are under way on the basis of field performance, tolerance to traits, plant type and grain shape. The crop is in field and data on yield components will be available during next report.

Figure 111 scientists observing IRRI material planted at RRI Kala Shah Kaku

Figure 112 Evaluation of salinity tolerant germplasm at SSRI Pindi Bhattian

National Institute for Biotechnology and Genetic Engineering, Faisalabad (NIBGE) together with IRRI selected three BLB best lines-BR1 *(Xa4, Xa21)*, BR18 *(Xa4, Xa21)* and BR23 *(Xa5)* for higher yield, resistance to 80% of the local BLB virulent and grain quality in comparison with parent (Super Basmati). The results revealed that BR-1 performed well in the field and produced 28% higher yield than parent variety (Super Basmati) (Fig. 113). The BR-1 has been recommended by Variety Evaluation Committee (VEC) for its approval from Provincial Seed Council. BLB resistant variety (BR-1) was planted at three locations (NIBGE, Faisalabad, RRI, Kala Shah Kaku and Kanzo Farm, Sheikhupura in Punjab province for spot examination. In addition, the seed of BR-1 was also distributed to 10 farmers for field evaluation and seed increase at half acre each.



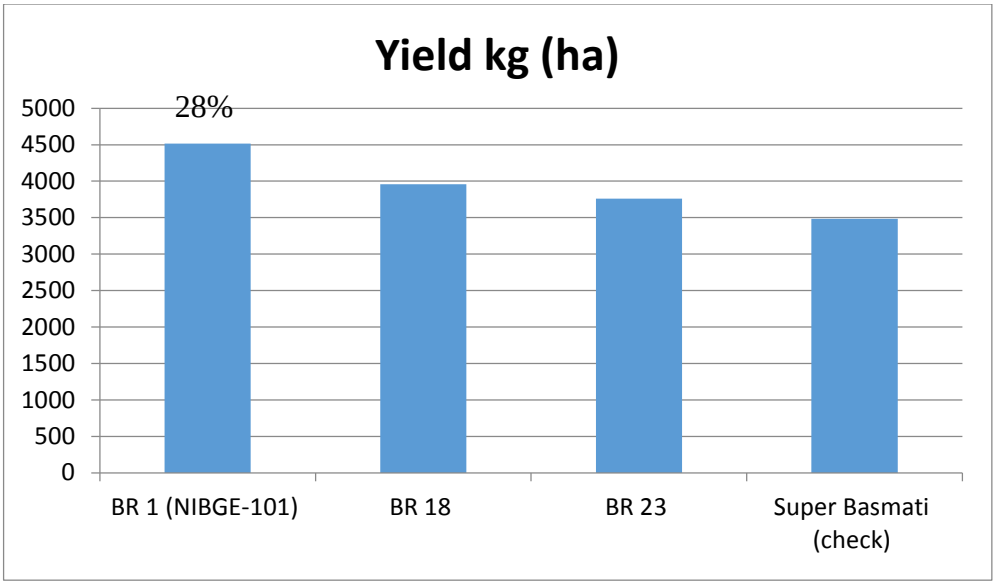


Figure 113 Comparison BR-1 and Super Basmati

Figure 114 Farmer examining BR-1 in his field at Muridke

1.1.5.1.2. Evaluation of Bio Power for BLB control

NIBGE has developed a consortium of PGPR strains including bio-control of potential bacterial strains. These bacterial strains have shown ability to control BLB in rice. To evaluate the biocontrol potential bacterial inoculums, trials were demonstrated in collaboration with NIBGE at four different locations namely NIBGE Faisalabad, RRI Kala Shah Kaku, Adaptive Research Farm Sheikhupura and Gujranwala. The crop is still in field and data on yield increment and cost reduction will be available after the harvest of crop by the end of November or early December.

Figure 115 Bio Power demon at NIBGE Faisalabad

1.1.5.1.3. Up-scaling of High-Yielding Basmati 515 Variety in Punjab

There is very narrow gene pool of basmati varieties in Punjab province and rice farmers have very limited choice to grow basmati varieties. Super Basmati is the sole variety grown on 70% of the basmati area in Punjab since 1996. This variety has lost its yield potential and is also prone to damage by insects and diseases. Due to this, farmer's interest is gradually shifting to the banned, non-basmati short duration varieties which are highly susceptible to diseases such as BLB and brown leaf spot. Basmati-515, is high yielding, better grain quality and comparatively short duration is an option to supplement super basmati. Under this activity, 10,000kg of certified seed of Basmati 515 was distributed among 305 farmers during the planting season for planting on 2000 acres in Sheikhupura, Gujranwala, Mandi Bahauddin, and Sialkot districts of Punjab province. In addition, certified seed of Basmati 515 was also distributed in non-traditional areas in collaboration with private sector partner Engro Eximp, Sheikhupura. Basmati 515 will provide a choice to the farmers to grow other varieties which gives 10% higher yield of worth extra income Rs. 6000/ acre than super basmati. Being low tillering variety, Basmati 515 is best suited for Dry Seeding of Rice (DSR). Ultimately, farmer's production will be increased and millers/ exporters be benefited to export good quality rice varieties.

Most of the farmers of project area have planted Basmati 515 variety by using their own random transplanting practices. However, these farmers were provided with information about DSR and Alternate Wetting and Drying (AWD) and applying good management practices to get maximum paddy yield. Of these 50 farmers established one acre demonstration on OPPM by random transplanting to compare with their own practices in Sheikhupura district. The average plant population in these plots was 20 plants per meter square, which is very close to recommended 80,000 plants per acre. The crop is still in the field, the data on yield and comparative benefits will be available in the next report.

Figure 116 Distribution of Basmati 515 seed to farmers

1.1.5.2. Improved Crop Management

1.1.5.2.1. Extension of Direct Seeding and AWD Technology in Different Rice Ecosystems

1.1.5.2.1.1. Demonstration of Dry Seeding of Rice (DSR)

In 2015, DSR technology was demonstrated on 974 acres of 322 farmers in rice growing areas with the support of public partners namely RRI, Kala Shah Kaku in Punjab province, RRI, Dokri and ARI, Tandojam in Sindh province and

Balochistan Agriculture Research & Development Centre Jafarabad in Balochistan province and a private partner Engro Eximp, Sheikhupura in Punjab province. Mostly farmers in Punjab and Sindh provinces, used drill for DSR. However, in Balochistan 20 farmers established their DRS plots with broadcasting of soaked seed. Different rice varieties were sown according to the ecologies. Basmati 515 having low tillering capacity is suitable for DSR. In Punjab, mainly Basmati 515 was used for DSR followed by Super Basmati and PK-386. In Sindh, IR-6, NIA Mehran and Shandar were planted. NIAB IR-9 and Super Basmati were planted in Balochistan. In Punjab, fields were lazer leveled before dry sowing. The data (Appendix 68) reveals that highest number of the DSR acreage was in Punjab province 937 acres in 4 districts namely Gujranwala, Sheikhupura, Mandi Bahauddin, Sialkot, 17 in Thatta district in Sindh and 20 in Jafarabad district in Balochistan. The highest number of acreage under DSR in Punjab may be due the awareness in farmers gained through the PSDP project already implemented by PARC. According to survey conducted by Engro Eximp during 2014, farmers acknowledge DSR benefits including good crop stand, saving in cost/ time/labor/fuel/water, conservation and environment.

Agronomic Observations

Data on different parameters were recorded from DSR plots in comparison with farmers' practices. Field results have shown that germination rate was highest in DSR with broadcast of soaked seed followed by DRS with drill. The lowest number of plants was found in farmers field (Appendix 69). Data on yield increment and economic benefits would be obtained after crop harvest.

Figure 117 Farmer with 20 acre DSR plot (Basmati 515) at Village Dahir (Muridke)

1.1.5.2.2. Demonstration of Alternate Wetting and Drying

In Punjab during rice season 2015, perforated water measuring tubes were distributed in partnership with Engro Eximp to100 Basmati 515 farmers in the Sheikhupura. This activity will popularize Alternate Wetting and Drying (AWD)'s water-saving technology. One pipe was installed for one location each. The results showed that there was a substantial reduction in water use with AWD as compared to farmers' practice. Most of the farmers saved 3-4 irrigations with help of water measuring pipes. On average, 20% water reduction was recorded in AWD plots. In AWD plots, the crop did not lodge. Data on yield and net benefit will be presented in next report.

Similarly, in Thatta, Sindh province, advisory services were also provided to farmers to popularize DSR and water saving technology on 400 acres with the support of scientists of Rice Research Station Thatta. The concerned farmers were educated regarding irrigation time to their crop. They were also making aware regarding importance of irrigation water availability in field at critical crop stage. The installation of porous plastic pipes in field and data recording in

pipes are also introduced to farmers. The results will be available in the next report.

1.1.5.2.3. Development of crop management tools for extension officers and farmers

IRRI developed crop check system was refined in collaboration with local partners. Benchmarks and crop checks were developed for all of the critical stages of crop production and harvesting. A local crop check system is now being used by 400 farmers with private sector Rice Partners Ltd. in Muridke, Punjab province. All recommendations and actual inputs were recorded. Weekly visits were made to 25 selected farmers with the quality control (QC) officers checking on compliance and crop management. Farmers acknowledge with the use of system and are being visited by the QC officers on a weekly basis. A field book has been developed for diagnostic purposes relating to crop nutrition, diseases and insects.

Figure 118 IRRI Scientists with Quality Control officer along with farmers

1.1.5.3. Improved Post-Harvest and Quality Control

1.1.5.3.1. Evaluation of hermetic storage bags

The IRRI hermetic storage super bag reduces post-harvest losses and can help preserve the freshness and quality of commodities. Super bag reduces the flow of both oxygen and water between the stored grain or seed and the outside atmosphere. When properly sealed, respiration of grain and insects inside the bag reduce oxygen levels from 21% to 5%. This reduction reduces live insects to less than 1 insect/kg of grain without using insecticides, often within 10 days of sealing.

An experiment for the evaluation of hermetic bags was established in January 2015 at National Agricultural Research Centre Islamabad, and Rice Research Institute, Kala Shah Kaku. The details of which are as below:

Grain moisture: Ranged from 13-14%.

Storage system: 3 different storage bags (Jute, PP, hermetic)

Storage regimes: 4 different storage regimes:

Paddy for stored for 6 months

Brown rice sorted for 6 months

Paddy stored for 2 months+ brown rice for 4 months

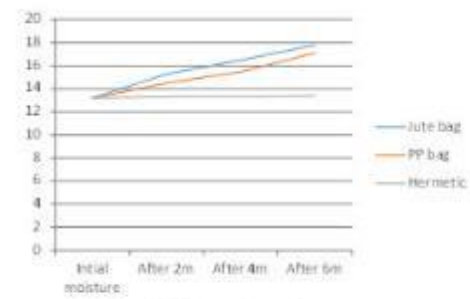
Paddy stored for 4 months + brown rice for 2 months

Tests: Aroma, aflatoxin contamination, pests and grain quality (Physical and chemical)

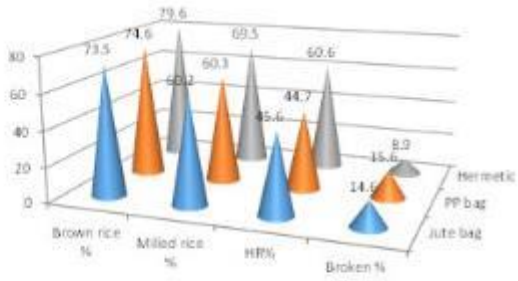
The results indicated that the moisture has drastically increased during storage in jute and PP bags and remained the same as initial in hermetic storage. Eventually, higher level of moisture contents affected the incidence of stored grain pests and head rice recovery. Hermetic storage also improved the

germination of seed by 10-15%.

Figure 119 Hermetic storage system



Moisture level



Grain Quality

Storage System	Pests	Germination (%)
Jute bag	71	80
PP bag	58	82
Hermetic	5	95

Hermetic storage test at NARC & RRI, KSK

1.1.5.3.2. Establish the level of losses and contamination in post-harvest processes

1.1.5.3.2.1. Determination of aflatoxin in rice

A system for determining aflatoxin contamination was implemented in Basmati growing areas of Punjab. Grain samples were collected in collaboration with Engro Eximp for analysis from the crop prior to harvest, the combine harvester Wheat and Kabuta during harvest, the transport trucks, drying facilities both ground and machine, and the storage facilities to determine the source of contamination.

The results revealed that generally aflatoxin contamination was higher in wheat combine harvest paddy and clay dying has drastically enhanced incidence. Sun drying of rice crop, as practiced by most of the farmers, does not reduce the moisture level desired for adequate storage of rice grains. In result, rice grains with higher moisture level enter in the storage, which provides quite favorable conditions for the growth of aflatoxin. Rice crop get infestation of this fungus in two phases. First, the contamination takes place in growing crop in the field, and secondly in the mature rice grains after harvesting in field as well as in storage conditions, where even dried rice grains are susceptible to the growth of the fungi. On the basis of these results, protocols and manuals for improved grain quality services and quality rice be available for the benefit of all the stakeholders.

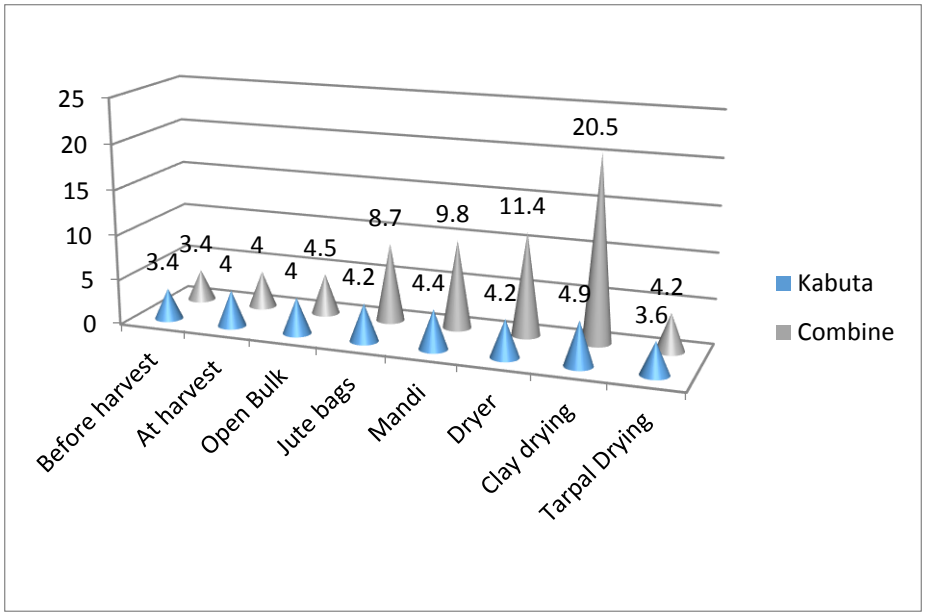


Figure 120 Comparison of Kabuta and Combine

1.1.5.4. Capacity Building for Rice Researchers and Extension Officers

1.1.5.4.1. Training of farmers water management

On May 31, 2015, rice component in partnership with Rice Research Station (RSS) Thatta in Sindh province organized a one day training on rice cultivation with less water at RRS, 71 farmers benefitted the training.

Figure 121 Participants of the training at Thatta in Sindh province

1.1.5.4.2. Field day on improved rice production technologies

A field day on direct seed rice (drilling), its importance and advantages over broadcasting rice seed in standing water and AWD was organized in collaboration with RRS Thatta at Thatta Agriculture Farm in Sindh province on September 22, 2015. The field day was attended by 10 rice researchers and extension officers and 93 farmers. The Super bag developed by IRRI Philippines for storage was also introduced among participants. 10 farmers were selected for evaluation of hermetic storage. The participating famers visited DSR demonstration plots. The farmers were convinced with the establishment of DSR crop and saving of irrigation water and willing to use these technologies at their farms in future.

Figure 122 Field day at Thatta in Sindh province

Figure 123 Farmer observing DSR in farmers' fields at Thatta in Sindh province

1.1.6. Cereal and Cereal System – Agronomy

1.1.6.1. Dissemination of Conservation Agriculture Technologies

AIP-Agronomy has continued its partnership for dissemination and demonstration of technologies with 12 national partners namely Wheat Research Institute (WRI) Sakrand in Sindh province, Barani Agriculture research Institute (BARI) Chakwal, WRI Faisalabad, AR Farms, Agronomic Research Station (ARS) Bahawalpur and Arid Zone Research Institute (AZRI) Bhakkar in Punjab province, Agriculture Research Institute (ARI) D.I. Khan and Cereal Crops Research Institute (CCRI) Pirsabak in KP province, Directorate of Agriculture Research (DAR) Jafarabad in Balochistan province and Engro Eximp and National Rural Support Program (NRSP). During April – September, 2015, all national partners except NRSP established 39 demonstrations on CA technologies, 66 demonstration on new seeders and 40 sites / demonstration on nutrient management in the project area. National partners were instrumental in conducting 15 farmer field days to observe CA demonstrations during wheat season. A total of 1470 farmers participated in these field days and it helped farmers to understand the benefits of various improved practice like ZT wheat, ridge planting of wheat, performance of new seeders and better nutrient management techniques.

1.1.6.1.1. Demonstration of CA Technologies

During Kharif season, AIP – Agronomy established 39 demonstrations of CA techniques that includes 24 on zero tillage (ZT) mung bean and guar, 07 on ZT maize and 08 on direct seeded rice (DSR). Demonstrations were established in collaboration with AZRI Bhakkar, BARI Chakwal, CCRI Nowshera and WRI Faisalabad in six districts of Pakistan.

During wheat Rabi season 2014-15, AIP-Agronomy established 325 on farm demonstrations in collaboration with its national partner's in12 districts of Pakistan. Farmers have following benefits from these improved techniques:

Figure 124. Zero tillage wheat after guar in Bhakkar

Figure 125. Ridge planting of wheat in DI Khan

- Dissemination ZT wheat planting after rice crop helped farmers to plant wheat 25 days earlier, save RS 7500/ha in cost of land preparation and obtain 0.5 t / ha more wheat grain.
- Farmer planted wheat with ZT technology after mung / guar crop in Bhakkar (Fig 1) and DI Khan districts and reported saving of RS 7500 / ha from cost of cultivation and 0.25 – 0.50 t / ha more wheat grains. Wheat followed by mung bean / guar occupies 0.12 million hectare area in this region and advantages of ZT technology would be attraction to other farmers for adoption.
- Ridge planting of wheat (Fig 2) demonstrated on 73 sites in six districts namely Bhakkar, Mianwali, Khushab and Bahawalpur in Punjab; DI Khan and Nowshera in KP province helped farmers in 30% saving of irrigation water. In addition, farmers also reported to have 10-15% higher wheat grain yield that equals to RS 9000 / ha of benefit.
- In nutrient management for wheat on 54 sites, application of nitrogen (N) and phosphorus (P) fertilizer in N & P ratio of 1.5:1, resulted in 0.5 t/ ha more wheat grain yield and its net benefit to famer were RS 8000 / ha in comparison with farmer practice.

1.1.6.1.2. Dissemination of CA Technologies through Field Days

During this reporting period, 9 national partners organized 15 farmer's field days included 11 on farmer fields and 4 on national partner farms for demonstration of improved agriculture techniques in district Bahawalpur, Bhakkar, Chakwal, Faisalabad, Sheikhupura (Fig 111), Vehari and Sahiwal in Punjab province, Nowshera and DI Khan (Fig 112) in KP province, and Shaheed Benazir Abad in Sindh province. In these events, 1470 Farmers participated and visited these fields along with their fellow farmers and agriculture professionals (Appendix 56). Farmers observed advantages of ridge planting, bed planting, zt planting and improved nutrient management techniques in wheat crop.

Figure 126. Farmer on zero till wheat field in DI Khan

Figure 127. Participants of field day in RRI, KSK, Shiekhupura

1.1.6.2. Pilot Testing and Refinement of New CA-Based Implements and Technologies

Pilot testing of new seeder (multi-crop bed planter for maize, multicrop planter for rice and push row planter) continued with 6 partners namely ARS Bahawalpur, AR Farms Vehari, CCRI Nowshera, NARC Islamabad, Engro Eximp and WRI Faisalabad. These partners were instrumental for demonstration of new seeders on 66 sites that included maize bed planting on 47 sites, DSR on 5 sites and hand planter use in maize on 14 sites. Multi crop zero till planter was locally fabricated in collaboration with Greenland Engineering Daska. CIMMYT staff trained 21 persons (farmers, operators and agriculture professional) on operation of multi crop bed planter and push row planter in Faisalabad, Vehari, Sahiwal and Nowshera districts.

1.1.6.2.1. Partnership to Pilot Test New Seeders

During this period, partnership with private machinery manufacturers namely Greenland Engineering, Daska and Shareef Engineering Faisalabad was established for local fabrication of new CA planters like Multi crop Zero till planter and Zero till Happy Seeder.

1.1.6.2.2. Pilot Testing and Demonstration of New Seeders

1.1.6.2.2.1. Pilot testing and demonstration of locally fabricated Multi – crop zero till planter for rice

Greenland Engineering, Engro Eximp and CIMMYT collaborated for local fabrication of Zero till multicrop planter (Fig 113) in the country. Greenland Engineering initiated local fabrication of inclined plates seeding technique and placed it on local zero tillage drill. Multicrop ZT planter was evaluated at 05 sites for direct seeding of rice and results indicated that there was no breakage of rice seed in dry and moist condition. Crop emergence was 115 plants / m2 with 13 Kg seed per acre and crop is also good.

Figure 128. Rice seeding with multicrop planter in Sheikhupura

1.1.6.2.2.2. Pilot testing of multi-crop bed planters for maize

During this Kharife season, CIMMYT imparted hands on training to operators on the use of multi crop bed planter and national partners were

able to establish 47 maize bed planting demonstration on area of 100 acres in districts of Nowshera, Faisalabad (Fig 114), Islamabad, Sahiwal, Vehari and Chiniot. Initial results showed that plant population in Faisalabad and Vehari was better with less precision on plant to plant distance.

Figure 129. Bed planting of maize in Faisalabad

1.1.6.2.2.3. Pilot testing of Chinese push row planter for maize

Small farmers in Khyber Pakhtunkhwa and northern areas plant maize crop through hand planting. CIMMYT arranged Chinese Push row seeder from CIMMYT Nepal and were evaluated in Nowshera (Fig 7). Under this activity, 14 farmers use these hand planter on their farms and were satisfied their performance. These planters have vertical seeding system and use for planting maize and applying fertilizer in one operation, saved time and required less labor.

Figure 130. Farmer planting maize with push row planter in Nowshera, KP

1.1.6.2.2.4. Pilot testing of zero till happy seeder in rice-wheat area

During wheat season 2014-15, national partners have demonstrated the planting of wheat with ZT happy seeder at 33 sites in Gujranwala, Sheikhupura (Fig 119), and Faisalabad and Sialkot districts. Results compiled from these demonstration showed that farmers planted wheat timely on combine harvested rice fields without burning of rice residue, saved 70% of cultivation cost, reduced tillage operation from 5 to 1, had 0.6 t /ha more wheat yield in comparison with conventional practice (Fig 118). Results were also shared in the form of poster in International Wheat Conference Sydney Australia.

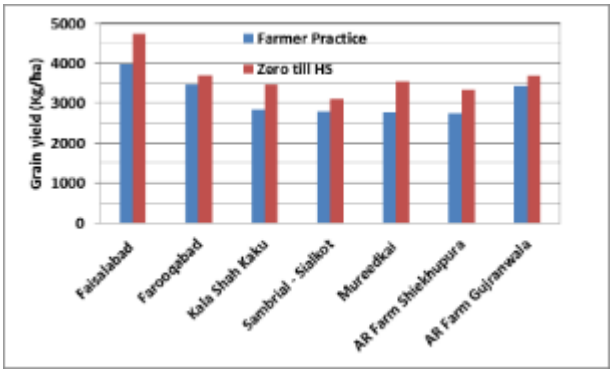


Figure 131. Wheat grain yield improvement with ZTHS planting in rice-wheat system

Figure 132 ZTHS planted wheat in Sheikhupura

1.1.6.2.2.5. Pilot testing of Multi – crop bed planter for wheat

During wheat season 2014-15, national partners planted wheat with multi crop bed planters on 25 sites and results showed that wheat grain yield were at par in comparison with farmer practice. However, there was 30 percent saving in irrigation water with bed planting in comparison with farmer practice.

1.1.6.3. Training of Stakeholders on New Seeders (Multicrop bed planter & Push row seeder)

In July and August 2015, CIMMYT staff in collaboration with national partners arranged hands on trainings on operation of multicrop bed planter for 12 trainees including operators, field staff, and farmer were trained in Sahiwal, Vehari and Faisalabad. Field training on operation of new push row planter was also provided to 09 smallholder farmers in district Nowshera.

1.1.6.4. Evaluation of Conservation Agriculture-Based Crop Management Technologies/ Methods in Different Cropping Systems

Under this activity five long-term trials and seven medium-term trials on planting methods and residue management techniques are in progress in rice-wheat, cotton-wheat, maize-wheat and rain-fed wheat.

1.1.6.4.1. Evaluation of Planting Techniques and Residue Management Techniques under Different Cropping Systems in the Country

Field trials are in progress at five sites in rice-wheat, maize-wheat, cotton-wheat and rain fed wheat cropping systems in the project area in partnership with national partners namely ARS Bahawalpur, BARI Chakwal, RRI Kala Shah Kaku, WRI-Faisalabad and CCRI Pirsabak Nowshera. These trials would help to generate new information, improve understanding of researchers and opportunity for capacity building of students and young researchers. Preliminary finding after the harvest of wheat crop are as under:

1.1.6.4.1.1. Evaluation of Different Planting Methods/ Techniques in Cotton-Wheat System at ARS Bahawalpur District of Punjab Province:

Because of higher emergence, hand planted cotton on beds had higher seed yield in comparison with drill and bed planted cotton. Early planting of wheat in relay planted (planting in standing cotton) plots had 0.6 t / ha

higher wheat yields in comparison with conventionally tilled (cotton harvested and prepared) drill and bed planted plots (Appendix 57).

1.1.6.4.1.2. Effect of Planting Techniques on the Productivity of Different Rain-Fed Cropping Systems at BARI Chakwal District of Punjab Province:

Preliminary results showed that summer crop particularly mung bean and soybean yield was better on raised bed in comparison with flat planting. However, wheat grain yield was higher with zero tillage in comparison with bed and conventional planting.

1.1.6.4.1.3. Evaluation Of Different Residue Management and Planting Techniques Under Heavy Residue Environment Of Rice-Wheat Cropping System at RRI Kala Shah Kaku, Sheikhupura District of Punjab Province:

After first year rice – wheat cycle, direct seeded rice (DSR) followed by ZTHS wheat in residue had highest system productivity of 7.11 t/ha including 3.6 t/ha rice and 3.5 t/ha wheat yield in comparison with other planting system. Wheat yield were higher in all plots planted with ZTHS in residue in comparison with conventional planting. (Appendix 58).

1.1.6.4.1.4. Effect of Planting Techniques such as ZT, Bed Planting and Farmers' Practice on the Productivity of Irrigated Maize-Wheat Cropping System at CCRI Nowshera District of KP Province

Preliminary results from this trial showed that maize yield was 4.5 t /ha with bed planting in comparison to 4.1 t/ha with farmer practice and zero tillage. However, wheat yields were 4.2 t/ha with zero till planting in comparison to 3.7 t/ha with farmer practice (Appendix 59).

1.1.6.4.1.5. Evaluation of Double No-Till of DSR and ZT Wheat in a Low Residue Environment of Rice-Wheat System at WRI Faisalabad district of Punjab province

Wheat grain yield with ZT after DSR was 0.2 t/ha higher in comparison with CT after DSR. In case of rice crop, paddy yield with direct seeding (DSR) at 2.6 t/ha and transplanted at 2.5 t/ha were insignificantly different.

1.1.6.4.2. Strengthening of CA research partners through capacity building and information sharing.

AIP– CIMMYT National Meeting on Conservation Agriculture in Pakistan:

National meeting on conservation agriculture was jointly organized by CIMMYT and PARC under USAID's Agricultural Innovation Program (AIP) for Pakistan. The meeting was attended by 58 agriculture professionals from various provincial and federal research institutes, agriculture extension, universities, private companies and international centers, who are involved in agronomy research and dissemination of CA technologies among the farming community under AIP. In this 2-day meeting, national partners from all four provinces, AJK and Gilgit Baltistan shared their experiences and progress on the dissemination of conservation agriculture technologies like zero tillage in cereal systems, ridge planting of wheat, improved agronomy; pilot testing of zero tillage happy seeder in rice – wheat system and multicrop bed planter in maize-wheat and cotton – wheat system; field trials on residue management and planting

techniques in wheat based cropping systems; site specific nutrient management. At the concluding session, participants agreed to focus on local manufacturing of the zero-till Happy Seeder and ZT multi-crop planter, disseminating CA planters and techniques through service providers, introducing small farm machinery to smallholders in northern Pakistan and building the capacity of national partners.

Figure 133 Participants of National meeting on conservation in Islamabad

1.1.6.5. Nutrient Management

Demonstration for validation of Nutrient Expert (NE) for hybrid maize were planted on 10 sites in Punjab. Leaf color chart (LCC) managed nitrogen in rice crop was demonstrated through national partners on 30 farmer fields in districts of Sheikhupura, Gujranwala and Faisalabad in Punjab province.

1.1.6.5.1. Nutrient management trials in wheat cropping system

Nutrient management for rain fed wheat crop at farmer fields

The trial on split N management was carried out at five farmers' fields in medium rainfall area of Chakwal district of Punjab. There was 63% increase in wheat yield with recommended fertilizer application as basal dose (80 Kg N and 58 Kg P/ ha) and 78% with split application (DAP applied as basal and Urea with first rainfall) in comparison with farmer fertilizer use.

1.1.6.5.2. Evaluation of Nutrient Expert for maize and wheat

Nutrient Expert is a decision support system (DSS) based on the principles of site-specific nutrient management (SSNM) that offers solutions for providing field-specific fertilizer recommendations to improve the yield and economics of maize growing famers in the region. Validation trials on Nutrient Expert™ for wheat crop were carried out at 28 sites in seven wheat growing districts of Nowshera, DI Khan, Shaheed Benazir Abad, Bahawalpur, Faisalabad, Sheikhupura and Bhakkar. In these trials, fertilizer management practices – farmer's practice and NE recommendation – were compared. NE recommended all P and K at planting and N in three doses (planting, first irrigation and 2nd irrigation). Farmer application included P at planting, no use of K and Nitrogen in 2 or 3 split doses. Results showed that farmers were able to get 425 Kg / ha more wheat with the additional application of 71 Kg of K_2O / ha. This have resulted in increase of RS 6635 / ha in fertilizer cost but with the net gain of RS 6000 / ha (Appendix 59). During Kharif (autumn) season, Validation demonstration on NE for hybrid maize has been planted on 10 sites in district of Pakpattan in Punjab.

1.1.6.5.3. Green Seeker Use for Nitrogen Management in Wheat

Evaluation of Green Seeker N management for wheat was done at 23 sites in districts of Nowshera, Sheikhupura, Faisalabad and Bahawalpur in collaboration with 4 national partners namely ARS, RRI, CCRI and WRI. In this activity, a rich N strip with the application of 200 Kg N / ha was established in one acre wheat field at planting. Results showed that farmer applied first N dose 28-31 days after planting of wheat. At second irrigation / Feeks 7-8 growth stage, green seeker reading from the wheat plot and rich N

strip were collected and GS managed N dose was calculated with Indian model. Fields were divided in to two sections and N applied according to farmer practice and GS recommendation. At maturity, yield data was collected from farmer's practice and GS managed area. Results from on farm demonstration showed that rich N strip had NDVI value in the range of 0.80 – 0.85 and GS nitrogen dose ranged between 2-14 Kg N /ha (Appendix 60). In GS managed plots, farmers saved 50 kg N/ ha without reducing wheat grain yield that helped farmer to save Rs. 4000 / ha in fertilizer cost.

Figure 134 Green Seeker use for measuring NDVI

1.1.6.5.4. Dissemination of Site-Specific Nutrient Management Techniques at Farm Level

Leaf color chart is Site-Specific Nutrient Management Techniques (SSNM) helps the farmers to save nitrogen fertilizer and improve rice crop yield. During autumn season–Kharif crop 2015, national partners namely AR farms Sheikhupura & Gujranwala, WRI Faisalabad, RRI Kala Shah Kaku and Engro established 30 farmer fields demonstration on LCC managed nitrogen application for rice in Faisalabad, Sheikhupura and Gujranwala districts of Punjab.

Figure 135 Farmer taking reading with LCC in Sheikhupura

1.2.1. Cereal and Cereal System – Socioeconomics

1.1.7.1. Adoption and Impact of CA Technologies at Farm Level

A survey was carried out in Punjab, Sindh, KP and Balochistan provinces to study the adoption and impact of the conservation agriculture (CA) technologies and nutrient management. A detailed comprehensive questionnaire was designed for data collection. The study primarily focused on CA technologies like Zero tillage (ZT) drill, happy seeder, bed planter, ridger, and laser land leveler along with CA practices such as micro nutrients application, reduced tillage, direct seeding of rice (DSR), crops' residue management and adaptation to climate change.

The preliminary survey findings indicated that raised bed planting demonstrated successfully to increase water use efficiency, minimizing hazards of water lodging, and improving plants' aeration, thereby, reduces risk of substantial income loss at one end and improves crops' yield on the other hand.

In Punjab province, small proportion of famers from Rice-Wheat i.e. 6%, Cotton-Wheat 4% and Mixed 1% reported use of ridger/ bed shaper, however, wheat cultivation on ridges in rain fed/arid areas is non-existent. Merely 3% farmers were

planting wheat on ridges throughout the province. As we look at the availability and affordability of the technology, less than one fourth i.e. 22% interviewees/ farmers affirmed its availability.
About 26% farmers from Sindh cultivate wheat on raised beds. Mostly the repair facility is available at sub-district level. In KP province, majority of the farmers had no idea of ridger as almost two third i.e. 64% reported non-availability of such technology in the area whereas more than one third i.e. 36% didn't responded to the question. A large number of farmers i.e. 98% considered it unaffordable for the farming community to adopt this technology. Same was the case in Balochistan province, where none of respondents had any information about raised bed planting technology.
The information about ZT technology was also low in the area. ZT drill was only used by the cotton-wheat zone farmers in Rahim Yar Khan district of Punjab province. 95.8% farmers had no idea about the repair of ZT drill, 6.4% farmers reported its availability in the area. Similarly, in Sindh province 87% farmers reported non-availability of ZT technology and only 3% farmers considered it affordable. Moreover, 79% farmers were unaware of repair facility of ZT drill, 16% reported at tehsil level and only 3% were of the view that ZT drill workshops were available in district market. In KP only 3% of the sample respondents had knowledge of ZT technology but never used while the remaining 97% had no knowledge of it. Almost two third i.e. 64% reported non-availability of ZT drill and more than one third didn't responded to the question.
Once the farmers were explored about availability of the technology, 98% clearly stated it unaffordable for the farmers.
From the survey findings, this can be concluded that majority of the farmers lack awareness to CA technologies and hence the adoption rate is very low among the surveyed farmers. The availability and affordability of the CA technologies are very important issues that needs to be addressed.

1.1.7.2. Income assessment of the Maize Street Vendors

A detailed comprehensive questionnaire was used to assess the income of maize street vendors. The survey was conducted on 204 interviewees including farmers and maize street vendors from 4 major cities of Pakistan namely Islamabad, Rawalpindi, Lahore and Faisalabad. The questionnaire was a mix of open ended and close ended questions to get additional information which was not apprehended in the closed ended questions. Data was analyzed using the Statistical Package for Social Scientists (SPSS 20.0) software and Microsoft Excel. The key survey findings indicated that the average profit earned by the maize vendors across the cities is Rs. 689 per day, against the total daily sale volume of Rs 1,820. The operational cost comprises of cost of fuel wood, cob material and other supporting elements which sums up to approximately Rs. 1,196 per day.

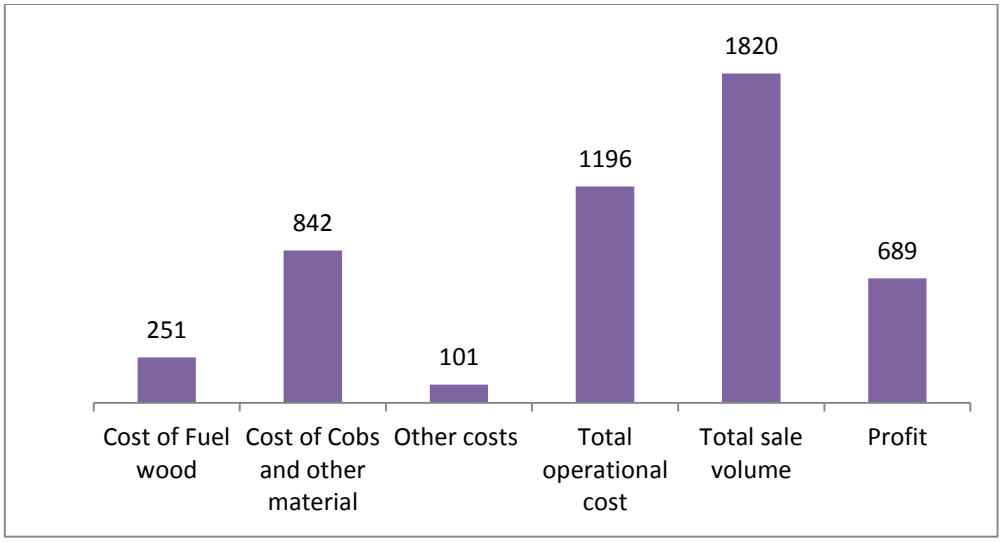


Figure 136 Cost and Profit (Price (Rs.)/ Day)

Fuel wood cost showing an average of Rs. 251 per day, average daily expenditure on buying cobs and other materials is Rs. 842. However other supporting cost is Rs. 101 per day which includes salt and spices, wrapping, shopper etc.

The major challenges faced by the maize street vendors are following

- Poor social security
- Lack of business skills
- Sometime stressed by the authorities
- Less profits due to seasonal variability

Figure 137 Interviewing Maize Street Vendors

1.1.7.3. Feasibility of Durum Wheat Value Chain

The feasibility study of Durum Wheat Value Chain revealed the milling unit was identified as key component where new investment is needed. In this regard, CIMMYT arranged a series of meetings with private sector companies include Buhler and Alapala.

These meetings led to a consensus that use of medium size swing milling units is the best option, keeping in view the small durum wheat production in the country.

Alternatively Pakistan can follow the Mexican and Australian model that they produce Durum within the country and then export.
During the meetings the third option explored was the Chinese company milling unit at price of US$ 100,000 with capacity of 26 tons per day.

1.1.7.4. Enhancing Data Analysis Skills of Social Scientists in KP province

A training for enhancing the data analysis skills of social scientists was organized by CIMMYT in partnership with SSRI Tarnab Peshawar on August 4 2015in KP province. In total 50 social scientists were trained on data analysis tools including SPSS and STATA.

Figure 138 Training of the Social Scientists regarding "Orientation to STATA and SPSS

1.2.1. Perennial Horticulture

1.1.8.1. Postharvest and Value Added Projects: AAUR

- Farmer Training in Postharvest Technology
- Dissemination of Postharvest Fruit Dehydration

These two projects have been successfully completed and the partners have submitted final project reports. These two projects trained 189 farmers (92 men, 97 women) through six practical trainings and one awareness seminar at KIU Gilgit on value addition of stone fruits. During the pre- training assessment, only 10% of male farmers and 25% female farmers could cite methods for making other products with fruit (e.g. jam, squash and tomato ketchup). After the training, 95% of the participants could cite methods for making such value-added products. The majority of the farmers were satisfied with the training program. The final project report is attached in the Appendix 62.

1.1.8.1.1. Grape Vineyard Development: AAUR

This innovative project builds the capacity of farmers in vineyard management by providing hands-on technical training throughout the season. The project uses the commercial scale demonstration vineyard at Koont farm Rawalpindi for these trainings. In this reporting period, the project has conducted eight hands- on trainings with 149 participants (123 men, 26 women), addressing insect and disease management, fruit thinning and fruit bagging. Through their participation in these vineyard technical trainings the farmers have become more knowledgeable about rainy season management, plant protection methods, vineyard weed control and how to increase airflow to reduce fungal diseases. Among the vineyard trainings were demonstrations of the impact of fruit bagging on fruit growth, harvest maturity, firmness, and quality, as well as its impact on insects, disease and birds. An added benefit of using these techniques is the reduction of insecticide use.

The principal investigator will be continuing this project by developing a water conservation model within the vineyard demonstration plot. Key results include:

- 18 farmers are applying new technologies in vineyard management
- 405 acres are being farmed using improved technologies
- 149 families benefited from trainings organized during this reporting period

1.1.8.1.2. Mango: UAF

1.1.8.1.2.1. Multiplication, Accession and Evaluation of New Mango Cultivars

In this reporting period, the establishment of the mango conservation block at University of Agriculture Faisalabad (UAF) continued. Multiplication of the selected mango accessions continued with the objective of distributing them to stakeholder cooperators for commercial evaluation. The project team visited the two nurseries in Multan to monitor the plants growth. At the Mango Day at Vehari on August, 20, 2015, 145 plants of four accessions namely MLT-240, RYK-265, KHW-250 and KHW-251 were distributed to 30 selected farmers of the 105 who attended. Chosen farmers were selected based on their ability and willingness to adhere to the rigorous monitoring required. Mango fruit from available accessions was also offered to the participants for eating. Trees and fruits of the available accessions were displayed at the UAF seminar on horticulture value chain and role of AIP. The PI has submitted another proposal for conducting the extended field evaluations of the distributed mangos. This follow on project is under review and a funding decision will be made by the end of October 2015.

1.1.8.1.2.2. Inline Automated Maturity Assessment System for Commercial Mango Cultivars

This one- year project has been successfully completed. The objective was to test the AWETA Firmness Sensor technology for determining maturity and fruit firmness changes during ripening in three Pakistani commercial mango cultivars namely Sindhri, Samar Bahisht Chaunsa and White Chaunsa. Mango varieties were harvested in early, mid and late season in three sizes; i.e. Size A: Large; Size B: Medium; Size C: Small, and then ripened at their respective optimal temperatures without ethylene. The Firmness Index (FI), acoustic resonance frequency (F0) and the destructive measurements (i.e. to evaluate the following characteristics the fruit needs to be mashed) of soluble solids content (SSC), dry matter, pulp color were recorded every other day. In addition, the physical characteristics were measured at three stages: pre-ripening, during ripening and at ripening. The average of the three readings, 2 lateral and 1 dorsal side, were recorded using the Automatic Firmness Tester device.

The ultimate goal of this research is to develop an inline automated maturity sorting system. In the future, a handheld NIR based system may be used to correctly estimate maturity for each variety. Further research is needed to determine the commercial potential of this concept. While this is beyond the scope of the AIP project, other commercial sources of funding exist to further develop this research.

1.1.8.1.2.3. Processing Mango Kernel Seed Waste as a Substitute for Cocoa Butter

The primary objective of this project was the incorporation of Mango seed fat as a cocoa butter replacement (CBR) for the development of Russet. Project team has successfully replaced the cocoa butter in the chocolate candy. Storage study of the developed CBR mango seed fat chocolate candy will be completed in December 2015 resulting in the completion of

this project. The final project report will also be submitted in the same month. AIP Annual Conference attendees sampled the chocolate candy made with this CBR and appreciated the taste, however no Performa's were filled for evaluation. Development of mango kernel seed fat as a competitively priced alternative to cocoa butter for production of chocolate will give farmers another income stream for an otherwise unused product that previously had no value.

1.1.8.1.2.4. Processing Mango Pulp as a Fruit Leather

Methods for producing a superior mango leather from four mango varieties namely Lal Badshah, Anwar Ratule, Chaunsa and Fujri have been developed. The storage study, physiochemical analysis and sensory evaluation of the prepared mango leathers was completed in June 2015. This product was also displayed at the AIP Annual Conference. The final report of this project will be submitted in December 2015.

Development of this improved mango leather will give farmers, both at the farm and commercial sales level, an additional use for otherwise wasted product. Mangos that are able for fresh sale can be processed at home as a stable storable and consumable food, or sold in local markets. Or sold to factories that produce mango leather as a commercial product. Additionally, marketing this product as a natural candy, as opposed to another fruit leather, will expand the market for processed mango products.

1.1.8.1.3. Citrus: CRI-Sargodha

Production: 4 projects

- Citrus Demonstration Block
- Citrus Rootstock Evaluation
- Nursery Growing Media Development
- Citrus IPM Practices

Postharvest: 3 projects

- Harvesting and Handling Practices
- Standardizing Packinghouse Techniques
- Pilot Plant for Small Scale Citrus Postharvest Technologies

These seven coordinated projects focus on packaging the information developed in previous projects for Farmer Field Days and Training Schools, and new extension applications. During the reporting period, seven hands-on trainings and one citrus mega field day were organized. Detail information of the trainings is given below in appendix 1. A total of 809 participants (574 men, 235 women) were trained. Female participants were specifically requested when organizing these trainings. Special trainings for women on the value addition of citrus fruit were organized in collaboration with Sanatzar, Industrial Home for Women, Sargodha. Some ingredients of the different citrus value added recipes were also distributed at Sanatzar.

Four citrus orchard model demonstration sites at CRI and five model orchards at farmer properties have been established in the Sargodha District. A post-harvest lab and lath house have been established and inaugurated by the DG of Research for Agriculture in the Punjab and by Dr. Louise Ferguson at CRI Sargodha on August 17, 2015. The lath house will be used for producing clean nursery plant for distributing them among growers while postharvest lab will work standardizing more recipes of citrus value added product. Packing house postharvest techniques and standardization of recipes, e.g. jam, squash, shreds, biscuits etc., of the citrus value- added products have been completed and taught in trainings.

While these seven projects will continue in the next reporting period, CRI-Sargodha in cooperation with the local citrus growers and packers, will further

package these materials as Farmer Field Schools for annual trainings.

1.1.8.1.4. Olives, Pistachios and Guava

Based on local feedback, gaps and needs identified during field visits and meetings with stakeholders, the Perennial Horticulture component will shift focus to the underserved crops and regions: olives in KPK, pistachios in Baluchistan, and guavas in Sindh. As a result of meetings at ARI-Quetta, ARI-Tarnab ATI-Sakrand during the last reporting period, AIP defined the major challenges facing the olive, pistachio and guava industries. Each commodity is discussed below based on the projects that have been funded to address the critical needs of each crop.

1.1.8.1.4.1. Olives: ARI Tarnab

UC Davis will collaborate with ARI Tarnab, Peshawar on two olive projects, which are set to start on September 15, 2015.

1.1.8.1.4.1.1. Boron project

The effect of boron on the fruit set and yield will be determined in a two year project. Different concentrations of foliar boron will be applied at different growth stages to determine the effects on fruit set, phytotoxicity and yield data. The results of the study will be showcased in a mega field day planned for December 2016. By the end of the project, appropriate brochures will be developed for growers.

1.1.8.1.4.1.2. Post-harvest handling of olive oil project

A one-year study of the effect of post-harvest handling of olive on oil quality will be conducted with ARI Tarnab. This study will produce a set of photos of the processing steps from harvest through final oil extraction. Three trainings on how to harvest, transport, handle and store olives and olive oil are planned for olive stakeholders (e.g. farmers, extension officers, and processors). After developing the extension education materials, a mega field day will be held. The project manager will also develop hard copy materials and extension education videos.

1.1.8.1.4.2. Pistachios: ARI Quetta

The UC Davis team held a two day strategy development meeting with the ARI Quetta team on August 12-13, 2015 in Karachi. The purpose of the meeting was to define the specific action steps for each of the three newly funded pistachio projects. The key points from each project are given below:

1.1.8.1.4.2.1. Pistachio block rehabilitation project

A pistachio block, neglected for decades, was planted at the ARI Quetta Field Station in 1970. Within this project, this block will first be evaluated for the potential of the cultivars in the block and then rehabilitated with pruning, a new irrigation system and fertilization. The block will be harvested in fall 2015 to determine which cultivars have commercial potential. It will be rejuvenated with pruning during the winter of 2015-2016 and a new irrigation system will be installed in the orchard in 2016.

1.1.8.1.4.2.2. Pistachio orchard project

A new model pistachio orchard block at ARI and in selected farmers' orchards one each in three local districts of Baluchistan: Quetta, Mastung and Pashin will be established with the objective of developing Farmer Field Schools to teach pistachio orchard establishment and production.

1.1.8.1.4.2.3. Pistachio nursery project

A nursery will be established at the research station with both indigenous and exotic pistachio varieties. One commercial nursery will also be developed under this project. For the extension program, there will be three pistachio production trainings followed by a mega field day.

1.1.8.1.4.2.4. Pistachio Growers' Association project

The ARI team will conduct a survey in the pistachio growing areas of Baluchistan. The growers will be solicited to form an association to aid in developing several needs- based grower trainings and to cooperate in industry development.

1.1.8.1.4.3. Guava: ATI- Sakrand

UC Davis has funded two projects on guava with ATI Sakrand in collaboration with the following Principal Investigators: Mr. Yousaf Channa, Dr. Raheel Anwaar, Mr. Ghulam Mustafa Jamali and Mr. Allah Rakhe Keerio. Brief highlights are below. s

1.1.8.1.4.3.1. Farmer Field Training Centre (FFTC) project

Sites for 7 Farmer Field Training (FFTC) have been selected in 3 districts Sakrand, Noshehro Feroz and Larkan in Sindh province. 7 extension officers, one for each FFTC and seven groups of motivated farmers have also been selected in above mentioned districts of Sindh. Each group consists of 15-20 guava growers. Training of Trainers for selected extension officers are scheduled for 2015 and 2016. Trainers will visit each FFTC on fortnightly basis to discuss the guava- related problems and their possible solutions with the registered growers in the area. The idea of involving UAF students in FFTC session as interns is under consideration.

1.1.8.1.4.3.2. Postharvest Resource Center

In June 2015, Mr. Allah Rakhe Keerio attended the UC Davis Postharvest Short Course on the UC Davis campus in California, USA. Using his new knowledge, he will develop a postharvest lab within this project. Basic lab equipment has already been provided to the ATI. Principal Investigator, Dr. Raheel is cooperating with Mr. Keerio on developing the core curriculum including lectures, power points, and practical laboratory exercises for extension workers. The first post-harvest course will be tested in January 2016, followed by an additional course later in the year. Two more trainings will be organized during 2017. In addition, UAF students may have the opportunity of an internship at ATI Sakrand, pending approval from the internship committee of the UAF.

1.1.8.1.5. Ber: UAF

One project focusing on commercialization and distribution of nine selected ber varieties namely Ajoba, Anokee, Bahawalpur, Dehli white, Mehmood wali, Dilbahar, Gola and Karela has been funded by the UC Davis team, led by PI Dr. Saeed Ahmed Sindhu. Value- addition aspects of ber will also be addressed by the project activities. Project start up activities are underway. Approximately 400 ber plants will be distributed to farmer in March 2016 for establishment of ber orchards on marginal lands. The PI will track performance evaluation of distributed plants through monitoring visits and grower evaluations.

1.2. HUMAN RESOURCE DEVELOPMENT

1.2.1. Graduate studies

All 14 scholars are presently in the USA attending classes and initiating their research projects. These students are located at the University of California, Davis (2PhD and 1MS), Texas A&M University (3MS), University of Missouri (1MS), University of

Minnesota (1PhD), Mississippi State University (1PhD), University of Massachusetts (1MS), and Washington State University (1PhD), Purdue University (1 MS), Mississippi State University (1 MS) and the University of Minnesota (1 MS). Full summary details in Appendix 63.

In June 2015, Dr. Rost conducted a survey to assess how the students were adjusting and progressing. He presented the results of the scholars' progress at the AIP Annual Conference in August.

1.2.2. Vocational Training

During the reporting period two workshops were conducted under the Vocational Training component:

1.2.2.1. Effective Meetings, part 2

On August 22, 2015 at UAF, Dr. Mark Bell led this workshop that had two objectives:

Objective 1. Review 5 steps for a good meeting; Objective 2. Identify how to deal with common meeting "problems." 22 participants including 16 men and six women attended this workshop. The evaluation results show that the workshop achieved its objectives and participants were very satisfied with the content and the style. Evaluation results include:

- Objectives met: Objective 1. Rated as 3.4 out of 4 (4 being highest); Objective 2. rated as 3.5 out of 4
- Very useful: rated 4.5 out of 5 (5 being highest)
- Very useful content: rated 4.5 out of 5
- Very useful materials: rated 4.4 out of 5
- Excellent presentation style: rated 4.6 out of 5

1.2.2.2. Scientific Writing Workshop

Dr. Mark Bell and Dr. Tom Rost (both of UC Davis) conducted a workshop on scientific writing at NARC on August 26-27, 2015. A total of 31 participants (21 men, 10 women) attended the workshop, including representatives of all AIP Partners (AVRDC, CIMMYT, PARC, IRRI and UCD). The purpose of this workshop was to 1. Know the primary sections included in a standard scientific paper; 2. To understand the primary content and purpose of each section; and 3. To draft (selected sections of) a scientific paper. The evaluation results show that the workshop achieved its objectives and participants were very satisfied with the content and the style. Evaluation results include:

- Objectives met: Objective 1. rated as 2.9 out of 3(3= Achieved); Objective 2. rated as 2.9 out of 3; and Objective 3. rated as 2.7 out of 3.
- Very useful content: Objective 1. rated as 4.8 out of 5 (where 5 = "Very Useful");
    - Objective 2. rated as 4.7 out of 5; Objective 3. rated as 4.5 out of 5.
    - Well-chosen audience: Limited experience in publishing scientific peer reviewed articles (i.e. between none and fewer than ten publications).
- Very good materials provided: The training support materials prepared and used for the course (PowerPoint and handout) rated 4.7 out of 5 (where 5 = "very good")
- Excellent presentation style: The group clearly enjoyed the interactive nature of the workshop instructors' style, as indicated by the almost perfect evaluation 4.97 out of 5 (where 5 = "Excellent"). There were numerous written comments on the evaluation that indicated the appreciation of the interactive and inclusive style of the instructors.

Additional activities in this reporting period included on-going preparation and review of both training materials and the online App (for the statistics package "R") for the planned statistics course.

The proposed trainings and priorities—as well as the approach to training—as agreed by the Vocational Training working group are captured on the E -Pak Ag site:
http://epakag.ucdavis.edu/delivery.

The Vocational Training working group has identified the next set of topics to be addressed:

- Extension material development – An Extension framework and developing the Key messages – developing the 1 minute “gem.” and how to plan and deliver an effective engaging workshop
- Use of ICT in extension
- Seed production
- Statistics
- R App demonstration

1.3. e-PAK AG

Although there is an e-Pak Ag website that is continually updated and expanded, the main focus of this component concerns the use of ICT in Ag extension. Thus, it looks at how ICT can be better used to integrate with traditional approaches and better deliver information to farmers. This includes how the information needed is validated, developed, packaged and delivered. A major emphasis of e-Pak Ag is how information can be better packaged to lead to action. Extension material from primary AIP partners (ILRI, IRRI, CIMMYT, AVRDC, UC Davis, and PARC) are regularly uploaded on the website.

Even though sharing best ICT practices is the goal, the website is still providing a valuable source of information. Use statistics show:

- **Slideshare**

For PowerPoint presentations loaded on the website, there is significant traffic to view these presentations. For example, while the Scientific Writing PowerPoint has only been up three weeks, it has received over 200 views.

- **Google analytics**

Internet traffic has seen almost 5,000 sessions on e-Pak Ag in this reporting period April 1 –September 30, 2015.

Theses completed

Two Master’s students who were receiving scholarships from AIP at UAF have completed their theses on: 1. Sources of Information for the Farmers; 2. Working Strategy of Public, Private and NGO sector (Assessed using the ASKME framework).

1.3.1. Consultative workshops

During this reporting period four consultative workshops were held, resulting in the completion of series of consultative workshops. The detailed information of these workshops is available in Appendix 1. Dr. Babar Shabaz has shared the main findings from these workshops during the AIP annual conference at Islamabad in August. These key findings include:

- There is huge data bank available on the internet and print media while the trustworthiness and authenticity of the data is still questionable at all available sources.
- There is strong need for the monitoring and evaluation of available data in terms of its usability and relevance. Therefore it is suggested that universities take lead in this matter.
- Start targeting the service provider and extension officers with ICT use and mobile apps could be best tool in this regards.

This project will continue in the next reporting period and will include finalizing a report on the overall findings.

1.3.2. ICT workshop UAF

On August 21, Dr. Mark Bell conducted a workshop with the following objectives: Objective 1. What is ICT? Objective 2. How is ICT used in Extension? Objective 3. What are the issues and how can we make ICT more effective? There were a total of 34 participants including 26 men and 8 women. The group was made up of a mix of people with considerable ICT experience and people with little or almost no ICT experience. The evaluation results show that the workshop achieved its objectives and participants were very satisfied with the content and the style. Evaluation results include:

- Objectives met: Objective 1. rated as 2.7 out of 3 (3= fully achieved); Objective 2. rated as 2.7 out of 3; Objective 3. rated as 2.4 out of 3.
- Very useful: rated 4.7 out of 5 (5= very useful)
- Very good materials: rated 4.2 out of 5 (5=very good)
- Excellent presentation style: rated 4.8 out of 5 (5=excellent)

1.3.3. ICT Use and Gender (AAUR)

This project, in collaboration with Dr. Aneela Afzal, is in the first phase of its implementation. The survey of the targeted areas has been completed and the report is being finalized. The project conducted a training and inauguration on August 20, 2015.

The ToT workshop was held on August 20, 2015 at AAUR with the objective of designing an engaging class to teach school girls how to use ICT for improving home agriculture. 65 participants, (30 men, 35 women) attended the workshop. The evaluation results show that the workshop achieved its objectives and participants were very satisfied with the content and the style. Evaluation results include:

- Objectives met: rated as 3.4 out of 4 (4= fully achieved)
- Very useful: rated 4.5 out of 5 (5= very useful)
- Very useful materials: rated 4.6 out of 5 (5=very useful)
- Excellent presentation style: rated 4.9 out of 5 (5=excellent)

The website (www.ictpakfarming.org.pk) was developed and launched on August 20, 2015 in a ceremony attended by approximately 100 stakeholders. The inauguration included speeches by Dr. Mark Bell and the chief guest, Prof. Dr. Rai Niaz, Vice Chancellor, PMAS-Arid Agriculture, University.

During his August 2015 trip to Pakistan, Dr. Bell initiated meetings with additional stakeholders on creating ICT linkages. These meetings included:

- August 21: Ministry IT – Met with Aamir Sami to request input on how best to support ICT to enhance information access. A "brief" on the structures and elements involved in ICT in extension was subsequently provided as a basis for future interaction.
- August 19: CABI – to learn more about their Plant wise (as a means to enhancing field diagnostics and recommendations) and their on-line (quarantine) training efforts (lessons learned).
- August 26: PIID - Pakistan Institute for Information Technology Development; introductory meeting.

1.4. COMPETITIVE GRANTS SYSTEM

Pakistan Agricultural Research Council (PARC) is responsible for the creation and implementation of a transparent and province-endorsed competitive grants system (CGS) and creation and establishment of provincial agricultural research for development (AR4D) Boards in Balochistan, KP and Sindh provinces in Pakistan. Due to government of of Pakistan procedural demands, the fund has not been released for the competitive grants

in the period of semiannual report. Below are the updates from the previous period.
AIP Secretariat received funds in March 2015 from State Bank of Pakistan (SBP) in AIP assignment account at National Bank of Pakistan in Islamabad.

1.4.1. Research to support enhanced agricultural growth in Pakistan

As approved CGS operational mechanism, Punjab Agricultural Research Board (PARB) advertised the first call for application of research proposals in first week of March 2015 with submission deadline for preliminary proposals being March 25 (Appendix 65). For Balochistan, KP and Sindh provinces first call for application of research proposals was advertised in the third week of March with submission deadline April 15, 2015 (Appendix 65). Total number of Preliminary proposals received by PARB were 207, whereas 142 preliminary proposals were received by AIP secretariat which includes 48 from Balochistan province, 89 from KP and 05 from Sindh (Appendix 64).
PARB has completed the evaluation process and shared shortlisted proposals for approval of Technical Advisory Committee and National Advisory Committee with AIP Secretariat.
Proposals received from KP province were shared with Interim Provincial Competitive Grants System Management Committee with the request to evaluate the proposals and submit the shortlisted proposals to AIP Secretariat for approval of TAC and NAC. So far, the committee has not shared list of shortlisted proposals with AIP Secretariat.
Government of Balochistan has not yet activated the Balochistan Agricultural Research Board (BARB) established under BARB Act-1998 and Interim Provincial Competitive Grants System Management Committee has not been notified. Proposals received from Balochistan province are still pending in AIP Secretariat for evaluation and shortlisting.
Only 5 preliminary proposals were received from Sindh province. CIMMYT and PARC has mutually decided to re-advertise the call for Sindh province.

1.4.2. Establishment of Provincial Agricultural Research for Development (AR4D) Boards

This matter will also be discussed in a joint meeting of all stakeholders to build up consesnsus of the matter and decide the way forward. In consultation with provincial stakeholders, Provincial AR4D Boards in three provinces namely Balochistan, KP and Sindh provinces were supposed to be established.
Due to involvement of provincial departments and prolonged legal procedures in the creation of Boards, Federal Secretary Ministry of National Food Security and Research (MNFS&R) requested the Provincial Chief Secretaries of Balochistan, KP and Sindh to constitute Interim Provincial Competitive Grants System Management Committees to expedite the process and manage of competitive grants funds utilization in their respective provinces.
In March 2015, the Government of KP notified the Interim Provincial Competitive Grants System Management Committee with the approval of Chief Secretary Govt. of Khyber Pakhtunkhwa. In May 2015, the first meeting of Interim Provincial Competitive Grants System Management Committee in KP was convened under the chairmanship of Secretary Agriculture Govt. of KP. The first draft of KP Agricultural Research Board Act was also circulated to the members of the Interim Provincial Competitive Grants System Management Committee for their comments.

1.4.3. Transfer of Funds to Respective Provinces

PARC is a public organization and follows the Ministry of Finance rules and regulation for the disbursement of funds to respective boards/ provinces. According to revised procedures of Revolving Fund Accounts (foreign Aid Assignment Account) devised by Ministry of Finance, Government of Pakistan vide letter No.F.2 (1) BR-II/2007-949, dated August 02, 2013, the mechanism of funds transfer to provincial stakeholders in lump sum is not embodied in the prescribed revised accounting procedure. To clarify the position, on the request of PARC, Federal Secretary, MNFS&R approached the Finance Division in April-2015 to grant exemption to the extent of release of funds

against approved budget allocated for provincial share to respective Provinces/Boards. On May 5, 2015 and July 29, 2015 Additional Finance Secretary -Budget, Ministry of Finance convened meetings of stakeholders including Accountant General Pakistan Revenues, Financial Advisor's (FA's) Organization, MNFS&R and PARC in his office. On August 5, 2015, Finance Division issued procedural directions to AIP Secretariat regarding transfer of funds to respective provinces/ boards.

The Finance Division clarified that AIP can transfer the respective share of funds to only legally constituted provincial board and that rest of the provinces may constitute legal boards to receive their share of funds.

1.4.4. Utilization of Balance Amount as on June30, 2015

According to Finance Division's mechanism of Assignment Account, at the close of Fiscal Year on June 30, approval of unspent balance is mandatory from Finance Ministry.

In July-2015, PARC initiated the approval of Technical Supplementary Grant (TSG) for FY 2015-16 for unspent amount of funds received from donor.

The FA's organization of Finance Division objected on the TSG and demanded for provision of copies of AIP PC-I approved from Planning Commission of Pakistan and a memorandum of Understanding (MoU) signed through External Affairs Division despite the fact that the same FA's Organization has approved TSG for FY 2014-15.

With involvement of MNFS&R, the FA's organization endorsed the TSG for FY 2015-16 and Secretary Finance Division approved the TSG for utilization of unspent balance in AIP Assignment Account in third week of October-2015. Notification of approved TSG is still awaited.

2. PERSONAL/ MANAGEMENT UPDATE

Livestock component recruited three young researchers on a daily paid basis to conduct water and balanced feed trials in Bahawalnagar, Punjab province and Swat, KP province. These young scientists also assisted the project with continuation of the volunteer farmer model farms, and improved fodder seeds distribution and planting at the project sites.

Under Vegetables component, two women research assistants on temporary assignments are recruited to work closely with partners and farmers on protected vegetable cultivation activities, at the project locations in Muzaffabad, AJK and Gilgit-Baltistan.

Dr. Warwick Easdown, Regional Director AVRDC, visited twice during this period to monitor the on-going activities of the vegetables component at the farmers' fields. He visited a vegetable field area in Haripur and witnessed spinach raised under green net. He participated in the harvesting process with combine harvester at traditional mungbean area of Bhakkar and documented the process for using as a reference in training programs. Dr Jun Acedo, postharvest specialist from Hyderabad India, also visited once to view facilities in partner institutions and to run a planning workshop with partners. Mr. Mazullah Khan, Vegetable Seed Specialist, and Mr. Mazahar Hussain, Socioeconomist, along with Dr. Mansab Ali, Team Leader AVRDC-Pakistan, attended the Postharvest Meeting and Theme Consumption Meeting in Dubai on August 31- September 3, 2015 which provided good contact with 11 other AVRDC projects with a postharvest component. At present, a graduate student from the Department of Entomology, Pir Mehar Ali Shah, Arid Agriculture University, Rawalpindi, Pakistan, is at AVRDC headquarters for a six-month internship starting August 5. This student is working under the supervision of Entomologist, Dr. Srinivasan Ramasamy on developing novel sustainable pest management strategies for tomato under protective structures. Mr. Rizwan Ahmed, Research Associate from Quetta, Balochistan is attending the 34th AVRDC International Vegetable Training Curse (IVTC); Model 1: "From Seed to Harvest" at AVRDC East & South Asia, Thailand on September 14-October 9. During the reporting period, the maize component conducted the mid-year performance assessment for two research associates. A hosting agreement has been signed to facilitate in hiring NRS and strengthen the IRRI office staff.

Dr. Imtiaz Hussain, team lead agronomy component, attended Global Conservation Agriculture Program meeting held on June 12-13 at CIMMYT headquarter in Mexico. He presented a poster on relay cropping of wheat in standing cotton: An experience in cotton – wheat system of Punjab, Pakistan. He also attended 9th International Wheat Conference on September 20-25 held at Sydney Australia, where he presented a poster on zero till Happy Seeder planted wheat in the rice –wheat area of the Punjab Pakistan.
The recruitment of the new research associate in socioeconomics is in progress.
The hiring of Ayesha Arif has greatly benefitted the UC Davis in AIP project. In recognition of her expanded job responsibilities, particularly for project development and monitoring, her position will be reclassified as a Junior Specialist as of October 1, 2015. In addition, Mr. Muhammad Yasir was hired as an Office Assistant on May 1, 2015.
Annual work plan was reviewed and objectives and activities for the year 2015-16 has been set.

3. LESSONS LEARNED

COMMISSIONED PROJECTS

Livestock

It is important to be aware/ understand the social structure/ barriers that exist in different societies that might impede implementation of program if not properly addressed at the onset of activities. This usually leads to certain sections of the villages being non-cooperative.

Vegetables

- For any disaster such as strong wind and hail storms, compact tunnel foundations and solid structures are pre-requisites to avoid crop and structural damage
- The contracts with Punjab Agriculture University-Ludhiana, India will help to bring innovative net houses and mungbean harvesting technologies to Pakistan. However, the relation between two countriues is hindering the transfer of technologies/expertise
- Application of fertilizer in soluble form and drip irrigation is beneficial in tunnel farming.
- Harvesting of mungbean intercropped with sugarcane needs to be mechanized to minimize the damage of sugarcane plants caused by manual harvesting to be able to continue this system.
- A proper sowing drill may need to be designed to obtain the optimum plant population under improved mungbean production and service providers must be explored.

Cereal and Cereal System – Wheat

Feedback from the partner organizations working with the wheat component at the grassroots level are summarized below:

- New varieties offer ample opportunities to close the wheat yield gaps from 23 to 113%
- Varietal popularization is as important as developing new varieties.
- Focus on varietal replacement rather than merely seed replacement for overall growth.
- Capacity building is vital for improving uptake and adoption of new technologies and innovations
- Creation of network is crucial as it offered platform for creating quick impacts

Maize

The major lesson learned during the reporting period are as follows:

- Slow process in the signing of the SGA from the public sector sub grantees which requires repeated follow up
- Importance of engaging food laboratories in monitoring the quality of biofortified maize varieties

Rice

- In Punjab, most of the farmers are recipients of improved crop management practices like DSR and AWD. However, some farmers are reluctant to establish their rice crops

through DSR due to the issue of weeds. Post–emergent herbicides are available in the market, but cannot control all weeds like Crowfoot grass (Madana grass) and *Leptochloa Chynensis* (horse grass). Timely application of herbicides is very important for effective weed management. There is a need for lazer land leveling before DSR for uniform irrigation and germination of rice seed.

- Training of researchers/extension staff and farmers in areas of Sindh and Balochistan on DSR and AWD is needed.
- More modified DSR drills are required, especially in Sindh and Balochistan.
- Timely reports from national partners cause delay further onward delivery to the concerned quarters.
- Need an economist immediately for carrying out various activities on M&E, survey on post-harvest etc.

Agronomy

- In pilot testing of ZT happy seeder, working with service providers in Faisalabad and Sheikhupura helped to demonstrate technology on more hectares and farmers.
- In pilot testing of multi crop bed planter, the performance of bed planting in maize was improved through field training of operators. These trainings were done by CIMMYT staff in Faisalabad, Sahiwal and Vehari area.

Socioeconomics

There was demand from the SPSS and STATA training course participants that duration of the training should to be increased, hence in future trainings, the duration will be increased.

Perennial Horticulture

The funding cycle and the project initiation cycles must be timed appropriately in order to achieve the expected goals, keeping in mind the agricultural seasons of the specific crops.

HUMAN RESOURCE DEVELOPMENT

Vocational Training

Participants responded very well to and learn better during an engaging form of presentation where they are actively involved throughout the workshop. High evaluation scores and written comments support the benefits associated with an interactive adult-learning oriented style of workshop. A workshop for partners on how to give an engaging workshop will be planned for the next reporting period.

E- Pak Ag

The series of workshops across the country have highlighted:

- A lot of technical information already exists
- There is a need for greater coordination between those producing technologies and with those delivering information,
- There is a continuing need to deliver farmer- focused information that responds to farmers' needs and interests.
- Information packaging - delivering information in the appropriate form (both in terms of language and educational level) remains a major need.
- There is a need to build in feedback mechanisms.

4. EXTERNAL FACTORS

Fragile security situations, slow administrative processing of the public sector organizations and climatic factors are some of the external factors which effects the team to achieve the targets.

Rain, heavy wind and hailstorm damaged wheat crop and adversely affected wheat seed quality. It has also affected the quality and yield of mungbean especially in Thal, Punjab. Terminal heat affected wheat crop. Consumption of seed by poor families may not serve the purpose of seed dissemination.

Additional conditions imposed by the Department of Plant Protection Karachi for the import seed, for research purposes, to be used in developing a new generation of stress-tolerant varieties for future release and adoption by farmers in stress-prone environments in Pakistan, making it difficult to acquire seed from abroad.
Getting Pakistani visa for resource persons has become difficult, which is causing repeated cancellation of scheduled trainings.

5. RISKS

Due to fragile security situations in some parts of the country especially Balochistan, KhyberPakhunkhwa and Sindh provinces, staff movements, arranging meetings/ workshops, data collection are curtailed. The process slowed down as a number of times the movement of local partners was also restricted.
Extreme weather conditions such as hailstorms, heavy rains and floods during the last season affected the food crops.

6. CONTRIBUTION TO USAID GENDER OBJECTIVES

AIP continues to strive to provide technical assistance and support to reduce gender disparities and enhance the capabilities of men and women working at different levels in the agricultural sector. Despite of the fact, at grass root level that most of the agricultural activates are carried out by women, the Pakistan's agriculture sector remains dominated by men. AIP has made concerted efforts to ensure women's participation in appropriate and meaningful ways.
All aspects of the project continue to be mindful of the gender dynamics in Pakistan, this has been made part of the new sub-grant agreements.
More than 24,942 beneficiaries, which includes 4,230 women and 20,712 men, have been involved in various AIP's activities including training, participation in meetings, field days and events etc. Overall 17% of AIP's beneficiaries are women (Fig. 124).

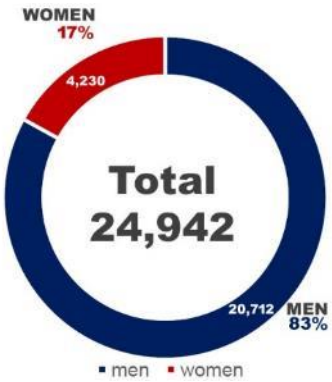


Figure 139 Gender wise beneficiaries data

A significant workload of livestock management is carried out by women. The dominance of men in the sector leads to extremely low participation of women in training/ awareness programs organized by livestock component which is only 1%.
The vegetables component hired 5 women researchers to provide field level services to collaborating partners and farmers.
AIP CIMMYT is sensitizing implementing partners to increase and ensure the participation of women in project activities including field days and training and other. In wheat component women participation in training and capacity building activities rose to 17% and 11% women as direct beneficiaries of wheat seed, variety and agronomy related activities. During reporting period, a total of 38 women participated in activities that includes five in the national meeting on conservation agriculture and

33 in field days organized by national partners in Punjab province and 10% women were trained by socioeconomics. More than 50% women workers are involved in sowing and harvesting operations of vegetables, and a total of five hands on, trainings are being arranged for awareness and safe handling of pesticides. Total six training and a workshop on postharvest management, vegetable production technology & IPM, health hazard training for 147 women were organized at Faisalabad and DI Khan in Punjab province and Swat in KP. As mungbean is included as an extra crop in a various cropping systems, male farmers are convinced to provide this extra income from mungbean to the women in their households in Thal, Punjab province. This is because of manual picking of beans by women at the rate of Rs. 1,600 per acre from intercropped mungbean in Punjab and Sindh provinces. AIP also ensured women's involvement in vegetable value adding activities through female workers trainings at DI Khan and Swat. Meetings were held in May 2015 with women farmers in Pothwar region to involve them in vegetable value chains activities. A separate training course on vegetable production technologies will also be arranged for them in future.

AIP maize is evaluating Quality Protein Maize (QPM) germplasm and Pro vitamin-A varieties which will help to reduce under five mortality rate and a good source of weaning food. AIP has introduced 24 new protein- and vitamin-enriched maize varieties to Pakistan, which will increase yield by 25 to 30 percent, and provide protein and micronutrients to improve nutrition of women and children to reduce rate of stunting which is among the worst in the world. The production and promotion of QPM in Pakistan will serve as a cheap source of Lysine for the poultry feed which will in turn help to reduce the cost of other sources of protein for the resource poor and disadvantaged communities.

Under HRD, 8 out of 14 scholars are women. Once they have completed their studies, they will return to Pakistan to contribute to their respective academic fields. E- Pak Ag is collaborating with AAUR to conduct a study on women in ICT for Agriculture that will better inform the approach and priorities as they relate to women.

7. ENVIRONMENTAL COMPLIANCES

COMMISSIONED PROJECTS

Vegetables

- Weak tunnel structures can lead to accidents when natural calamities like strong winds and hail storms occur.
- Mungbean production is environmentally safe since the selected desiccants used have a low environmental impact. Furthermore, the residual effect of desiccants is not yet known. It will be further explored to make this technology free from any health and environmental hazard.

Cereal and Cereal System – Wheat

All the wheat varieties under AIP are thoroughly evaluated and released in Pakistan; a few of the varieties are also being developed in Pakistan. Some of these varieties are drought tolerant and require less water. AIP wheat component only popularized newly released, rust resistant and high yielding wheat varieties, which will minimize the use of pesticides.

Several activities of AIP wheat component are highly integrated with agronomy component to popularize best agronomic practices for farmer preferred and locally adapted wheat varieties. Some of the on-farm variety by agronomic practices evaluated and popularized this year, e.g. seed priming, fertilizer trials and ridge planting will help improve plant stand establishment and judicious use of fertilizers and planting methods for positive impact on the environment. There will no adverse environmental impact of growing these wheat varieties in Pakistan.

Cereal and Cereal System – Maize

Most of CIMMYT's maize germplasm are climate smart varieties which can best perform

under stress environments. CIMMYT's germplasm which are tolerant to heat and water stress will benefit farmers in water scarce environments. In addition, CIMMYT materials which are under evaluation in Pakistan are developed through conventional breeding techniques, hence, they don't need additional inputs or extra environmental/biosafety care as compared to germplasms developed through non-conventional ways. The evaluation of maize tolerant to maize stem borer and low soil nitrogen stress have a positive impact on environment as it will reduce the use of chemical pesticides, nitrogen fertilizers.

Cereal and Cereal System – Rice

IRRI germplasm planted in Usta Muhammad was totally damaged by severe floods in the area. DSR and AWD are resource conservation technologies and environmentally friendly as omission of methane gas is lower compared to transplanted crops.

Cereal and Cereal System – Agronomy

The technologies that are being evaluated and disseminated are resource-conserving and has positive impact on the environment. Use of ZT and happy seeder in rice-wheat areas has reduced the burning crop residue in those plots which is environment friendly.

8. MONITORING AND EVALUATION

A comprehensive strategy document was developed to cover different indicators deviation and shared with AIP primary partners for feedback and implementation. The strategy document was prepared to achieve the set targets. An inclusive M&E plan was prepared and shared with USAID.

The quarterly data from all the AIP primary partners i.e. CIMMYT, ILRI, IRRI, AVRDC, PARC and UCDAVIS was collected and uploaded on USAID's website i.e. PAKINFO. Also addressed the comments received from USAID on uploaded data (PAK INFO).

After discussion with USAID, mission strategic framework (MSF) indicators were refined. The policy indicators were dropped as it had less relevance with AIP interventions.

Periodic meetings were held with primary partners to discuss the data related issues. The summary of the activities by partner organizations is given in the Appendix74.

Monitoring and Evaluation quarterly meeting was held at CIMMYT office in which different organizations participated. AIP-M&E also participated in working group meetings organized by USAID.

9. COMMUNICATIONS

In this reporting period, AIPs' Communications proactively highlighted the AIP's interventions which include arranging annual conference, developing newsletter, visibility in the media and maintaining social media presence (Appendix 70). The branding and making guidelines were followed strictly to ensure the visibility of USAID.

Under AIP, due emphasis has been given to communicate the project activities to local and international stakeholders following the branding and marking guidelines of USAID. The following mediums were utilized to communicate the AIP activities:

- AIP-newsletter
- Social media (Flickr, facebook, twitter, blog)
- Landing page
- Publications
- CIMMYT's Blog and e-newsletter
- Events
- Electronic and print media
- Radio shows

9.1. Publications

AIP quarterly newsletter was developed, disseminated among the relevant public and private sector entities. The electronic copies were distributed through emails to a maintained list and limited printed copies were sent to mostly public sector.

Livestock, rice, and vegetable components have prepared communication material including one pagers, handbooks, flyers etc. (Appendix 70).

9.2. Social media

AIP activities were showcased using CIMMYT's as well as USAID's Pakistan's social media forums. During the AIP annual conference, hashtag #AgriInnovation was used for highlighting the event. Key messages, photos and blurbs were shared with USAID Pakistan DOC for this campaign. Also the information is being shared by national partners, links below:

http://www.uaar.edu.pk/gallery.php?album_id=279

https://www.facebook.com/CRISargodhaPK

Figure 140 AIP's presence on CIMMYT's Social media

Figure 141 AIP's presence on USAID Pakistan's Social media

9.3. Landing Page

AIP landing page aip.cimmyt.org at CIMMYT's website was launched earlier in the previous reporting sector which is now fully functional.

Figure 142 AIP landing page

9.4. Blog and e-newsletter

Regular Contribution were made to CIMMYT's informa and AVRDC Fresh and CIMMYT's online blog for highlighting the activities of AIP globally (Appendix 70).

9.5. Events

AIP annual conference 2015

AIP held its annual conference, organized by CIMMYT in partnership with Pakistan Agriculture Research Council (PARC) and funded by USAID, in Islamabad, Pakistan, on 24-25 August.

The conference highlighted AIP's accomplishments and the latest innovations it has introduced to improve agricultural productivity and economy. The conference was formally inaugurated by Sikander Hayat Khan Bosan, Pakistan's Federal Minister for National Food Security and Research (MNSFR), along with USAID-Pakistan Mission Director John Groarke and CIMMYT Director General Martin Kropff. Several high level government officials, diplomats, policy makers, private sector representatives, academics, international experts, scientists, and other major stakeholders including farmers, students and representatives of local organizations attended the event.

Figure 143 AIP annual conference

CIMMYT Country Representative Dr. Imtiaz Muhammad presented an overview of AIP

activities and their impact on overall agricultural productivity. This was followed by a technical session which was led by the Project Manager AIP Ms. Shamim Akhtar. This comprised of component updates and global trends followed by a discussion with national and international experts. The speaker's profiles are available at http://aip.cimmyt.org/speakers/. The details of component wise technical session are given below:

Livestock: Better Lives through Livestock

Led by the International Livestock Research Institute (ILRI)

Dr. Iain Wright, the International Livestock Research Institute (ILRI), presented the Innovations for Enhanced Livestock Productivity, which was followed by the updates on "Targeting interventions to Increase Animal Productivity and Income" presented by Prof. M.N.M. Ibrahim who is the livestock component lead. A panel discussion which included the expert panelists Dr. Iain Wright, Dr. Barbara Rischkowsky, Dr. Shahid Rafiq, Dr. M. Afzal and Mr. Aftab Ahmad Wattoo was held with the audience.

Vegetable: Quality Vegetable Production

Led by the World Vegetable Center (AVRDC)

Dr. Warwick Easdown, The World Vegetable Center (AVRDC), presented the Innovations in Vegetable Production. Dr. Mansab Ali the Vegetable component lead presented the updated on "Increasing Nutritious Vegetable Production with Improved practices". This was followed by a panel discussion by experts including Dr. Antonio Acedo, Dr Shahid Niaz, Mr. Bashir Ahmad Bangulzai, Ch. Muhammad Rafiq and Mr. M. Sulaiman.

Perennial Horticulture: Diversifying Tree Fruit Crops

Led by the University of California Davis (UC Davis)

Dr. Louise Ferguson from UC Davis talked about "Innovations and Interventions in Perennial Horticulture in Pakistan". This session concluded on a panel discussion by Dr. Nadeem Akhter Abbasi, Dr. Asif Ali Khan, Dr. Abdul Samad, Dr. Muhammad Javed Tareen and Mr. Haji Muhammad Azam Tatari

Strengthening National Agricultural Research System

Led by the Pakistan Agriculture Research Council (PARC)

Dr. Shahid Masood, Member Plant Sciences PARC and focal person AIP secretariat, spoke about Provincial R&D boards and competitive grants. A panel comprising of experts including Dr. Iftikhar Ahmad, Dr. Md. Imtiaz, Dr. Noor-ul-Islam and Mr. Nazim Ali (USAID) later discussed about the potential of R&D in the agricultural sector.

Cereal and Cereal System

Rice: Innovations for Sustainable Rice Production

Led by the International Rice Research Institute (IRRI)

Dr. Joseph Rickman, IRRI, highlighted the "Innovations in rice production" and Dr. Abdul Rehman, Lead AIP Rice component, spoke about "Improving rice productivity through cost effective practices". Expert panel which included Dr. M. Shahid Masood, Dr. Muhammad Akhtar, Dr. Nihal Uddin Mari and Mr. Abid Ilyas Dar, discussed the challenges and opportunities in the rice production in Pakistan.

Maize: Better Nutrition and Environment through Maize Innovations

Led by the International Maize and Wheat Improvement Center (CIMMYT)

Dr. B.M. Prasanna, Director Global Maize Programme CIMMYT International, talked about the "Global Trends, Challenges and Opportunities of Maize: Lessons for Asia" via Skype. Dr. AbduRahman Beshir spoke in detail about the scenario of Maize crop in Pakistan. He presented to the audience the "Enhancing Availability and Affordability of Maize Seeds and Varieties in Pakistan: A Public-Private Alliance for a Sustainable Maize Production". This was followed by penal discussion on Better Nutrition and Environment through Maize Innovations by the experts which includes Mr. Daniyal J. Qureshi, Dr. Khalid Aziz, Dr. M. Shahid Masood, Mr. Sajid Mahmood and Dr. Fazl Rehman.

Wheat and Agronomy: Bridging Wheat Yield Gap

Led by the International Maize and Wheat Improvement Center (CIMMYT)

Dr. Etienne Duveiller, CIMMYT, spoke about the Wheat Based Cropping Systems in South Asia. Dr. Krishna Dev Joshi, compoentnt lead AIP wheat, talked about the closing Wheat Yield Gap in Pakistan: Learning from Past Innovations and Initiatives. Dr. Imtiaz Hussain, component lead AIP Agronomy, shared the ways for Improving Cereal Systems' Through Better Agronomy. A panel consisting of Dr. M. Shahid Masood, Dr. Makhdoom Hussain, Dr. Ehsan Ullah Chahal, Dr. Akhlaq Hussain and Dr. Qaiser Rashid discussed about workable solutions for Bridging Wheat Yield Gap in Pakistan.

Socioeconomics: Impact and Scalability of Technologies

Led by the International Maize and Wheat Improvement Center (CIMMYT)

Dr. Akhter Ali, component lead Socioeconomics, shared the "Assessment and Evaluation of Agricultural Technologies to Improve Farmers' Livelihood". This was followed by a panel discussion by Dr. Syed Muhammad Khair, Dr. Hafiz Zahid Mahmood, Mr. Muhammad Azam Niazi, Dr. Umer Farooq and Dr. M. Azeem Khan.

Enriching Skills for Improved Agriculture

Led by the University of California Davis (UC Davis)

Dr. Thomas L. Rost, UC Davis presented the highlights of Scholar's program while Dr. Babar Shahbaz shared the findings and suggestions of the ICT consultative workshop. A session on "Building capacity and improving information access" was led by Dr. Mark Bell. Later a panel discussion involving the audience on "Enriching Skills for Improved Agriculture" was carried out which included the panelists Dr. Babar Shahbaz, Dr. Mark Bell, Dr. Thomas L. Rost, Dr. Iqrar Ahmed Khan and Dr. Jim Hill.

The main attraction for visitors was the AIP product display area, which showcased the innovative trends, modern practices, and new technologies across all the commisioneed projects of AIP.

9.6. Success Story

Sowing Yet another Seed of Hope to Grow More

CIMMYT's wheat varietal deployment benefits woman headed household in Punjab province in Pakistan

"AIP helped me and many other farmers, to grow more. The seed's quality is great. Using a new wheat variety has been profitable."

Naheed Fatima, a 34 years old woman wife of a drug addict and mother of 12 year old boy, belongs to Jabbi Shah Dilawar village in Chakwal district of Punjab province. Like many other women headed household in Pakistan, her struggle is to meet every day expenses and earn a little extra to educate her son. She is responsible for all the house chores, to add to her livelihood she stitch clothes for her fellow villagers and also works as a daily wage laborer. In addition to this, she leases in 1.5 acres of land every year for growing wheat and pays rent of 100kg wheat grain after harvesting the crop. The wheat produce from this hardly meets her family's annual grain requirement. Since Naheed is left with no cash so she ends up using the leftover wheat grain or she has to borrow it from her fellow villagers. Buying a quality seed was like a dream for Naheed.

National Rural Support Program (NRSP) is a partner of AIP wheat component for dissemination of quality wheat seed. They have reached out to 9,000 farmers which includes men and women farmers across Pakistan. Nasheed was Fortunate to receive 25kg quality seed of a new wheat variety named 'Millat- 11.

Figure 144 Naheed Fatima (second from left) explaining her story in her house to AIP team

She planted this seed on half acre plot while on the rest of one acre; she planted Inqilab-91, a wheat variety that she has been growing for the several years. She was really overjoyed to see the performance of this new seed. She had not seen home saved seeds germinating so nicely, Wheat plants looked healthier and darker and grew faster and the crop-stand was quite uniform. Unusually, weed problem was also less with new variety and surprisingly there were no diseases in the crop. She was happy with the seed's quality. Despite of harsh weather, she harvested 7.5 *maunds* wheat grain from new variety, 50% higher than her own seed which only produced 5 *maunds* from similar size of the plot", she expressed her happiness. She saved 150kg seed of Millat-11 to plant her entire plot with new variety in the next wheat season and will sell the rest of the produce as 'seed' probably at a good profit. The good quality seed and higher yield from the new wheat variety gave her new hope and confidence to support her family in a better way.

"I am thankful to the American People, USAID, CIMMYT and NRSP for reaching out to me and sowing yet another seed of hope for many landless people in Pakistan."

10. APPENDICES

Village (District)		No. of Beneficiaries				Quantity of seed (kg)				
	Rhodes Grass	Sorghum	Guar	Mott Grass	Maize	Rhodes Grass	Sorghum	Guar	Mott Grass (root slips	Maize
Noor Sar (Bahawalnagar)	2	11	0	0		4	55	0	0	
Ahata Mukhian (Bahawalnagar)	3	10	5	0		6	50	12.5	0	
28/3-R (Bahawalnagar)	2	10	8			4	50	37.5		
67/4-R (Bahawalnagar)	2	9	1	3		4	45	10	120	
Chella (Bahawalnagar)	0	0	0	4					120	
Nara Kot (Kotli)					8					50

Livestock

Appendix 1 Completed model training farms details

District	Tehsil	Village	No. of model farms
Bahawalnagar	Bahawalnagar	Ahata Mukhian	3
		Noor Sar	4
	Haroonabad	28-3-R	1
Jhang	Jhang	Chella	4

Appendix 2 Completed model training farms details Beneficiaries of Improved Forage Seed

Appendix 3 respondents of Baseline Survey to assess the challenges and opportunities in the dairy sector

District(s)	Tehsil	Village	Respondent
Chakwal	Chakwal	Beghal	11
Chakwal	Talagang	Dhulli	20
Chakwal	Talagang	Dhulli	17
Jhang	Jhang	Cheila	20
Jhang	Jhang	Cheila	19
Jhang	Jhang	166 JB	20
Bahawalpur	Mandi Yazman	93 DB	22
Bahawalpur	Mandi Yazman	93 DB	22
Bahawalpur	Mandi Yazman	93 DB	20
Bahawalpur	Mandi Yazman	54 DB	15
Bahawalpur	Mandi Yazman	54 DB	27
Bahawalnagar	Bahawalnagar	Ahata Mukhiaan	14
Total			227

Appendix 4 Formulation of experimental rations

Ingredients	T1	T2	T3	T4	T5
Wheat	10	-	-	-	-
Wheat bran	27	15	13	16	15
Rice polish	8	-	-	-	-
Rape seed cake	3	-	-	-	-
Rape seed meal	1	-	-	-	-
Cotton seed cake	12	35	-	-	-
Cotton seed meal	1	-	-	-	-
Sun flower meal	1	-	-	-	-
Maize grain	25	24	40	40	40
Molasses	10	-	9	9	9
Common salt	1	1	1	1	1
Di-calcium phosphate	1	1	1	1	1
Barley grain	-	24	-	-	-
Soybean	-	-	12	10	0
Canola cake	-	-	9	8	9
Maize Gluten 30%	-	-	15	15	25
CP %	15.39	16	17.85	16.65	15.45
TDN %	90.98	75	70	70	69
Energy (Kcal/Kg)	2900	3100	3200	3000	2800

Appendix 5 Impact of different rations on live-weight gain of lambs/kids

Site	Groups	No. of animals	Ration	Changes in live-weight (Kg)		
				Initial (Day 1)	Final (30 days)	Difference
Quetta	A	60 Lambs	T1	48.36	49.58	1.22
	B	60 Lambs	T2	50.41	52.5	2.09
	C	60 Lambs	Control/grazing	49.8	49.5	-0.3
Dhulli	A	16 Lambs	T3	62.37	67.81	5.44
	B	16 Lambs	T4	50.68	54.75	4.07
	C	16 Lambs	T5	50.62	54.43	3.81
	D	16 Lambs	Control/grazing	50.12	51.37	1.25
	A	30 Kids	T3	43.63	47.43	3.8
	B	30 Kids	T4	41.6	44.7	3.1
	C	30 Kids	T5	48.3	50.73	2.43
	D	30 Kids	Control/grazing	42.93	43.63	0.7

Appendix 6 Location wise respondents of Snapshot Survey carried out to identify the challenges by dairy farmers in Balochistan, Sindh, AJK and Gilgit Baltistan

Village	Tehsil	District	Province	Respondent(s)
Derwesh Abad	Quetta	Quetta	Baluchistan	17
Hakelzai	Saranan	Pishin		16
Faizabad	Pishin	Pishin		6
Karim Abad	Pishin	Pishin		2
Jatak Stop	Quetta	Quetta		24
Total				65
Garhi Doupatta	Garhi Doupatta	Muzaffarabad	AJK	31
Mujhoi				15
Malsi				25
Nara Kot	Charohi	Kotli		28
Total				99
Astana	Skardu	Skardu	Gilgit Baltistan	45
bara gaon				24
Zhood Khun	Hunza Nagar	Gilgit		37
Danyore	Hunza Nagar	Gilgit		40
Total				146
Moosa Katian	Hyderabad	Hyderabad	Sindh	40
Hussain Bhambhro	Matyari	Matyari		39
Wada Simang	Khairpur	Khairpur		37
G.H. Hundial				39
Total				155

Appendix 7 Impact of rotational grazing on live-weight gain at different sites

	Beghal-1 (before monsoon)		**Beghal-2 (after monsoon)**		**Dhulli-1 (before monsoon)**		**Dhulli-2 (after monsoon)**	
Parameters	RGPA	RGUPA	RGPA	RGUPA	RGPA	RGUPA	RGPA	RGUPA
Total Areas (ha)	50		50		50		50	
Numbers of Blocks	3		3		3		3	
Number of heads	6	4	6	4	6	4	13	8
Average initial weight (kg)/head	53.16	52	54.66	53.5	63.33	66.66	53.61	57.63
Average Daily Gain (Grams)	30.00	10.00	76.92	50.77	64.92	-16.50	84.50	30.00
Days on pasture	50	50	13	13	59	20	20	20

RGPA= Rotational grazing in protected area, RGUPA=Grazing in un-protected area

Appendix 8 Seed distribution to Pakistani institutions, till September 2015

Department / Institute	Crop	AVRDC Advance Lines
Agricultural Research Institute (N), Mingora, KP	Tomato	
Agricultural Research Station, Baffa-Mansahra, KP		
Vegetable Program, NARC- Islamabad		11
Nuclear Institute for Agriculture & Biology, Faisalabad-Punjab		08
Arid Zone Research Institute, Bahawalpur-Punjab		21 (10+11)
Arid Zone Research Institute, UmerKot-Sindh		10
Nuclear Institute for Agriculture & Biology, Faisalabad-Punjab		11
Institute of Plant Introduction, Karachi-Sindh		11
		10
		10
Agricultural Research Station, Baffa-Mansahra, KP	Chili	07
Vegetable Program, NARC- Islamabad		21 (13+8)
Arid Zone Research Institute, Bahawalpur-Punjab		13
Arid Zone Research Institute, UmerKot-Sindh		13
Vegetable Program, NARC- Islamabad	Onion	10
Arid Zone Research Institute, Bahawalpur-Punjab		05
Arid Zone Research Institute, UmerKot-Sindh		05
Institute of Plant Introduction, Karachi-Sindh		05
Agricultural Research Institute (N), Mingora-KP	Bitter gourd	
Arid Zone Research Institute, DI Khan-KP		06
Vegetable Program, NARC- Islamabad		06
Vegetable Research Institute-AARI, Faisalabad-Punjab		06
Arid Zone Research Institute, UmerKot-Sindh		06
Balochistan Agricultural Research Center, Quetta-Balochistan		06
		06
Oilseed Program, NARC, Islamabad	Soybean	15
Pulses Program, NARC, Islamabad	Mungbean	18
TOTAL		240

Appendix 9 Comparison of best performing tomato hybrids under protected cultivation

Location	Hybrid	1st top yielded(t/ha)	Hybrid	2nd top yielded(t/ha)
Mingora-Swat	Cosmic	52.7	Anna	38.5
Haripur	Anna	98.9	Denar	95.5
DI Khan	Denar	42.2	4040	40.8
Muzaffarabad	Sahil	48.3	-	-
Rawalpindi	Sahil	27.2		
Sheikhupura	Sallar	85.5	Sahil	80.5
Gojra-Faisalabad	Sandal	83.3	Sallar	78.2
NoorpurThal	Sahil	20.5	Kimia	18.8
Bahawalpur	Fonto	30.9	-	-
Quetta	Sahil	89.9	Denar	86.9
Bostan	APCL	72.0	-	-

Appendix 10 Comparison of best performing cucumber hybrids under protected cultivation

Location	Hybrid	1st top yielded (t/ha)	Hybrid	2nd top yielded (t/ha)
Mingora-Swat	Local	56.3	Nine ring	53.1
DI Khan	Ozbek	32.9	Kandil	27.1
Sheikhupura	Waleed	149.5	Ramzan	120.8
Gojra-Faisalabad	2833	64.6	Saver	48.8

Appendix 11 Comparison of best performing tomato hybrids grown under natural off-season conditions

Location	Hybrid	Top yields(t/ha)	Hybrid	2nd top yields(t/ha)
Muzaffarabad-AJK	T-1359	48.5	Sahil	48.3
Thoamehram-Talagang	T-1359	35.2	T-1757	31.9
Soon Valley-Khushab	T-1359	17.8	Local	11.9
Katha Saghral-Khushab	Sahil	28.1	Kimia	27.3
Badin- Sindh	Supper	36.4	T-786	34.9

Appendix 12 Comparison of best performing Bitter gourd hybrids under natural off-season conditions

Location	Hybrid	1st top yielded (t/ha)	Hybrid	2nd top yielded (t/ha)
Mingora-Swat	Palee	25.5	-	-
Gojra-Faisalabad	Prachi	57.2	BG-888	52.6
DI Khan	Palee	37.5	BG-485	33.8

Appendix 13 Summary of farmer's practices vs. proposed practices for insect control

Common Insect	Farmer's practice	Proposed practice
Aphid	Imidacloprid Carbusulfan Bifenthrin Imidacloprid + acetamiprid	Nitenparam Thiomethoxam Imidacloprid Leufenuron or Buprofezin 25 WP
Fruit Fly	Trichlorphon	G.F-120 N.F Dichlorvos or Dichlorvos + MAT + Sanitation
Army Worm	Emmamectin benzoate	Leufenoran Emmamectin benzoate or Match
White Fly	Accetamaprid Nitenparam	Diafenthuron Buprofezin or Flonicamide
Fruit Borer	Emmamectin Benzoate Lambada cyhalothrin Perfenophos + Cypermethrin	Bifenthrin Spinosad Flubendiamide or Belt, Steward

Appendix 14 Summary of farmer's practices vs. proposed practices for disease control

Technical Name	Farmer Control	Proposed Control
Early Blight (Tomato)	1. Score (Difenoconazole) 2. Mancozeb (Dithane M-45) 3. Ridomil (Chlorothalonil + Manlozeb) 4. Acrbat MZ (Dimethimorph) 5. Cabrio Top (Pyclostrobin + Metirim)	1. Daconil (Chloro Thalonil) 2. Idex (Propineb + Cymoxanil 3. Ridomil (Chlorothalonil + Mancozeb) 4. Score (Difenoconazole) 5. Cabrio Top (Pyclostrobin + Metirim)
Canker/blight of tomato	Score (Difenoconazole)	Agrimycim
Collar rot of Sweet Pepper	Fostyl Aluminium (Allite OWP)	1. Ridomil (Chlorothalonil + Mancozeb) 2. Alligate (Fostyl Aluminium +Mancozeb
Downey Mildew in cucumber	1. Curzate (Cymoxinal + Mancozeb) 2.Antracol (Propineb) 3. Topsin M (ThioPhanate Methyl) 4. Melody Due (Iprovalicarb +propineb)	1. Folio Gold (Mefenoxam +cholorothalomil) 2. Radomil (Chlorothalonil + Mancozeb) 3. Triger (Tebuconazole) 4. Alligate (Fostyl Aluminium +Mancozeb
Powdery Mildew in cucumber	1. Fosetyl Aluminium (Alligate) 2. Topsin M (Thiophanate Methyl)	1. Score (Difenoconazole) 2. Tilt (Propiconazole)

Appendix 15 Details of trainings conducted across Pakistan (April to September, 2015)

Title	Date	Venue	Collaboration	No. of Participants		
	2015			Male	Female	Total
Pesticide awareness, health hazardous effects and precautions	14 Oct	Chevanda, Faisalabad	VRI-AARI, Faisalabad	0	21	21
Healthy Vegetable Seedling Production and IPM	29 April	Chattar plain Mansehra	ARS Baffa-Mansehra	21	0	21
Healthy Vegetable Seedling Production and IPM	13 May	MangvaltanCharbagh Swat	Agricultural Research Institute, Mingora	29	0	29
Healthy Vegetable Seedling Production and IPM	6 June	Naushera, Soon Valley-Khushab	HRS Soon valley	19	01	20
Healthy Vegetable Seedling Production for growing off season tomatoes	17 June	BARI Chakwal	Barani Agricultural Research Institute, Chakwal	29	03	32
Improved Vegetable production technology and IPM	July 31	Komikot, Azad Jammu Kashmir	Ag Research, Muzaffarabad, AJK	28	0	28
Improved Vegetable production technology and IPM	22 Aug	Hattian, Azad Jammu Kashmir	Ag Research, Muzaffarabad, AJK	0	15	15
Healthy Vegetable Seedling Production	02 Sept	Shinkiari, Mansehra	NTHRI, Shinkiari	23	0	23
Total				**149**	**40**	**189**

Appendix 16 Leafy vegetables raised under shade net from May to July, 2015

Crop	Area (Sqm) /10 marla	Yield (Kg)	Rate/kg	Income per tunnel
Spinach	255	482	24	11460
Coriander	255	69	110	7783

Appendix 17 Net revenue gains from mungbean production in the traditional mungbean growing area of Layyah &Bhakkar (Punjab). The varieties used were AZRI-06 and NM-11.

District	Cluster Name	Farmer Benef.	Area planted (ha)	Seed produced (t)	Mean Yield kg / ha	Total income/ha @ Rs. 100/- per kg	Cost of productionper ha (Rs.)	Net Revenue Gain/ha (Rs.)
Bhakkar	Thal -I	15	7.29	8.54	1172	117200	43,000	74,200
	Nashaib	8	3.24	4.46	1375	137500	43,000	94,500
	Tibba Hamid Shah	6	2.23	2.80	1260	126000	43,000	83,000
	Luck Kallan	10	4.45	4.89	1098	109800	43,000	66,800
Layyah	Thal-II	11	4.45	4.38	985	98500	43,000	55,500
	ChowkAzam	8	3.24	3.14	970	97000	43,000	54,000
Note: The value of by-products and cost of irrigation were almost equal, therefore are not considered in the calculation.								

Appendix 18 Net revenue gained from mungbean production as a catch crop in the rice-wheat cropping system of Punjab and Sindh provinces.

District	Cluster Name	Farmer Benef.	Area Planted (ha)	Total grain production (t)	Mean Yield kg / ha	Total income/ha @ Rs. 75/- per kg	Cost of production per ha (Rs.)	Net Revenue Gain/ha (Rs.)
Sheikhupura	Farooqabad	4	0.81	1.05	1297	97275	25,000	72,275
Nankana Sahib	Chandikot	21	4.09	4.78	1170	87750	25,000	62,750
Larkana	Ratodero/ Larkana	15	6.88	4.09	594	44550	25,000	19,550

Note: The variety used was NM-11. The value of by-products (nitrogen & straw) and cost of irrigation were almost equal, and therefore are not considered in the calculation.

Appendix 19 Net revenue gained from mungbean production intercropped with sugarcane and citrus

District	Intercropping system	Cluster Name	Farmer Benef.	Area planted (ha)	Mean Seed Yield (kg/ha)	Value of seed @ Rs. 75/- per kg	Value of byproducts per ha (Rs.)	Total income per ha (Rs.)	Cost of production per ha (Rs.)	Net Revenue Gain/ha (Rs.)
Thatta	Sugarcane	Makli	12	5.25	217	16,275	8,000	24,275	3,000	21,275
Sajawal	---Do---	Syedpur	12	4.26	190	14,277	8,000	22,277	3,000	19,277
T.T.Singh	---Do---	Mumdana Kallan	29	5.87	520	39,000	8,000	47,000	3,000	44,000
Sargodha	Citrus	Chakian	5	2.00	667	50,018	8,000	58,018	3,000	55,018

Appendix 20 A plant level evaluation

1	EC 693356	8	ML 1299	
2	EC 693357	9	PDM 139	
3	EC 693358	10	IPM 205-7	
4	KPS-1		11	EC 693372
5	EC 693361	12	EC 693376	
6	EC 693365	13	MASH 1-1	
7	EC 693370			

Appendix 21 A field level evaluation

1	PAU 611
2	EC 693367
3	EC 693362
4	VC-6369 (53-97)
5	EC 693360
6	EC 693372

Appendix 22 Quality Seed production of high yielding varieties; AZRI-06 and NM-11, by seed villages developed in the traditional mungbean growing areas of Layyah and Bhakkar in Punjab province

District	Cluster Name	Farmer Benef.	Area planted (ha)	Seed produced (t)	Mean Yield kg / ha	Total income/ha @ Rs. 100/- per kg
Bhakkar	Thal -I	15	7.29	8.54	1172	117200
	Nashaib	8	3.24	4.46	1375	137500
	Tibba Hamid Shah	6	2.23	2.80	1260	126000
	Luck Kallan	10	4.45	4.89	1098	109800
Layyah	Thal-II	11	4.45	4.38	985	98500
	ChowkAzam	8	3.24	3.14	970	97000

Appendix 23 Parental lines and cross combinations of mungbean crossing block during summer, 2015

Parent Lines	Major characters	Cross combinations
V1001709 B-G	Bruchid Resistant	AVMU 8901 X NM-11
V 1001802 B-G	Bruchid Resistant	AVMU 8901 X NM-06
AVMU 8901	Bruchid Resistant	AVMU 8901 X AZRI-06
NM-06	High Yielding, Bold seeded, shiny testa, well adapted	AVMU 8901 X NCM-2013
NM-11	High Yielding, Bold seeded, shiny testa, well adapted & susceptible to bruchid	V1001709 B-G X NM-11
NCM 2013	High Yielding, Bold seeded, shiny testa, well adapted & susceptible to bruchid	V1001709 B-G X NM-06
AZRI-06	High Yielding, Bold seeded, shiny testa, well adapted & susceptible to bruchid	V1001709 B-G X AZRI-06
		V1001709 B-G X NCM-2013
		V1001802 B-G X NM-11
		V1001802 B-G X NM-06
		V1001802 BG X AZRI-06
		V1001802 B-G X NCM-2013

Appendix 24 List of F_1, F_2 and F_3 populations

F_1 Generation	F_2 Generation	F_3 Generation
NM-06 X AVMU 8901	NM-11 X AVMU 8901	V 1001709 B-G X NM-11
NM-11 X AVMU 8901	V1001709 B-G X NM-11	AVMU 0401 X NCM 2013
NCM 2013 X AVMU8901	AVMU 8902 X NM-11	AVMU 0002 X NCM 2013
V1001709 B-G X NM-11	NM-11 X V 1001709 B-G	V 06322 A-G X NM-06
V 1001709 B-G X NCM 2013	V 1001802 B-G X NM-11	V1001709 B-G X NM-11
V 1001802 B-G X NM-11	AVMU 0401 X NM-11	AVMU 8902 X NCM 2013
NM-11 X V 1001709 B-G	V 1001709 B-G X NCM 2013	AVMU 0401 X NM-11
NM-06 X V1001709 B-G	-	

Appendix 25 List of Back crosses to be made during summer, 2015 (Table 2.3.4).

F_1 X Adapted Parent
(NM-06 X AVMU 8901) X NM-06
(NM-11 X AVMU 8901) X NM-11
(NCM 2013 X AVMU8901) X NCM 2013
(V1001709 B-G X NM-11) X NM-11
(V 1001709 B-G X NCM 2013) X NCM 2013
(V 1001802 B-G X NM-11) X NM-11
(NM-11 X V 1001709 B-G) X NM-11
(NM-06 X V1001709 B-G) X NM-06

Appendix 26 Areas (ha) per crop planted for seed production in winter and summer seasons in 2014-15

Institute /Seed Company		October 2014-March 2015		April –September 2015			Total
		Onion	Peas	Tomato	Chili	Okra	
ARI Quetta, Balochistan(13)		1.9	-	-	-	0.5	2.4
AZRI Umerkot, Sindh (4)		1.0	-	-	1.0	-	2.0
ARI, Mingora, KP (24)		0.5	0.7	-	-	0.7	1.9
VRI-AARI, Faisalabad, Punjab(5)		-	1.3	0.5	-	1.5	3.3
NARC, Islamabad, Federal Area (4)		0.5	-	-	-	0.5	1.0
Beacon Seeds, Kunri, Mirpurkhas, Sindh		1.0	-	-	1.0	-	2.0
ARCO Seeds, Gujranwala, Punjab (2)		-	1.0	-	-	2.0	3.0
Total		4.9	3.0	0.5	2.0	5.2	15.6

Values in parentheses are the number of contract farmers involved in seed production.

Appendix 26 A List of Provincial Partner Institutions

a) Institutions for Protected Cultivation (April to September, 2015)

1. Agricultural Research, Gilgit-Biltistan
2. Agricultural Extension, Gilgit-Biltistan
3. Agricultural Research , Muzaffarabad, Azad Jammu & Kashmir
4. Agricultural Research Institute (N) Mingora-Swat
5. Agricultural Research Station, Baffa-Mansahra
6. National Tea and High Value Crops Research Institute, Shinkiari-Mansahra
7. Vegetable Program, HRI, NARC, Islamabad
8. Barani Agricultural Research Institute (BARI), Chakwal
9. Vegetable Research Institute, AARI, Faisalabad
10. Agricultural Research Institute (S), DI Khan
11. Arid Zone Research Institute, Bahawalpur
12. Sindh Horticultural Research Institute(SHRI), Mirpurkhas
13. Arid Zone Research Institute, Umerkot
14. Institute of Plant Introduction, SARC, Karachi
15. Directorate of Vegetable Seed Production, ARI, Saryab-Quetta

Private Companies & Progressive Growers

- Soon Valley Development Project, Khushab

b) Institutions for Mungbean Production (April to September, 2015)

1. Pulses Program, CSI, NARC, Islamabad
2. Citrus Research Institute, Sargodha
3. Pulses Research Institute, AARI, Faisalabad
4. Arid Zone Research Institute (AZRI), Bhakkar
5. Quaid-e-Awam Agriculture Research Institute (QAARI), Larkana
6. National Sugar & Tropical Horticulture Research Institute (NSTHRI), Thatta

Private Companies & Progressive Growers

- Mumtaz Seed Company, Rahim Yar Khan

c) Institutions for Vegetable Value Chains (April to September, 2015)

1. Agricultural Research Institute (N) Mingora- Swat
2. Vegetable Program, HRI, NARC, Islamabad
3. Vegetable Research Institute, AARI, Faisalabad
4. Postharvest Research Center, AARI, Faisalabad
5. Directorate of Vegetable Seed Production, ARI, Saryab, Quetta

Private Companies & Progressive Growers

- Shuga Seed Growers Association, Gokand Valley, Buner, KP
- ARCO Seed, Gujranwala, Punjab
- Beacon Seed Company, Kot Ghulam Muhammad, Sindh

Appendix 26 B Target Areas, Clusters and Direct Beneficiaries in Pakistan

(a)

Sub-Component-I		Province	District	Cluster	Direct Beneficiaries
Protected Cultivation of Vegetables		AJK	Muzaffarabad	2	45
		Balochistan	Dadhar, Pishin, Quetta	3	14
		Gilgat-Baltistan	Gilgat, Diamer, Hunza Nagar, Gizer, Sakurdu	9	21
		Sindh	Hyderabad, Umerkot, Mirpurkhas, Badin	5	35
		Punjab	Faisalabad, Sheikhupura, Khushab, Chakwal, Bahawalpur	7	79
		KPK	Haripur, Dera Ismail Khan, Swat, Mansahra	11	178
		Federal	Rawalpindi/Islamabad	1	12
Total				38	384

(b)

Sub-Component-II	Province	District	Cluster	Direct Beneficiaries
Improved Mungbean Production	Punjab	T.T. Singh, Kasoor, Sheikhupura, Sargodha, Bhakkar, Layyah	10	81
	Federal	Chakwal, Jhelum, Attock, Rawalpindi, Islamabad	7	63
	Sindh	Larkana, Thatta, Sajawal	3	29
Total			20	173

(c)

Sub-Component-III	Province	District	Cluster	Direct Beneficiaries
Vegetable	KPK	Mingora, Buner	1	13

Value Chains	Punjab	Haripur, Attock, Rawalpindi, Islamabad, Sheikhupura, Chiniot, Faisalabad, Pakpattan	3	8
	Sindh	Mirpurkhas, Umerkot	1	3
	Balochistan	Quetta, Pishin, Khuzdar, Jafferabad, Mastung	1	10
Total			6	36

Appendix 27 Volume of seeds (kg) produced from April to September 2015 by public and private sector partners and their contract farmers

Institute /Seed Company	October 2014-March 2015		April –September 2015			Total
	Onion	Peas	Tomato	Chili	Okra	
ARI Quetta, Balochistan(13)	1040	-	-	-	IP	1040
AZRI Umerkot, Sindh (4)	126	-	-	IP*	-	126
ARI, Mingora, KP(24)	288	193	-	-	292	773
VRI-AARI, Faisalabad, Punjab(5)	-	2115	18	-	830	2963
NARC, Islamabad, Federal Area(4)	65	-	-	-	250	315
Beacon Seeds, Kunri, Mirpurkhas, Sindh	206	-	-	IP*	-	206
ARCO Seeds, Gujranwala, Punjab(2)	-	1700	-	-	995	2695
Total	1725	4008	18	-	2367	8118

** IP- iIn progress (crop still standing in the field)*

Appendix 28 Activities linking seed value chain actors, April 2015 to September 2015.

Activity	Date	Purpose	Venue	Partners	Brief Outcome
Workshop	April 30	Consultation with seed dealers	Quetta	Directorate of Vegetable Seed Production	Seed producers and dealers linked up and had access to technical support from AVRDC and its partners
Coordination meeting	May 10	Kharif sowing	Gujranwala	ARCO Seeds	Okra crop sown; planned for peas and okra seed packing
Packing ceremony	June 10	Onion seed packing	Umarkot and Kunri, Sindh	AZRI and Kunri	Seed producers, seed dealers and staff of AZRI Umerkot had increased knowledge on onion seed packing in pouches; seed producers and seed dealers linked up
Coordination meeting	May 14	Consultation with Partners, and seed producers	Mingora, Swat and Shuga, Buner	Partners in public and private sector	Seed producers linked up with Zamindar Seedsat Mingora for seed marketing
Conference	August 06	Participate in Agricultural Development Conference in Balochistan	Quetta	FAO and ARI Quetta	Increased knowledge on Agriculture Development in Balochistan; farmer-seed growers and seed dealers were linked up.

Appendix 29 Performance of tomato varieties at ARI, Mingora, Swat in 2015.

Varieties	Yield (ton/ha)	Total soluble solids (Brix)	Water content (%)	Shelf Life at ambient (days)
AVTO-9708	23.8 AB	3.4 F	92.6 AB	7
AVTO-1288	27.0 A	5.1 A	96.5 A	5
AVTO-1289	23.2 AB	4.9 B	90.1 BC	6
AVTO-1405	17.0 C	3.7 C	93.9 AB	5
AVTO-1409	22.6 AB	3.7 CD	91.7 ABC	6
AVTO-1418	25.4 A	3.6 CD	90.7 BC	4
AVTO-1420	15.8 CD	3.5 DE	89.9 BC	7
AVTO-1424	19.2 BC	3.4 EF	87.5 C	5
AVTO-1429	24.3 A	3.5 DE	92.0 ABC	5
AVTO-1455	17.2 C	3.7 CD	92.6 ABC	6
AVTO-1456	10.9 D	3.3 F	92.1 ABC	5
LSD, 5%	**5.1**	**0.22**	**6.8**	

Means in a column with the same letter are not significantly different based on LSD, 5%.

Appendix 30 Performance of onion varieties in the field and store at ARI Mingora, Swat in 2015.

Varieties	Bolting (%)	Shelf life(days)	Yield (tonnes/ha)
Chiltan - 89	35.3 A	17 D	15.8 DE
Saryab Red	33.0 A	21 BCD	15.0 E
NARC-1	25.0 B	26 B	38.0 A
NARC-2	19.0 C	31 A	41.3 A
Pulkhara	18.0 C	23 BC	25.0 BC
Swat-1	19.7 C	34 A	30.0 B
Brown Spanish	16.3 C	24 B	20.8 CD
Hunter River	16.0 C	27 B	23.0 C
Sun Set F_1	17.3 C	20BC	23.8 C
LSD, 5%	**4.9**	**3.5**	**5.8**

Means in a column with the same letter are not significantly different based on LSD, 5%.

Appendix 31 Temperature and RH in the solar dryers

Parameter	SDR	SDT	Open sun
Tomato drying			
Temp, ^oC	33.4-39.9	32.6-39.8	29.0-34.6
RH, %	34.5-50.0	40.0-60.9	42.0-60.8
Onion drying			
Temp, ^oC	38.2-44.2	37.2-45.5	32.1-40.9
RH, %	31.7-46.8	32.7-48.3	34.7-53.7

Appendix 32 Drying period, color, rehydration ratio and vitamin C content of tomato and onion dehydrated in solar dryer with rotary chimney (SDR), tunnel type solar dryer with transparent polyethylene

film cover (SDT) or open sun drying (SUN).

Vegetable	Drying method	Hours to < 10% moisture content	Lightness*	Rehydration ratio	Vitamin C (mg/100g FW)	Vitamin C loss (% of initial content)**
Tomato	SUN	71a	40.8	4.3a	13.0	22.4
	SDT	51b	39.8	3.9b	12.7	24.4
	SDR	47b	39.6	4.1ab	11.4	32.2
	CV, %	5.0	4.7	1.6	9.4	26.4
	LSD 5%	9.0	ns	0.2	ns	Ns
Onion	SUN	72a	58.6	9.2c	6.1a	10.3b
	SDT	48b	55.5	10.2b	5.2b	22.7ab
	SDR	44b	54.7	10.3a	5.1b	24.2a
	CV, %	5.1	4.0	0.2	5.0	20.9
	LSD 5%	9.0	ns	0.08	0.8	12.7

**Lightness values for fresh tomato and onion were 53.7 and 57.4, respectively.*
***Vitamin C content of fresh produce (initial content) was 16.8 and 6.8 mg per 100 g fresh weight (FW) for tomato and onion, respectively.*
Mean separation within columns per commodity by LSD, 5%.ns-not significant

Appendix 33 Temperature and RH in the greenhouse solar dryer (GSD), solar dryer with rotary chimney (SDR), tunnel type solar dryer with transparent polyethylene film cover (SDT) or black polyethylene film cover (SDB), and open sun drying; days to drying; and color L* and a* values of the dried chili.

Drying Condition	Temperature ^{o}C		RH, %		Days to drying	L* (lightness)		a* (red color)	
	Min	Max	Min	Max		Fresh	Dried	Fresh	Dried
GSD	33.5	74.5	10.5	46.0	4	34.2	26.3	43.4	16.7
SDR	29.2	40.4	23.6	54.3	6		24.5		35.5
SDT	28.8	39.2	24.8	60.1	6		30.3		27.4
SDB	26.5	37.9	25.4	63.8	7		31.5		39.5
Sun drying	23.6	30.4	34.2	72.2	9		28.2		27.4

Appendix 34 DA index, color L*, a*, b*, chroma and hue angle values, non-destructive firmness (shore), destructive firmness by hand-held penetrometer (Firm-HHP), total soluble solids (TSS), acidity and vitamin C content of tomato at different maturity stages.

Maturity Stage	DA Index	Color						Firmness	Firm-HHP	TSS	Acidity	Vitamin C
		L	a	b	Ch	H						

		*	*	*	roma	ue		(shore)	(kg)	(ºB)	(%)	(mg/100 g)
Stage 1 (mature green)	1.3	64.1	-7.2	32.5	33.3	-77.4		34.5	2.3	4.2	3.5	21.3
Stage 2 (breaker)	1.0	61.7	-5.3	33.4	33.8	-80.8		31.9	2.2	4.2	3.8	20.8
Stage 3 (turning)	0.7	66.1	3.5	52.9	53.0	86.2		27.5	2.1	4.3	3.8	19.3
Stage 4 (pink)	0.5	62.8	8.0	56.4	57.1	81.8		21.3	1.7	4.3	3.9	18.6
Stage 5 (light red)	0.1	51.3	18.9	43.4	47.4	66.2		17.4	1.5	4.5	4.0	17.4
Stage 6 (red)	0.0	39.3	35.3	28.2	45.2	38.6		16.4	1.0	4.1	4.0	16.4
Correlation coefficient with DA index (R^2)		**0.63**	**0.88**	**0.01**	**0.33**	**0.50**		**0.98**	**0.90**	**0.20**	**0.75**	**0.97**

Appendix 35 Correlation coefficient (R^2) between DA index and a* values (reddening), weight loss and TSS of tomato AVRDC lines 'DET-56' and 'CH-151' and commercial variety 'Arka Saurabh' during chilling and ambient storage.

Parameters correlated	Chilling storage				Ambient storage		
	DET-56	CH-151	Arka Saurabh		DET-56	CH-151	Arka Saurabh
DA index and a* values	0.75	0.48	0.63		0.86	0.96	0.84
DA index and weight loss	0.89	0.89	0.89		0.71	0.85	0.93
DA index and weight loss	0.68	0.43	0.44		0.35	0.95	0.19

Appendix 36 Correlation coefficient (R2) between non-destructive firmness (NDF) and destructive firmness using hand-held penetrometer (DFP) or digital firmness tester (DFD) of tomato AVRDC Lines 'DET-56' and 'CH-151' and commercial variety 'ArkaSaurabh' during chilling and

ambient storage.

Parameters correlated	Chilling storage				Ambient storage		
	DET-56	CH-151	Arka Saurabh		DET-56	CH-151	Arka Saurabh
NDF and DFP	0.95	0.82	0.97		0.95	0.97	0.96
NDF and DFD	0.69	0.0002	0.81		0.94	0.99	0.59

Cereal and Cereal System

Wheat

Appendix 37

Appendix 38 Value of growing new wheat variety with or without the use of certified seeds

Treatment description	Treatment codes	Yield difference	Yield difference (kg/ha)	Yield difference (%)
Galaxy certified seed	T1			
Galaxy farm saved seed	T2	T1-T2	304	7.0
Seher-06 certified seed	T3	T1-T3	1824	64.2
Seher-06 farm saved seed	T4	T1-T4	2072	79.9
		T2-T3	1520	53.5
		T2-T4	1768	68.2
		T3-T4	298	11.5

Appendix 39 GGE rank of durum wheat varieties evaluated in durum wheat NUYT, 2014-15

Durum wheat genotype	GGE Rank_ 1=best
1	1
6	2
8 (durum wheat check)	3
5	4
12 (bread wheat check)	5
10	6
4	7
9	8
7	9
2	10
3	11
11	12

Maize

Appendix 40 List of climate resilient maize trials evaluated during spring 2015

No	Type of trial	Trial code	No of sets	No of entries	Kernel color	Germplasm source
1	Early maturing hybrid	EHYB14	5	45	White	Zimbabwe
2	Early maturing open pollinated varieties	EPOP14	5	30	“	“
3	New sets of intermediate	PAKINT1	5	72	“	“

	maturing hybrids	5				
4	New sets of late maturing hybrids	PAKLATE15	5	100	“	“
5	Intermediate maturing hybrids	IHYB14	2	60	“	“
6	Late maturing hybrids	LHYB14	4	40	“	“
7	Tropical early to intermediate maturing hybrids	TTWCWL	5	15	“	Mexico
8	Lowland tropics maize hybrids	TTWCWN	4	24	“	“
9	New set of tropical maize hybrids	TLXTFACTWN	2	40	“	“
10	Tropical/subtropical yellow maize hybrids	ASA18HY	5	16	Yellow	Colombia
11	Tropical/subtropical yellow maize hybrids	TTWCYN	3	21	Yellow	Mexico
12	Yellow maize hybrids for lowland tropics	TTWCYL	5	12	Yellow	Mexico
Total			50	475		

Appendix 41 List of AIP maize partners participated in the maize travelling seminar

Institution name	Province	Ownership	No of participants
National Agricultural Research Institute	Islamabad	Public	2
Cereal Crops Research Institute	KPK	“	1
Maize and Millet Research Institute	Punjab	“	2
Four Brothers Group	“	Private	1
Zamindara Seed Company	“	“	1
Jullundur Private Ltd	“	“	1
ICI Pakistan limited	“	“	1
Tara Crop Sciences	“	“	1
Ali Akbar Seeds	“	“	1
University of Agriculture Peshawar	KP	Public	1

University of Agriculture Faisalabad	Punjab	“	1
CIMMYT-Pakistan	Islamabad	CG center	2

Appendix 42 Words from maize travelling seminar participants

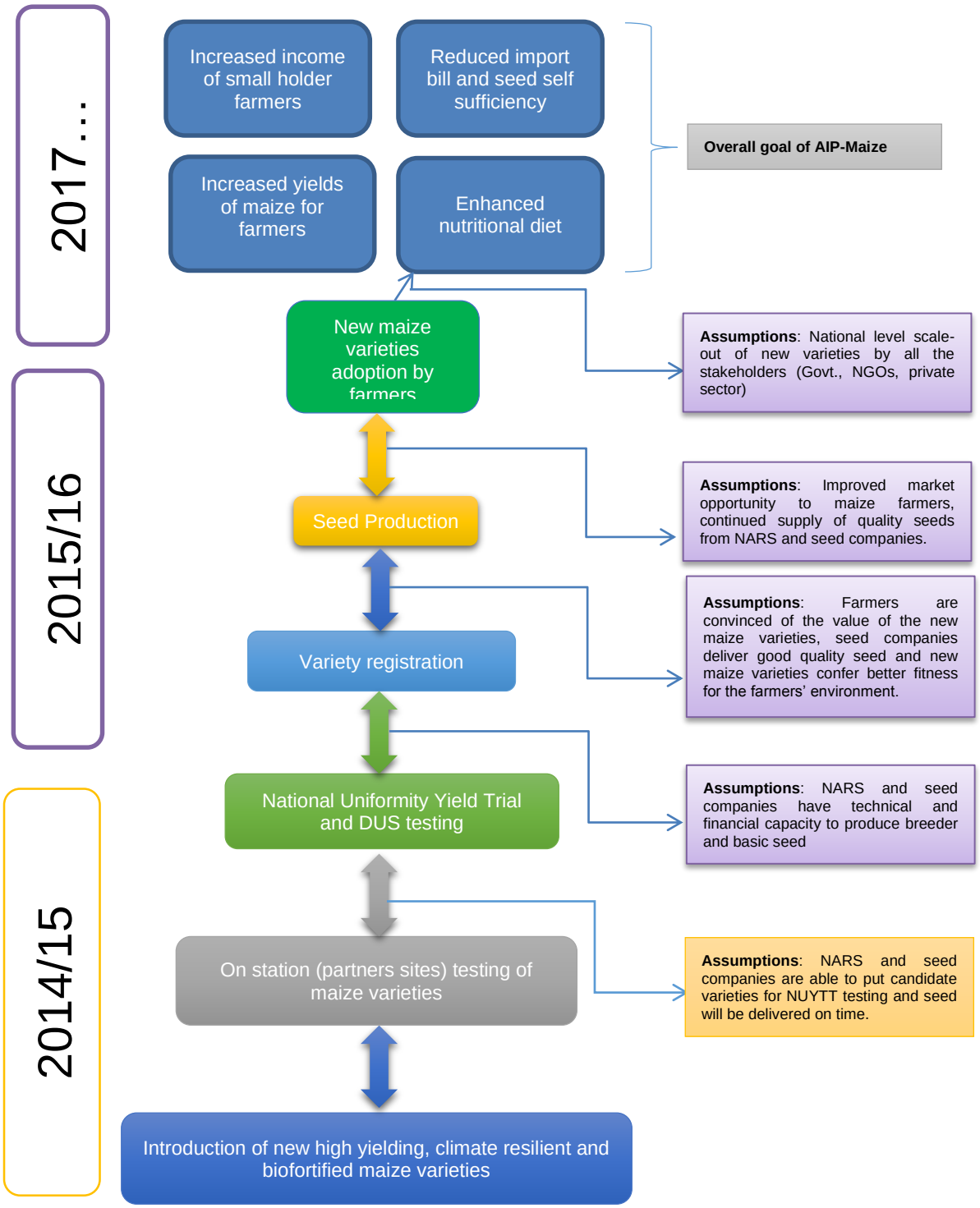
Appendix 43 maize varieties selected by AIP maize partners (spring 2015)

No	AIP maize Partner institution	Ownership	No. of selected hybrids	No. of selected OPVs	Total no. of selected entries
1	National Agricultural Research Center	Public	3	2	5
2	Cereal Crops Research institute	Public	6	6	12
3	Tara Crop Sciences	Private	3	-	3
4	Four brothers group	Private	6	1	7
5	Jullundur Private Limited	Private	8	-	8
6	Imperial Chemical industry (ICI)	Private/MNCs	15	-	15
7	Ali Akbar Seeds PLC	Private	4	-	4
8	Petal Seeds Plc	Private	-	3	3
9	Agricultural research Institute (Gilgit B)	Public	-	2	2
Total			39	14	53

Appendix 44 AIP-maize partners participated in the evaluation of spring maize trial (2015)

No	Partner name	Province	Ownership	No. of trials	Status
1	Jullundur Private Limited	Punjab	Private	5	Completed
2	4B group	Punjab	Private	4	Completed
3	Ali Akbar Pvt	"	Private	4	Completed
4	ICI-Pakistan	"	Private	7	Completed
5	Tara Crop Sciences Pvt	"	Private	2	Completed
6	Kanzo Quality Seeds Pvt	"	Private	3	Completed
7	Tassko Seeds Pvt	Sindh	Private	2	Completed
8	Maize and Millet Research Institute (MMRI)	Punjab	Public	6	Completed
9	Cereal Crops Research Institute (CCRI)	KPK	Public	9	Completed
10	National Agricultural Research Institute (NARC)	ICT	Public	8	Completed
11	Agriculture research Institute Balochistan	Balochistan	Public	2	Completed
12	Agriculture research Institute Sindh	Sindh	Public	1	Completed
13	Zamindara Seed Corporation	Punjab	private	3	Completed
14	Petal Seeds Corporation	KPK	Private	3	Completed

Appendix 45 Schematic diagram showing program pathway of AIP-maize



Appendix 46 Updated list of Public and private maize R&D institutions working with AIP-maize (As of October, 2015)

No	Institution	Ownership	Main activity/business	Geographical coverage in Pakistan	Involvement in maize variety development in Pakistan
1	National Agricultural Research Center	Public	Research and development	Mainly in Islamabad and surrounding areas	Yes
2	Cereal Crops Research Institute-Nowshera, KPK	Public	Research and development	KPK province	Yes
3	Maize and Millet Research Institute-Sahiwal, Punjab	Public	Research and development	Mainly southern Punjab	Yes
4	Punjab Seed Corporation	Public	Seed business	Punjab province and spill over to KPK and Sindh provinces	No
5	Agr. Research Institute (ARI)-Balochistan	Public	Research and development	Baluchistan province	Mainly variety testing
6	Agr. Research Institute (ARI)-Sindh	Public	Research and development	Sindh province	Mainly variety testing
7	Agr. Research Institute (ARI)-Gilgit	Public	Research and development	Gilgit Biltistan province	Mainly variety testing
8	Univ. of Agr. Peshawar	Public	Academics and research	KPK province	Yes
9	Univ. of Agr. Faisalabad	Public	Academics and research	Punjab province	Partly
10	Department of Agriculture, AJK	Public	Research and development	Azad Jammu and Kashmir	Mainly variety testing
11	Imperial Chemical industry	Private	Mixed business	Nation wide	Yes
12	4 brothers group	Private	Mixed business	Mainly in Punjab provinces	Mainly testing
13	Jullundur Private Limited	Private	Mixed agri. business	Mainly in Punjab and Sindh. Maize OPVs in KPK	Yes
14	Petal Seeds Company	Private	Mixed agri. business	Mainly in KPK province	Mainly testing
15	Ali Akbar Group	Private	Mixed agri. business	Mainly in Punjab provinces	Yes
16	Tara Crop Sciences	Private	Mixed agri. business	Mainly in Punjab provinces	Mainly testing
17	Kanzo Seeds Pvt	Private	Mixed agri. business	Mainly in Punjab provinces	Mainly testing
18	Tassko seeds Pvt	Priva	Mixed agri.	Mainly in Sindh	Mainly testing

		te	business	provinces	
19	Zamindara Seeds Plc	Private	Mixed agri. business	Mainly in Punjab provinces	Yes
19	Monsanto Pakistan	Multi national	Mixed business	Nation wide	Mainly testing for adaptation
20	Syngenta Pakistan	Multi national	Mixed business	Nation wide	Mainly testing for adaptation
21	Pioneer Pakistan	Multi national	Mainly seed business	Nation wide	Mainly testing for adaptation
22	PARC	Public	Coordination and policy	Nation wide	Yes in coordination

Appendix 47 List of on farm demonstration of AIP maize and other locally developed hybrids

Name of candidate variety	Hosting institute	Location	Date of sowing	Farmer Name
TP1217	Gilgit	Diamer (Near Gonar Farm)	**9/7/2015**	Kareem Khan
TP1220	Gilgit	Agi Extention Farm Chillas	**10/7/2015**	
ZM521	Gilgit	Danyor Gilgit	**7/7/2015**	Subadar Dar Ameen
TP1217	Petal Seeds	Haji Ahsan	**27-07-15**	Ashraf Ud Din Zarifa Qala
		Petal Seeds/ Mardan	**13-07-15**	Ashraf Ud Din Zarifa Qala
TP1219	Petal Seeds	Petal Seeds/Mardan	**13 -07- 15**	Ashraf Ud Din Zarifa Qala
		M.Usman	**31-07-15**	Muhammad Shah Qala
TP1219	4B	Swabi	**31-7-15**	Fazla Rahman
		Zozo Banda (Yar Hussain) Swabi	**2/8/2015**	Sajid Khan
TP1219	CCRI	Nowshera	**27-07-15**	
ZM309		Nowshera	**27-07-15**	
ZM309 ZM521	ARI Balochistan	Dhadar (Bolan district)	16-09-15	Muhammad Aslam
CZP132001	NARC	Not identified so far	Not planted	
TP1217	NARC	"	"	
CZP132006	CCRI	Nowshera	27-07-15	
CZH131007 (hybrid)	CCRI	Nowshera	27-07-15	
YH1898		Sahiwal	2-Aug-15	Mr. Muhammad Asghar
		Sahiwal	16-Jul-15	Mr. Ahsan-Ul-Haq
		Sahiwal	16-Jul-15	Mr. Muhammad Qasim
		Sahiwal	16-Aug-	Mr. Muhammad

			15	Awais
		Toba Tek Singh	14-Aug-15	Mr. Saif-Ur-Rehman
		Chichawatni	7-Jul-15	Mr. Farooq Ahmad
		Sahiwal	7-Jul-15	Mr. Rana Muhammad Abbas
		Sahiwal	11-Jul-15	Mr. Muhammad Rafique
		Sahiwal	12-Aug-15	Mr. Shahid Ramzan
	MMRI	Noorpur Pakpatan	1-Aug-15	Mr. Haji Muhammad Sadique
QPM hybrids	NARC	Rawala kot (AJK)	8-May-15	Muhammad Sadeeq Tahir
		Danna Kacheely (AJK)	1-Jun-15	Shouqat Hussain
		Kaghan (KPK)	27-May-15	NARC Kaghan site

Appendix 48 Distribution of AIP maize funds to partners for the period April'15 to March'16

No.	Partner institutions	Sector	Budget assigned
1	NARC	Public	$ 15,107.90
2	MMRI	"	$ 7,386.49
3	CCRI	"	$ 5,076.73
4	ARI-Quetta	"	$ 4,526.73
5	ARI-Gilgit	"	$ 4,146.73
6	JPL	Private	$ 3,455.45
7	4B group	"	$ 3,290.42
8	Zamindara seeds	"	$ 2,683.17
9	ARI-Sindh	Public	$ 3,226.73
10	Ali Akbar seeds	Private	$ 2,321.78
11	AJK-Muzafarabad	Public	$ 2,926.73
12	UAP	"	$ 1,425.00
13	UAF	"	$ 1,234.00
14	Tara Crop Sciences	Private	$ 1,794.42
15	Petal seeds co	"	$ 1,375.25
16	KQS	"	$ 1,113.86
17	Tassko Seeds plc	"	$ 975.25
		Total	**$ 62,066.63**

Appendix 49 Summary of AIP maize funds across commissioned projects

Commissioned Project	Budget	Percent
Climate resilient and biofortified maize	$ 22,918.42	37%
Biotic stress tolerant maize	$ 5,000.00	8%
Enhance the maize seed sector	$ 11,520.00	19%
Across	$ 22,628.71	36%
Total	**$ 62,067.13**	**100%**

Appendix 50 List of equipment distributed to AIP maize partners

Partner institution	Laptop	Desktop	Printer	Camera	Moisture meter
NARC	2	1	1	1	1
MMRI	1	1	1	1	0
CCRI	1	1	1	1	1
4B group	1	0	0	0	1
JPL	1	0	1	0	0
Petal SC	0	0	0	0	1
UAF	0	0	0	0	1
AAS	1	0	0	1	0
ZS	1	0	0	0	0
KQS	0	0	0	1	1
TS	0	0	0	0	1
TCS	1	0	0	0	1
UAP	0	0	0	0	1
ARI-Sindh	1	1	1	1	1
ARI-Gilgit	1	1	1	1	1
ARI-Quetta	1	1	1	1	1
AJK-MuzafarAbad	1	1	1	1	1
Total	**13**	**7**	**8**	**9**	**13**

Appendix 51 List of low soil nitrogen stress tolerant maize varieties

No	Name	Grain color
1	LNTP-Y C7	Yellow
2	LNTP-W C4	White
3	TZPB Prol C4	White

4	BR 9928-DMRSR LN C1	Yellow
5	TZL COMP 1 C6 LN C1	White
6	LA POSTA SEQUIA C6	White
7	Sint Marzoca Larga	White
8	BR 99 TZL Comp 4 DMSRSR	White
9	Acr 97 TZL Comp 1-W LN C1	White
10	Acr 9931 DMRSR LN Syn F2	Yellow
11	Local Check 1	Yellow
12	Local Check 2	Yellow

Appendix 52 Drought tolerant maize inbred lines introduced under the AIP maize program

No	Name	No	Name	No	Name
1	TZMI761	12	TZMI754	23	TZMI1162
2	TZMI745	13	TZMI755	24	TZMI1163
3	TZMI751	14	TZMI878	25	TZMI1164
4	TZMI899	15	TZMI882	26	TZMI1165
5	TZMI757	16	TZMI886	27	TZMI1167
6	TZMI763	17	TZMI889	28	TZMI1169
7	TZMI764	18	TZMI903	29	TZMI407
8	TZMI765	19	TZMI909	30	TZMI102
9	TZMI747	20	TZMI1159	31	TZMI407-Short
10	TZMI748	21	TZMI1160	32	Check
11	TZMI753	22	TZMI1161		

Appendix 53 AIP maize trail distributions and partners for Kharif 2015

No	Partner name	Trial code	No. of entries	Type of Trial	Crop Stage
1	JPL Pvt. Ltd (Arifwala)	EHYB15129	55	On going	R3 (milk stage)
		15CHTPROA4	24	New Trial	“
		14TTWCYL48	12	On going	“
		14TTWCWL34	15	On going	“
2	4B group (Lahore)	IHYB1579	60	On going	R3 (milk stage)
		EHYB15131	55	On going	“
		15CHTPROA5	24	New Trial	“
		LHYB1574	42	On going	“
		ADVQPM1556	60	Ongoing	“
3	Ali Akbar Pvt (Chiniot)	IITA Yellow hybrids (33)	30	NEW	R3 (milk stage)
4	ICI-Pakistan (Sahiwal)	14TTWCYL49	12	On going	R3 (milk

					stage)
		EHYB15132	55	Ongoing	“
		14TTWCWL35	15	On going	“
		IITA white hybrid	20	New trial	“
		POP Corn (OPVs)	1	New trial	VT (flowering)
		Sweet Corn	2	New trial	“
5	Tara Crop Sciences (Sahiwal)	IITA yellow hybrid	30	New Trial	R3 (milk stage)
		14TTWCWL36	15	On going	“
6	Kanzo Pvt (Sheikupura)	IITA white hybrids	20	New trial	R4 (dough stage)
		14TTWCYL50	12	On going	“
7	Petal seeds Co (Mardan)	02-14TTWCWN	24	New Trail	Harvested
		EPOP1590	30	On going	“
		IHYB1573	60	New Trail	“
8	Sohni Dharti (Sahiwal)	14TTWCWL37	15	New Trail	R4 (dough)
9	NARC (ICT)	EVT-LSR (White)	16	NEW	R3 (dough stage)
		EMVT (90-95 days)	21	NEW	“
		EEVT (80-85 days)	20	NEW	“
		IITA White hybrids	20	NEW	R3 (milk stage)
		IITA Yellow hybrids	30	NEW	“
		Stem borer tolerant	15	NEW	“
		Low N tolerant OPVs	12	NEW	R3 (milk stage)
		Mid altitude DT lines	32	NEW	“
		15CHTPROA6	24	On going	“
		14TTWCWL38	15	Ongoing	“
		POP and Sweet Corn	3	NEW	VT (flowering)
		On-station demos	46	NEW	R2 (kernel setting)
10	CCRI (Pirsabak)	LHYB1575	42	On going	VT (flowering)
		EVT-LSR (White)	16	NEW	“
		IITA White hybrids	20	NEW	“
		14TTWCWL39	15	NEW	R1 (silking)
		15CHTPROA7	24	NEW	“
		Stem borer tolerant	15	NEW	“
		Low N tolerant OPVs	12	NEW	“
		Mid altitude DT lines	32	NEW	“
		On farm demo plots	4	NEW	R3 (milk stage)
		POP Corn (OPV)	1	NEW	VT (flowering)
		Sweet Corn (White)	1	NEW	“
		Sweet Corn (Yellow)	1	NEW	“

11	MMRI (Yousafwala)	EVT-LSR (White)	16	NEW	R3 (milk stage)
		EMVT (90-95 days)	21	NEW	“
		15CHTPROA8	24	New	“
		Stem borer tolerant	15	NEW	“
		Low N tolerant OPVs	12	NEW	“
		Mid altitude DT lines	32	NEW	“
12	UAF (Faisalabad)	15CHTPROA9	24	New	R3 (Milk stage)
		ADVQPM1558	60	On going	“
13	UAP (Peshawar)	EMVT (90-95 days)	21	NEW	R3 (milk stage)
14	ARI-Sindh (Tandojam)	EEVT (80-85 days)	20	NEW	VT (flowering)
15	ARI Gilgit (Diamer, Skurdu, Gilgit)	EPOP1584	30	On going	R4 (dough stage)
		EPOP1585	30	On going	“
		EEVT (80-85 days)	20	New	“
16	AJK (Muzafarabad)	EPOP1586	30	New	Harvested
		EPOP1587	30	New	“
17	ARI (Balochistan)	EPO1588	30	Ongoing	Harvested
		EPOP1589	30	“	“
18	Tassko (Tando Alayar)	IITA white hybrid	20	New	R3 (milk stage)
19	Zamindara Seeds (Dipalpur)	EHYB15130	55	Ongoing	R3 (milk stage)
		IHYB15 80	60	On going	“
		ADVQPM1557	60	Ongoing	“
		14TTWCWL40	15	NEW	“

Appendix 54 bio fortified maize

No	Trial Name/code	Trial description	No of entries	No. of sets	Trial status	Crop stage
1	15CHTPROA	ProA (entries enriched with VitA) of subtropical materials	24	6	Ongoing trials from CIMMYT Mexico	R1 (silking stage)
2	ADVQPM	Advanced white kernel QPM hybrids	50	5	Ongoing trials from CIMMYT Zimbabwe	Harvested
3	PK14A/13BEAR HQPMY	Yellow kernel QPM hybrids	10	5	CIMMYT Colombia	Harvested
4	ADVQPM	Advanced white kernel QPM hybrids	60	4	Ongoing trials from CIMMYT Zimbabwe	R3 (milk stage)

Appendix 55 Status of stem borer tolerant maize varieties planted during Kharif 2015

Appendix 56 Field days organized for dissemination of CA technologies during April - September 2015

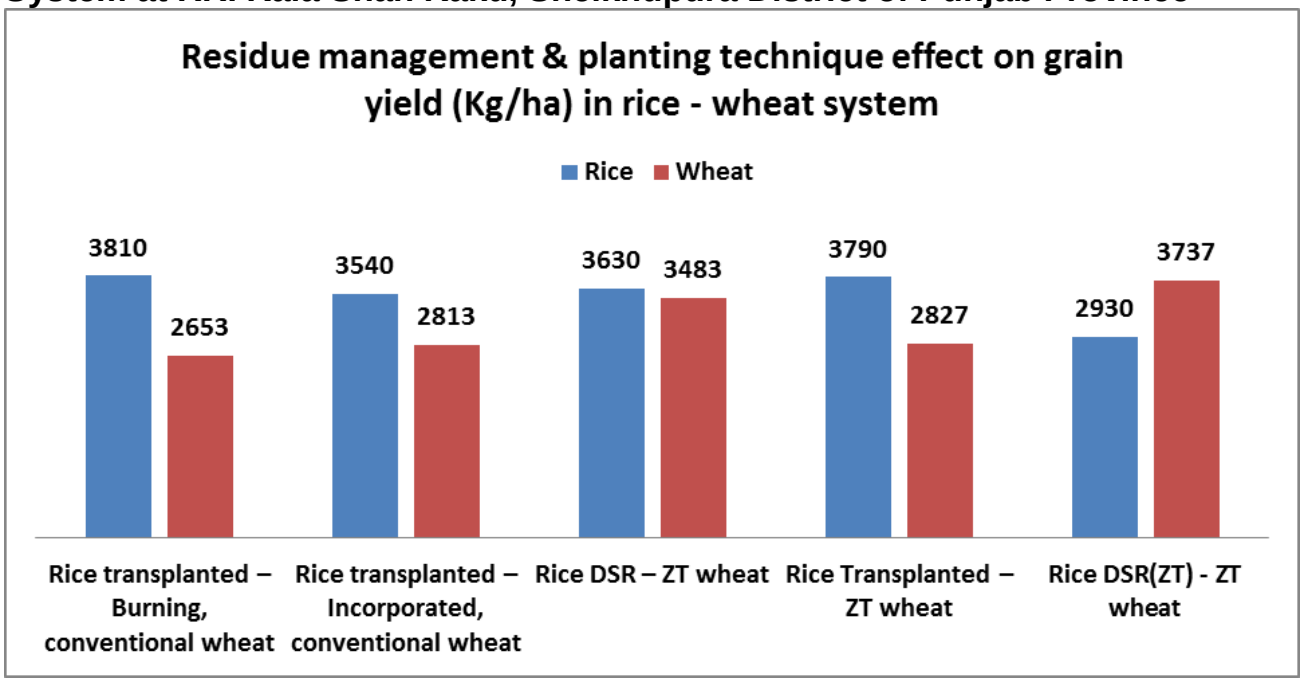
S.No	National Partner	Venue	Title of the field day	Date	Persons (No)
1	AZRI - Bhakkar	Farzand Ali Farm, 209/TDA, Bhakkar	Ridge planting of wheat	01.04. 2015	91
2	Wheat Research institute, Faisalabad	Thatta Ismail, Satyana, Faisalabad	Zero tillage Happy Seeder wheat after rice	03.04. 2015	82
3	Adaptive Research Farm, Vehari	Adaptive Research Farm, Vehari	Bed planting of wheat	03.04. 2015	136
4	Adaptive Research Farm, Vehari	Ghouri Farm, Chak No. 86/WB, Mailsi - Vehari	Bed planted wheat after	04.04. 2015	112

5	Adaptive Research Farm, Vehari	Ch. Aslam, Chak No. 149/9L, Sahiwal	Bed planted wheat after	06.04. 2015	125
6	Rice Research Institute, KSK	Rice Research Institute, KSK, Sheikhupura	Conservation agriculture technologies	07.04. 2015	88
7	Wheat Research institute - Sakrand	WRI, Sakrand, Shaheed Benazir Abad	Bed planting of wheat and nutrient management	09.04. 2015	79
8	ARI, DI Khan - KP	Ghulam Yasin Farm, Chah Mapal, DI Khan	Ridge planting of wheat	9.04.2 015	106
9	Agronomy Research Station Bahawalpur	Shafiqe Farm, Bahawalpur	Bed planting, ridge planting, relay cropping, nutrient management	10.04. 2015	48
10	Wheat Research institute, Faisalabad	Wheat Research institute, Faisalabad	Conservation agriculture technologies	13.04. 2015	104
11	Rice Research Institute, KSk	Farmer field - Shamke, Sheikhupura	Zero tillage Happy Seeder wheat after rice	15.04. 2015	90
12	BARI - Chakwal	Barani Agri Research Institute - Chakwal	Zero tillage, bed planting & fertilizer trial in in wheat	16.04. 2015	56
13	Arid zone Research Institute - Bhakkar	Ghulam Abass, Chah Lakha wala, Bhakar	Ridge planting of wheat and zero tillage	17.04. 2015	130
14	ARI, DI Khan - KP	Ghulam Fareed, Chah Mapal , DI Khan	Zero tillage wheat	20-04-2015	113
15	CCRI - KP	Taj Muhammad farm Pirsabak, Nowshera	Bed planting and Zero tillage in maize- wheat	22.04. 2015	110

Appendix 57 Evaluation of Different Planting Methods/ Techniques in Cotton-Wheat System at ARS Bahawalpur – Punjab.

Treatment No.	Cotton planting	Wheat planting	Seed cotton Yield (kg/ha)	Wheat Grain Yield (Kg/ha)
FP-CBH-WB	Hand planting on wide beds	Planting after land preparation	2772	4089
FP-CBH-WR	Hand planting on wide beds	Relay planting with broad casting	2616	4729
FP-CFH-WB	Hand drill planting on flat	Planting after land preparation	2412	4203
FP-CFH-WB	Hand drill planting on flat	Relay planting with broad casting	2356	4658
FBC - FBW	Bed planting fresh	Bed planting fresh	2630	3650
PBC - PBW	Bed planting in residue	Bed planting in residue after sticks removed	1810	3544
PBC - PBW	Bed planting in residue	Relay planting with broad casting	1973	4838

Appendix 58 Evaluation Of Different Residue Management and Planting Techniques Under Heavy Residue Environment Of Rice-Wheat Cropping System at RRI Kala Shah Kaku, Sheikhupura District of Punjab Province



Appendix 59 Performance of NE based recommendation for wheat at farmer fields.

Parameter	Unit	NE	FP	NE - FP
Fertilizer - N	Kg/ha	132	136	-4
Fertilizer - P_2O_5	Kg/ha	65	76	-11
Fertilizer - K_2O	Kg/ha	76	5	71
Grain Yield	Kg/ha	**3689**	**3268**	421
Fertilizer Cost	RS/ha	**29125**	**22490**	6635

Appendix 60 Evaluation of Green Seeker based N management for wheat at farmer fields.

	Total N applied (Kg/ha)		NDVI readings		Grain Yield (Kg/ha)	
District	Farmer practice	Green Seeker	Farmer practice	Rich N strip	Farmer practice	Green Seeker
Faisalabad	156	108	0.76	0.81	4150	4123
Nowshera	135	82	0.64	0.81	4442	4393

Bahawalpur	149	98	0.81	0.85	3680	3758
Sheikhupura	149	100	0.72	0.80	3131	3124

Appendix 61 Events Calendar for Meeting Held (April 1, 2015 – September 30, 2015)

No	Meeting Name	Date	Purpose	Person Responsible	Venue	Partners	Brief Outcome
Perennial Horticulture							
1.	Training on citrus crop management at chak 98 NB, Sargodha	April 9, 2015	Farmer Capacity Building	Louise Ferguson	CRI Sargodha	CRI Sargodha	CRI scientists trained 35 (male) farmers on orchard management practices, citrus disease and insect's management and post-harvest management of the crop.
2.	Training on Summer management practices of vineyard	April 16, 2015	Technical Assistance and Capacity Building	Louise Ferguson	Rawalpindi	AAUR	27 participants (15 men, 12 women) were trained.
3.	Village women training on Value Addition of fruits at AAUR	April 23, 2015	Technical Assistance and Capacity Building	Louise Ferguson	Rawalpindi	AAUR	27 participants (4 men, 23 women) attended the training.
4.	Industrial Home's students training on domestic citrus added products manufacturing	April 28, 2015	Technical Assistance and Capacity Building	Louise Ferguson	Sargodha	CRI Sargodha	72 women attended the training.
5.	TOT on the Value addition of citrus fruit	May 5, 2015	Technical Assistance and Capacity Building	Louise Ferguson	Sargodha	CRI Sargodha	13 women staff members attended the training.

6.	Value Addition of Fruits at AAUR for Baluchistan Farmers	May 15, 2015	Technical Assistance and Capacity Building	Louise Ferguson	Rawalpindi	AAUR	34 participants (27 men, 7 women) were trained.
7.	Value Addition of Fruits at Rawalakot	May 20, 2015	Technical Assistance and Capacity Building	Louise Ferguson	Rawalakot, AJK	AAUR	21 participants (18 men, 3 women) were trained.
8.	Training on Preharvest Fruit Bagging of grapes	May 24-27, 2015	Technical Assistance and Capacity Building	Louise Ferguson	Rawalpindi	AAUR	26 participants (21 men, 5 women) were trained.
9.	TOT for Citrus Extension officers of District Sargodha at CRI	May 26, 2015	Technical Assistance and Capacity Building	Louise Ferguson	CRI Sargodha	CRI Sargodha	77 participants (74 men, 3 women) were trained.
10.	Training on Summer Season Vineyard Management	June 1, 2015	Technical Assistance and Capacity Building	Louise Ferguson	Rawalpindi	AAUR	44 participants (40 men, 4 women) were trained.
11.	Training on Value Addition of Citrus Fruit to Domestic Women	June 9, 2015	Technical Assistance and Capacity Building	Louise Ferguson	Sargodha	CRI Sargodha	60 participants (10 men, 50 women) were trained.
12.	Training on Citrus Orchard Management and Handling	June 11, 2015	Technical Assistance and Capacity Building	Louise Ferguson	Sargodha	CRI Sargodha	70 participants (51 men, 19 women) were trained.
13.	Training on Value Addition of Stone Fruits	June 15, 2015	Technical Assistance and Capacity Building	Louise Ferguson	Gilgit Baltistan	AAUR	28 participants (19 men, 9 women) were trained.
14.	Training on Value Addition of Stone Fruits	June 16, 2015	Technical Assistance and Capacity Building	Louise Ferguson	Gilgit Baltistan	AAUR	43 women were trained.

15.	Effect of Trellising Systems on Table Grapes Quality	July 1, 2015	Technical Assistance and Capacity Building	Louise Ferguson	Chakwal	AAUR	22 men were trained.
16.	Training on Value Addition of Stone Fruits	June 17, 2015	Technical Assistance and Capacity Building	Louise Ferguson	Sakrdu	AAUR	36 participants (34 men, 2 women) were trained.
17.	ARI Quetta Team Strategy Meeting	August 12-13, 2015	Technical Assistance and Capacity Building	Louise Ferguson	Karachi	ARI Quetta	7 (male) participants attended. Plans for each project were developed.
18.	Citrus Mega Field Day	August 17, 2015	Technical Assistance and Capacity Building	Louise Ferguson	Sargodha	CRI Sargodha	397 participants (392 men, 5 women) were trained.
19.	One Day Training for Preparation of Value Added Products to Domestic Women	August 18, 2015	Technical Assistance and Capacity Building	Louise Ferguson	Sargodha	CRI Sargodha	85 participants (13 men, 72 women) were trained.
20.	Mango Field Day at Vehari	August 20, 2015	Technical Assistance and Capacity Building	Louise Ferguson	Vehari	UAF	105 (male) participants were trained.
21.	Transfer of Grapes Production Technology to the Farmers of Pothwar Region	September 14, 2015	Technical Assistance and Capacity Building	Louise Ferguson	Attock	AAUR	30 participants (25 men, 5 women) were trained.
Human Resource Development							
	No trainings were conducted in this reporting period.						
Vocational Training							
1.	Effective meetings (part 2)	Saturday, August 22, 2015	1) Review five points to run good meetings 2) Identify how to deal	Mark Bell	UAF	UAF	22 total participants (16 men, 6 women) were trained.

			with common meeting "problems"				
2.	Scientific writing	Wed-Thurs Aug 26-27, 2015	1. Know the primary sections included in a standard scientific paper 2.Understand the primary content and purpose of each section, and 3. Draft (selected sections of) a Scientific paper.	Mark Bell and Tom Rost	NARC	CIMMYT, IRRI, ILRI, AVRDC, PARC	31 total participants (21 men, 10 women) were trained.
E- Pak Ag							
1.	Symposium on recent trends in outreach Agri. Extension at AAUR	May 21, 2015	Share overall trends in agricultural extension	Mark Bell	UAF	UAF	92 participants (63 men, 29 women) were trained.
2.	One Day Stakeholder Consultative Workshop on the Use of ICT	August 4, 2015	Collect information on existing ICT efforts and suggested improvements for more effective use.	Mark Bell	UAF	UAF	73 participants (59 men, 14 women) were trained.
3.	Train-the-Trainer - ICT and gender workshop development, Arid university	August 20, 2015	Design an engaging class to teach school girls how to use ICT for improving home agriculture.	Mark Bell	AAUR	AAUR	65 participants, (30 men, 35 women)
4.	UAF ICT workshop	August 21, 2015	What is ICT? How is ICT used in Extension? What are the issues and how can we make ICT more	Mark Bell	UAF	UAF	40 participants (32 men, 8 women)

			effective?				

Appendix 62 Final Report of Activity No. 2 and 3 of AAUR

Project Name: Dissemination of Developed Technology of Value Addition of Fruits to the farmers

Principal Investigator: Dr Anwaar Ahmed **Institute: PMAS-Arid Agriculture University Rawalpindi**

A. Executive Summary

Pakistan is blessed with rich soil, amazing climate for horticulture crops, plenty of sunshine, natural water resources and great potential to grow vast varieties of fruits and vegetables with unique taste. But most of the fruit is wasted due to highest post harvest losses, ranging from 18 to 46% in cherry, peach, plum, apricot, grapes, apple etc. By adopting new techniques of preservation, these losses can be curtailed. There was a need to educate fruits growers to use scientific methods of preservation for production of safe nutritious and wholesome food. Fruits are characteristically soft-fleshy and highly perishable, with a limited market life potential. Fruit processing can give better return to the growers of the region if the excess produce is properly dried and preserved by following the most recent techniques of dehydration. If this cost effective technology is transferred to the farmer, he will be able to generate income by producing value added products.

B. Technical and Work plan Update:

The farmers were given on spot **six** practical trainings and **one** awareness seminar at KIU Gilgit on value addition of stone fruits.

1. **Farmer Training at Rawalpindi**

Farmers were contacted through an NGO Lok Sanjh and Vice Chancellor inaugurated the 1st Farmer Training. All the farmers who attended were from the villages of Rawalpindi District and majority of the participants were females. They were given training on preparation of different food products with fruits. They showed a lot of interest in practical training.

2. **Baluchistan Farmers trained at AAUR**

A delegation of the farmers belonging to Baluchistan Province (Pakistan) was on visit of University. They requested for training on value addition of fruits as they were potential and progressive farmers involved in farming of Horticulture crops in Baluchistan. After getting permission from competent Authority, one day farmer training was arranged at Food Processing Unit of Arid Agriculture University Rawalpindi. It was whole day training and Resource Persons and farmers interacted practically in formulation of different food products with fruits. They were also given a lecture on Food Safety and Hygiene.

3. **Farmer Training at Rawalakot (AJK)**

Prof. Dr Siddique Awan from Department of Food Science & Technology, University of The Poonch Rawalakot was contacted to conduct farmer training at Rawalakot. He invited progressive fruit growers and offered his Fruit Processing Lab for practical training. It was a bad experience to know that majority of the farmers were ignorance of the latest techniques of food processing and preservation. They were given a whole day training on food processing and preservation.

4. **Farmer Training at Attock (Punjab)**

Dr Riffat Hayat Director Sub Campus of AAUR (100 Kilometer away from Rawalpindi) arranged farmers training at Attock. He invited progressive fruit growers at Groundnut Research station Attock. Dr Manzoor Hussain Incharge of the center offered his training Hall and Lab for practical training. Mr Muhammad Hussain Agriculture Office (Extension) Attock came with a number of farmers to attend the training. Majority of the farmers showed interest in the latest techniques of food processing and preservation. They were given whole day training on value addition of fruits and food processing and preservation.

5. **Awareness Seminar at Karakuram International University Gilgit**

Prof. Dr. Nadeem Akhtar Abbasi accompanied during visit of Gilgit Baltistan that is producing enormous quantities of fruits such as peach, apricot, apple, mulberry, grapes, cherries, nectarines and plum. We met with the farmers, interviewed them and analyzed their problems. Majority of fruit producing valleys were visited and fruit trees were checked. Most of the population of northern areas depends on fruits and vegetables as their major source of earning in fresh as well as dry form. A farmer training was arranged in collaboration with Dr Fazal-ur-Rehman Director General Agriculture and Syedha Mishal Agricultural Officer (Extension) at Gilgit. Dr Fazal-ur-Rehman decided activity at his office (that was well equipped with food processing lab) but two changes were made by the hosts due to arrival of a team of JAICA experts to monitor the projects of Department of Agriculture (on 15-06-15) and Start of final examination of students at KIU (on 16-06-15). He apologized to facilitate us in the training due to his involvement with JAICA. As University collaborating faculty (Dr Sartaj Ali, Dr Zulifqar Ali and Dr. Mir Muhammad Nasir Qayyum) and from department of Agriculture Ms. Mishaal with permission of Concerned Director decided to conduct joint seminar session at KIU for students and the community on 15-06-15 (That was adjacent to the Department of Agriculture Gilgit). Dr Nadeem Akhtar Abbasi delivered presentation on "Quality Production of Apricots" and my presentation was on "Value addition of stone fruits in Pakistan". We shared our observations regarding postharvest management of fruits with the farmers and the students. It was a nice experience. We are very much obliged to the Department of Food Technology KIU, Department of Agriculture Gilgit and especially Dr Fazal-ur-Rehman, Dr Sartaj Ali, Dr Zulifqar Ali and Dr. Mir Muhammad Nasir Qayyum for providing us facility to share knowledge with the community, farmers as well as students.

6. Farmer Training at Haramosh (Baltistan)

At Haramosh farmer training was arranged in collaboration with an NGO i.e. Haramosh Development Organization (HDO). It is an NGO that is working for the welfare of the farmers in the area. They arranged a group of 43 female farmers at Haramosh (about 70 Km away from Gilgit). They were given practical training in the village on value addition of stone fruits. We are very much thankful to Haramosh Development Organization who arranged training session in such a remote area.

7. Farmer Training at Skardu (Baltistan)

At Skardu farmer training was arranged in collaboration with Department of Agriculture Skardu. Mr Asghar Mahmood Director Agriculture (Extension), Zahid Ali Khan, Dr. Ghulam Abbas, Muhammad Iqbal Deputy Director Agriculture and Mr Ijlal Hussain Agriculture Officer (Extension) Skardu fully cooperated and arranged training for the farmers. At skardu 37 farmers participated and they were trained about osmotic dehydration and solar drying of Apricot.

From the training imparted, following objectives were achieved.

- To preserve the fruits (apricot, peach and cherry) in more stable dried form during peak season
- To reduce post harvest losses and to enable commercialization of high quality fruits.
- To increase processing of selected fruits into value added products

C. Required indicators: Please fill in the below table

Indicator	Location	Female	Male	Total
Activity # 2- AAUR Farmer Training on value addition of food	Rawalpindi	30	3	33
	Rawalpindi (Baluchistan farmers)	6	28	34
	Rawalakot (AJK)	5	16	21
	Attock	6	26	32
	Total	**47**	**73**	**120**

Activity # 3- AAUR Farmer Training on value addition of stone fruits	Gilgit	18	10	28
	Haramosh	43	-	43
	Skardu	-	37	37
	Total	**61**	**47**	**108**
Number of rural households benefiting from trainings	**Pakistan**	**108**	**120**	**228**

D. Lessons Learned:

There is a vast potential of food processing such as sun drying/solar dehydration of stone fruits, value addition of fruit in the Pakistan especially in the area of KPK, Baluchistan and Gilgit Baltistan. The farmers are using their traditional unhygienic method of food preservation. Resultantly dry fruits and value added food products being produced are contaminated with pathogenic bacteria, dust, aflatoxin etc. There is a need of awareness campaign and more training for the farmers of KPK, Baluchistan and Gilgit Baltistan on Food Safety and art of production of safe and nutritious value added fruit products. It is proposed that a project activity may be planned in this specific area through a separate project.

Pre and Post Assessment of Farmers Training

Questionnaire was developed to assess the knowledge of farmers participating in the training program with following questions.

- What is the importance of fruits?
- What do you know about value addition of fruits?
- What is food safety and its importance?
- What are food preservation techniques?
- Can you prepare Jam, Squashes and Tomato Ketchup?
- What were your expectations about this training program?

The developed Performa was served to the farmers before and after training. A total of 228 farmers (108 Females and 120 Male) participated in the training program. The response of the farmers was very much encouraging. They appreciated the effort done by USAID on start of AIP.

It was estimated that 75% farmers were ignorant about importance of fruits, only 38% farmers know about value addition of fruits, majority of the farmers do not had the knowledge about importance of food safety and latest techniques of food preservation. 10% male and 25% female farmers replied correct answer about different recipes of Jam, Squashes and Tomato Ketchup. It was assessed that majority of the farmers was satisfied with the training program.

E. Activities Planned for Next Two Years:

There is a dire need of the farmers regarding awareness about Food Safety. The dry fruit being produced is contaminated and causing health hazards. It is proposed that a project activity may be planned for that specific area through a separate project.

A proposal has been submitted for funding from AIP entitled "**Screening and mitigation of aflatoxin in dry and fresh cut fruits in Pakistan"** amounting 44066 US Dollars to achieve the following objectives:

1. To introduce farmers with the fresh cut fruits technique developed by UC DAVIS.
2. To screen out aflatoxins contamination in dry fruit and fresh cut fruits produced in Pakistan.
3. To reduce the level of aflatoxin with application of different techniques
4. To safeguard consumer health
5. To create awareness among different stake holders like farmers, processors, exporters and consumers

Methodology:
The study will comprise of Sample Collection, Screening of Fruit for Aflatoxin and Application of Different Techniques for Mitigation, Development of Fresh Cut Fruit Technology, Farmer Training and development of Pamphlets and brochures on the subject These activities will be started subject to the approval of requested subjected to the AIP Authorities.

F. Appendix, as appropriate: Please attach as an Appendix the attendance list of any trainings or field days held in the reporting period. Attendance list should include: Participant name, gender, age, and village/town.

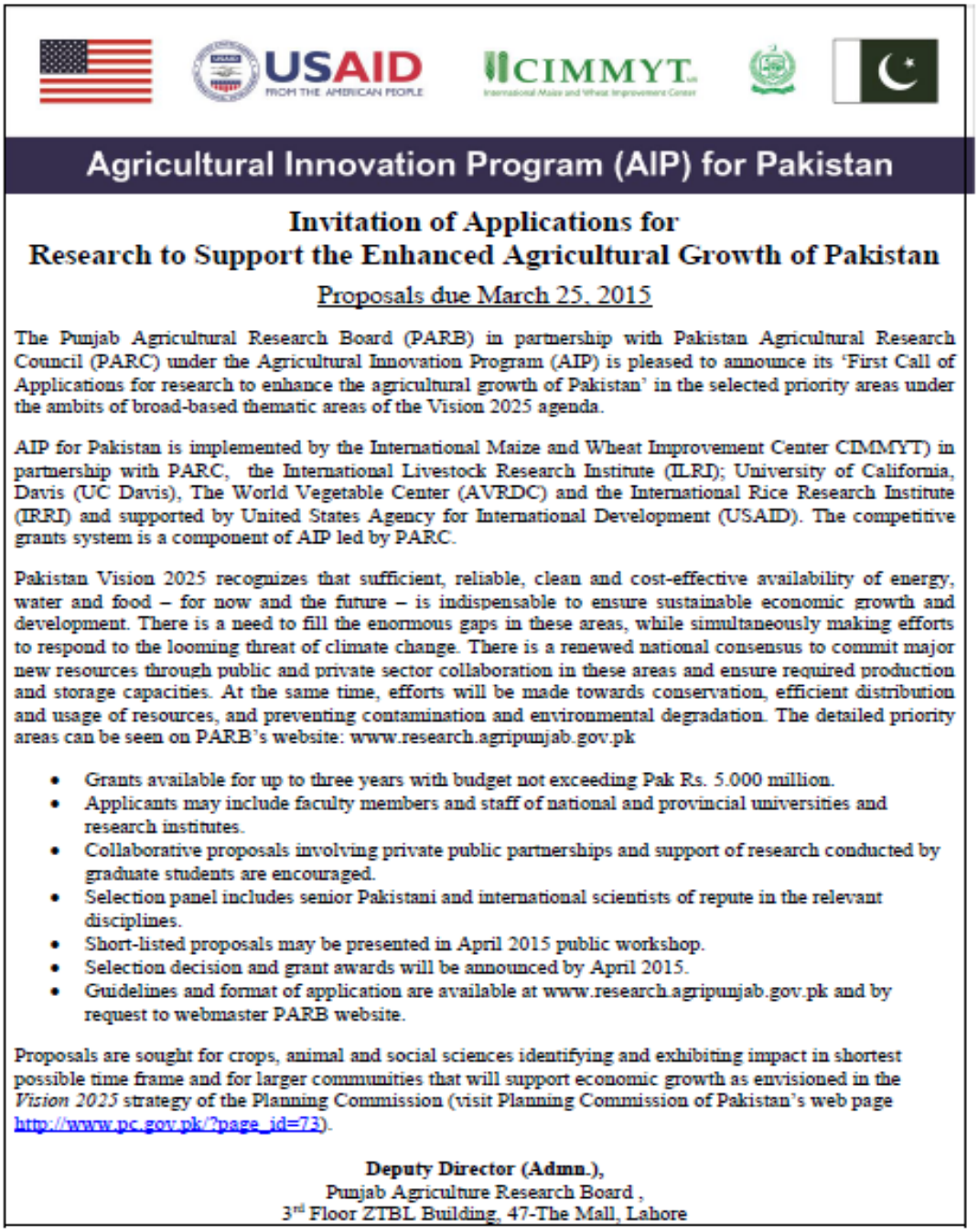
Appendix 63 HRD- Graduate studies

Student name	Gender	Region	University	PhD / MS	Proposed Topic
Abbasi, Juliya	Female	Punjab	UC Davis	PhD	Wheat genomics
Barkat, Noorani	Female	Gilgit	TAMU	MS	Post-harvest fruit
Fayyaz, Laila	Female	KPK	UC Davis	PhD	Tomato breeding
Habibullah	Male	Baluchistan	U Missouri	MS	Soils, plant nutrition
Khan, Ismail	Male	KPK	Mississippi State U	MS	Metabolic engineering horticulture crops
Khan, Muhammad Ehsan	Male	Punjab	WSU	PhD	Wheat / stress
Manan, Fazal	Male	KPK	UMN	MS	Plant pathology
Naqeebullah	Male	Baluchistan	Mississippi State U	PhD	Salinity rice
Noshad, Salma Bibi	Female	KPK	TAMU	MS	Rice genetics
Rauf, Yahya	Male	Punjab	U MINN	PhD	Wheat / drought stress
Solangi, Maria Amir	Female	Sindh	U MASS	MS	Animal disease
Ullah, Marwa Zafar	Female	Punjab	UC Davis	MS	Drought stress, wheat proteins
Zahra, Sabahat	Female	Sindh	TAMU	MS	Maize breeding
Zia, Bazgha	Female	Punjab	Purdue	MS	Horticulture, plant stress

Appendix 64

Balochistan	Khyber Pakhtunkhwa	Punjab	Sindh
48	89	207	05

Appendix 65 Punjab Agricultural Research Board (PARB) First Call for Application of Research Proposals from Punjab province



Agricultural Innovation Program (AIP) for Pakistan

Invitation of Applications for Research to Support the Enhanced Agricultural Growth of Pakistan

Proposals due March 25, 2015

The Punjab Agricultural Research Board (PARB) in partnership with Pakistan Agricultural Research Council (PARC) under the Agricultural Innovation Program (AIP) is pleased to announce its 'First Call of Applications for research to enhance the agricultural growth of Pakistan' in the selected priority areas under the ambits of broad-based thematic areas of the Vision 2025 agenda.

AIP for Pakistan is implemented by the International Maize and Wheat Improvement Center CIMMYT) in partnership with PARC, the International Livestock Research Institute (ILRI); University of California, Davis (UC Davis), The World Vegetable Center (AVRDC) and the International Rice Research Institute (IRRI) and supported by United States Agency for International Development (USAID). The competitive grants system is a component of AIP led by PARC.

Pakistan Vision 2025 recognizes that sufficient, reliable, clean and cost-effective availability of energy, water and food – for now and the future – is indispensable to ensure sustainable economic growth and development. There is a need to fill the enormous gaps in these areas, while simultaneously making efforts to respond to the looming threat of climate change. There is a renewed national consensus to commit major new resources through public and private sector collaboration in these areas and ensure required production and storage capacities. At the same time, efforts will be made towards conservation, efficient distribution and usage of resources, and preventing contamination and environmental degradation. The detailed priority areas can be seen on PARB's website: www.research.agripunjab.gov.pk

- Grants available for up to three years with budget not exceeding Pak Rs. 5.000 million.
- Applicants may include faculty members and staff of national and provincial universities and research institutes.
- Collaborative proposals involving private public partnerships and support of research conducted by graduate students are encouraged.
- Selection panel includes senior Pakistani and international scientists of repute in the relevant disciplines.
- Short-listed proposals may be presented in April 2015 public workshop.
- Selection decision and grant awards will be announced by April 2015.
- Guidelines and format of application are available at www.research.agripunjab.gov.pk and by request to webmaster PARB website.

Proposals are sought for crops, animal and social sciences identifying and exhibiting impact in shortest possible time frame and for larger communities that will support economic growth as envisioned in the *Vision 2025* strategy of the Planning Commission (visit Planning Commission of Pakistan's web page http://www.pc.gov.pk/?page_id=73).

Deputy Director (Admn.),
Punjab Agriculture Research Board ,
3rd Floor ZTBL Building, 47-The Mall, Lahore

Appendix 66 AIP Secretariat, PARC First Call for Application of Research Proposals from Balochistan, Khyber Pakhtunkhwa and Sindh Provinces

Agricultural Innovation Program (AIP) for Pakistan

Invitation of Applications for
Research to Support the Enhanced Agricultural Growth of Pakistan
(Balochistan/Khyber Pakhtunkhwa/Sindh)

Proposals due April 15, 2015

The Pakistan Agricultural Research Council (PARC) is pleased to announce its 'First Call of Applications for research to enhance the agricultural growth of Pakistan' in the selected priority areas under the ambits of broad-based thematic areas of the Vision 2025 agenda. Scientists/Researchers from Balochistan, Khyber Pakhtunkhwa and Sindh provinces can apply for these competitive grants. For Punjab province, PARB has already advertised the call for proposals.

Agricultural Innovation Program (AIP) for Pakistan is implemented by the International Maize and Wheat Improvement Center CIMMYT in partnership with PARC, the International Livestock Research Institute (ILRI), University of California, Davis (UC Davis), The World Vegetable Center (AVRDC) and the International Rice Research Institute (IRRI) and supported by United States Agency for International Development (USAID). The competitive grants system is a component of AIP led by PARC.

Pakistan Vision 2025 recognizes that sufficient, reliable, clean and cost-effective availability of energy, water and food – for now and the future – is indispensable to ensure sustainable economic growth and development. There is a need to fill the enormous gaps in these areas, while simultaneously making efforts to respond to the looming threat of climate change. There is a renewed national consensus to commit major new resources through public and private sector collaboration in these areas and ensure required production and storage capacities. At the same time, efforts will be made towards conservation, efficient distribution and usage of resources, and preventing contamination and environmental degradation. The detailed priority areas can be seen on PARC's website: www.parc.gov.pk

- Grants available for up to three years with budget not exceeding Pak Rs. 5.000 million.
- Applicants may include faculty members and staff of national and provincial universities and research institutes.
- Collaborative proposals involving private public partnerships and support of research conducted by graduate students are encouraged.
- Selection panel includes senior Pakistani and international scientists of repute in the relevant disciplines.
- Short-listed proposals may be presented in April-May 2015 public workshop.
- Selection decision and grant awards will be announced by May 2015.
- Guidelines and format of application are available at www.parc.gov.pk and AIP Secretariat, PARC, G-5/1, Islamabad by request (Email: pakistan.aip@gmail.com).

Proposals are sought for crops, animal and social sciences identifying and exhibiting impact in shortest possible time frame and for larger communities that will support economic growth as envisioned in the *Vision 2025* strategy of the Planning Commission (visit Planning Commission of Pakistan's web page http://www.pc.gov.pk/?page_id=73).

AIP Secretariat
Pakistan Agricultural Research Council
20 Ataturk Avenue, G-5/1, Islamabad

Appendix 67 Evaluation of IRRI rice germplasm in Pakistan during 2015

Trait	RRI KSK	RRI Dokri	NIBGE Faisalabad	NIAB Faisalabad	ARI Jafarabad	ARI Mingora	ARI D.I Khan	ARS Thatta	CDRI NARC	Emkay Seeds	Engro Eximp
Biotic stress tolerant											
HY-Elite	300	122	70	50	35	74	75	157	-	66	66
BLB	264	-	41	-	-	-	-	-	48	40	30
Isogenic lines (*Xa*)	30	-	-	30	-	-	-	-	30	-	-

Climate reliant											
Sabitri Sub1	38	19		-	-	-	-	-		-	-
IR6 Sub1	145	135		-	10	10	-	115		80	64
Drought	23	-	6	-	-	-	6	23		10	-
Heat	9	25		-	16	-	-	-		-	-
Salinity	9	-		-	-	-	-	9		-	-
MAGIC	6	-	6	-	-	-	-	-		6	-
Total	**824**	**301**	**123**	**80**	**61**	**84**	**81**	**304**	**78**	**196**	**160**

Appendix 68 Number of DSR farmers (direct beneficiaries)

Province/District	**Acres**	**Farmers**
Punjab		
Sheikhupura	202	141
Mandi Bahuddin	190	66
Gujranwala	359	81
Sialkot	186	10
Sindh		
Thatta	17	5
Balochistan		
Usta Mugammad (Jafarabad)	20	7
Total	**974**	**322**

Appendix 69 Germination count in various plots in Punjab

S#	**Planting technique**	**Lowest plants/m^2**	**Highest plants/m^2**	**Average**
1	Direct seeding of rice (Drill)	80	110	95
2	Direct seeding of rice (Broadcast)	90	130	110
3	Farmers practice	15	20	17.5

Appendix 70 communication

Title	**Component**	**Type[2]**	**Purpose**	**Release Date**	**Language**
AIP quarterly newsletter Jan-March 2015	AIP	Publication	External promotion	July 2015	English
Inauguration of seminar on improvement of perennial horticulture at citrus research institute (Photo+story) Daily Dunya (Sargodha)	AIP – Perennial Horticulture	Press Clipping	External promotion	August 18, 2015	Urdu
seminar on value addition of citrus fruits at district industrial	AIP – Perennial	Press Clipping	External promotion	August 20, 2015	Urdu

[2] Types includes Press Clippings, Press Releases, Radio/TV Interviews, Advertisement and Publications, etc.

home (Sanatzar) Sargodha Daily Dunya (Sargodha)	Horticulture				
Seminar on value addition of citrus fruits at Sanatzar Sargodha (Story) Daily Khabrain (Sargodha)	AIP – Perennial Horticulture	Press Clipping	External promotion	August 20, 2015	Urdu
Seminar on value addition of citrus fruits at Sanatzar (Story) Daily Nawaye sharar (Sargodha)	AIP – Perennial Horticulture	Press Clipping	External promotion	August 20, 2015	Urdu
Seminar on value addition of citrus fruits at Sanatzar (Story+ Photograph) Daily Rafaqat (Sargodha)	AIP – Perennial Horticulture	Press Clipping	External promotion	August 20, 2015	Urdu
Seminar on value addition of citrus fruits at Sanatzar (Story+ Photograph) Daily zaroorat (Sargodha)	AIP – Perennial Horticulture	Press Clipping	External promotion	August 20, 2015	Urdu
One day international seminar on Cultivation of Citrus fruits for women (Photo+story) Daily Nai baat (Sargodha)	AIP – Perennial Horticulture	Press Clipping	External promotion	August 20, 2015	Urdu
One day seminar/ training for women at Sanat zar (Photo+story) Daily Jang (Lahore)	AIP – Perennial Horticulture	Press Clipping	External promotion	August 20, 2015	Urdu

seminar/ training for women under AIP (Photo+story) Daily Pakistan (Lahore)	AIP – Perennial Horticulture	Press Clipping	External promotion	August 20, 2015	Urdu
seminar at Sanat zar (Photo+story) Daily Dunya	AIP – Perennial Horticulture	Press Clipping	External promotion	August 20, 2015	Urdu
Photo Daily Asad (Lahore)	AIP – Perennial Horticulture	Press Clipping	External promotion	August 20, 2015	Urdu
Pakistan has tremendous potential in pistachio, olive farming http://nation.com.pk/business/25-Aug-2015/pakistan-has-tremendous-potential-in-pistachio-olive-farming	AIP – Perennial Horticulture	Press Clipping	External promotion	August 25, 2015	English
Training workshop held at PMAS-AAUR http://www.thenews.com.pk/Todays-News-6-335557-Training-workshop-held-at-PMAS-AAUR	*E -Pak Ag*	Press Clipping	External promotion	August 22, 2015	English
USAID Weekly Radio Show "Aap, Hum aur Behtar Zindagi" on FM-101	AIP	Radio	External promotion	August 20, 2015	Urdu
USAID Weekly Radio Show "Aap, Hum aur Behtar Zindagi" on FM-101	AIP	Radio	External promotion	August 27, 2015	Urdu/ English
Mega field day FM93	AIP – Perennial Horticulture	Radio	External promotion	August 17, 2015	Urdu
Value addition training FM93	AIP – Perennial Horticulture	Radio	External promotion	August 18, 2015	Urdu
“Shehr Nama” on the production of vegetables under cover Radio Pakistan, DI Khan	AIP – Vegetables	Radio	External promotion	June 6, 2015	
onion seed packing ceremony Radio Pakistan, Hyderabad	AIP – Vegetables	Radio	External promotion	June 10, 2015	Sindhi
Training manual on Artificial Insemination in goats	AIP-livestock	Publication	External promotion	16 June 2015	English
Factsheets on dairy cattle and buffalo management (Factsheet nos. 5-8)	AIP-livestock	Publication	External promotion	6 April 2015	English/ Urdu
Factsheets on dairy cattle and buffalo management (Factsheet nos. 9-14)	AIP-livestock	Publication	External promotion	10 April 2015	English/ Urdu

Assessment and Evaluation of Constraints Faced by Dairy Farmers in Punjab and Khyber Pakhtunkhwa	AIP-livestock	Publication	External Promotion	30 June 2015	English
Feeding Chart: Guide for Feeding Milking Buffaloes	AIP-livestock	Publication	External Promotion	15 July 2015	English/ Urdu
Feeding Chart: Guide for Feeding Milking Cows	AIP-livestock	Publication	External Promotion	15 July 2015	English/ Urdu
Small Ruminant Value Chain Rapid Assessment in Districts of Punjab (Chakwal and Bahawalpur)	AIP-livestock	Publication	External Promotion	16 July 2015	English
AVRDC at Agri Expo in Pakistan FRESH, News from AVRDC-The World Vegetable Center vol-3	AIP-Vegetables	Publication	Internal	April 17, 2015	English
Net houses cross the border FRESH, News from AVRDC-The World Vegetable Center vol-3	AIP-Vegetables	Publication	Internal	April 17, 2015	English
Certified onion seed and bulbs revive hopes of growers FRESH, News from AVRDC-The World Vegetable Center vol-5	AIP-Vegetables	Publication	Internal	June 05, 2015	English
Empowering Pakistan's women to improve farm productivity FRESH, News from AVRDC-The World Vegetable Center vol-5	AIP-Vegetables	Publication	Internal	June 05, 2015	English
Partnering with PARC FRESH, News from AVRDC-The World Vegetable Center vol-5	AIP-Vegetables	Publication	Internal	June 05, 2015	
Breeders in Pakistan using AVRDC germplasm FRESH, News from AVRDC-The World Vegetable Center vol-6	AIP-Vegetables	Publication	Internal		English
AIP Roundup: Spinach fits well in plasticulture cycle Better onion on the way New approaches to mungbean production Seeding new skills FRESH, News from AVRDC-The World Vegetable Center vol-6	AIP-Vegetables	Publication	Internal	July 10,2015	English
AIP Roundup: Spinach fits well in plasticulture cycle Better onion on the way New approaches to mungbean production Seeding new skills FRESH, News from AVRDC-The World Vegetable Center vol-6	AIP-Vegetables	Publication	Internal	July 10,2015	English

Wheat seed growers in Balochistan, Pakistan, benefit from first sector-wide training CIMMYT's Informa No. 1934	AIP-Wheat	Publication	Internal	May 11-15, 2015	English/ Spanish
Durum wheat production in Pakistan: keeping up with changing demands CIMMYT's Informa No. 1936	AIP-Wheat	Publication	Internal	May 25-29, 2015	English/ Spanish
Changing Wheat Landscape in Pakistan Demands New Breeding Strategies CIMMYT's Informa No. 1932	AIP-Wheat	Publication	Internal	April 27-30, 2015	English/ Spanish
Fostering Public-Private Partnerships for Decentralized Wheat Seed Production in Pakistan CIMMYT's Informa No. 1944	AIP-Wheat	Publication	Internal	July 27-31, 2015	English/ Spanish
AIP-CIMMYT Conducts the Largest Evaluation of Maize Germplasm in Pakistan's History CIMMYT's Informa ;1933	AIP-Maize	Publication	Internal	May 4-6. 2-15	English/ Spanish
Pakistani Stakeholders Evaluate the Performance of CIMMYT Maize Germplasm across Punjab CIMMYT 's Informa: 1946	AIP-Maize	Publication	Internal	September 7-11, 2015	English/ Spanish
Dry direct seeded rice	AIP-Rice	Publication	External promotion	2015	English
Water saving technology	AIP-Rice	Publication	External promotion	2015	English
Why dry seeding of rice?	AIP-Rice	Publication	External promotion	2015	English
IRRI Super Bag: Hermetic storage	AIP-Rice	Publication	External promotion	2015	English
"Chaawal ki bazria beej braa-he-rasat kashat" (Dry direct seeded rice)	AIP-Rice	Publication	External promotion	2015	Urdu
"Paani ki bachat ka tariqa" (Water saving technology)	AIP-Rice	Publication	External promotion	2015	Urdu
Alternate Wetting and Drying (AWD) Happy Farmer	AIP-Rice	Post card	External promotion	2015	English
Basmati 515- production technology	AIP-Rice	Publication	External promotion	2015	Urdu
CIMMYT hold National Meeting on Conservation Agriculture in Pakistan. CIMMYT's Informa No. 1940	AIP – Agronomy	Publication	Internal	June 29-July 02 2015	English/ Spanish

Innovate, grow more, live better (OPED) Express tribune (LHE, KHI, ISB)	AIP	News clipping	External promotion	August 24, 2015	English
Investment in agriculture research urged to boost production (Story) Dawn (LHE, KHI, ISB)	AIP	News clipping	External promotion	August 25, 2015	English
Bosan for more investment in agri research, development (Story) Daily the Pak Banker (Khi)	AIP	News clipping	External promotion	August 25, 2015	English
Unable to discurse $00m aming provinces: PARC (Story) Express tribune (LHE, KHI, ISB)	AIP	News clipping	External Promotion	August 25, 2015	English
Bosan calls upon the importance of agriculture sector (Story+ photo) The messenger (KHI)	AIP	News clipping	External Promotion	August 25, 2015	English
PAK-US to enhance partnership in agri-sector: Bosan (Story+ photo) Pakistan Observer (LHE, KHI, ISB)	AIP	News clipping	External Promotion	August 25, 2015	English
Pakistan has tremendous potential in pistachio, olive farming (Story) Nation (LHE, KHI, ISB)	AIP	News clipping	External Promotion	August 25, 2015	English
PAK-US to enhance partnership in agri-sector: Sikander (Story+ photo) Frontier post (ISB)	AIP	News clipping	External Promotion	August 25, 2015	English
Investment in agri R&D a must to ensure food security: Bosan (Story+ photo) Business reorder (LHE, KHI, ISB)	AIP	News clipping	External Promotion	August 25, 2015	English
Investment in agriculture is immensely essential for economic development Sikander Bosan (Story+ photo) Daily Nai baat (KHI)	AIP	News clipping	External Promotion	August 25, 2015	Urdu

Goal of USAID to grant scholarship to 32000 Pakistani students (Story) Daily express (ISB)	AIP	News clipping	External Promotion	August 25, 2015	Urdu
AIP Conference update on PTV news – News bulletin	AIP	TV	External Promotion	August 24, 2015	Urdu
Federal Minister Sikander Hayat Bosan inaugurating AIP Conference 2015 (story) Daily Aftab (KHI)	AIP	News clipping	External Promotion	August 25, 2015	Urdu
Investment in agriculture research urged to boost economic ad agri (story) Daily Din (ISB)	AIP	News clipping	External Promotion	August 25, 2015	Urdu
More investment in needed agriculture sector to boost economy (Story) Daily Jang (ISB)	AIP	News clipping	External Promotion	August 25, 2015	Urdu
Investment in research in agriculture ought to done eradicate hunger (Story) Daily Express (ISB)	AIP	News clipping	External Promotion	August 25, 2015	Urdu
Maximum investment is needed in agriculture sector to boost economy: Sikander Bosan (Story+photo) Daily Nawa I Waqat (ISB)	AIP	News clipping	External Promotion	August 25, 2015	Urdu
Maximum investment is necessary in agriculture sector: Sikander Bosan (Story+photo) Daily Khabbarain (ISB)	AIP	News clipping	External Promotion	August 25, 2015	Urdu
Vision of fulfillment of food procurement can be achieved through priority in agriculture (Story) Daily Jinnah (ISB)	AIP	News clipping	External Promotion	August 25, 2015	Urdu
AIP Conference update on Sohni Dharti	AIP	TV	External Promotion	August 24, 2015	Urdu
AIP Conference update on Express news– News bulletin	AIP	TV	External Promotion	August 24, 2015	Urdu
AIP Conference update on dunya– News bulletin	AIP	TV	External Promotion	August 24, 2015	Urdu

AIP Conference update on Waqt news– News bulletin	AIP	TV	External Promotion	August 24, 2015	Urdu
AIP Conference update on Geo news– News bulletin	AIP	TV	External Promotion	August 24, 2015	Urdu

Appendix 71 Summary of maize varieties included under NUYT (Kharif 2015)

No	Type of maize under NUYT	Total number	CIMMYT germplasm source
1	White kernel OPVs	13	Zimbabwe
2	White Kernel Hybrids	20	Zimbabwe
3	White Kernel Hybrids	5	Mexico
4	Yellow kernel Hybrids	5	Mexico
5	Yellow kernel Hybrids	3	Colombia
	Total	46	

Appendix 72 Partial list of AIP maize candidate varieties included under NUYT (Kharif 2015)

A. Open pollinated varieties (white kernel)

No	Name	NUYT Code	Maturity	Remark
1	CZP132001	WVAR-1	Early	NUYT+ On farm demo
2	CZP132002	WVAR-2	Early	NUYT only
3	CZP132006	WVAR-3	Early	NUYT+ On farm demo
4	CZP132011	WVAR-4	Early	NUYT
5	CZP132012	WVAR-5	Early	NUYT
6	TP1217	WVAR-6	Early	NUYT+ On farm demo
7	TP1219	WVAR-7	Early	NUYT+ On farm demo
8	TP1220	WVAR-8	Early	NUYT+ On farm demo
9	TP1221	WVAR-9	Early	NUYT
10	TP1222	WVAR-10	Early	NUYT
11	ZM309	WVAR-11	Early	NUYT+ On farm demo
12	ZM401	WVAR-12	Early	NUYT
13	ZM521	WVAR-13	Early	NUYT+ On farm demo

B. White kernel hybrid maize varieties

No	Name	NUYT Code	Maturity
1	CZH1247	WHYB-1	Early

2	CZH1248	WHYB-2	Early
3	CZH1258	WHYB-3	Early
4	CZH132134	WHYB-4	Early
5	CZH132140	WHYB-5	Early
6	CZH132150	WHYB-6	Early
7	CZH132151	WHYB-7	Early
8	CZH132163	WHYB-8	Early
9	CZH132164	WHYB-9	Early
10	CZH131007	WHYB-10	Late
11	CZH131008	WHYB-11	Late
12	CZH132067	WHYB-12	Late
13	CZH132070	WHYB-13	Late
14	CZH1218	WHYB-14	Intermediate
15	CZH1221	WHYB-15	Intermediate
16	CZH131010	WHYB-16	Intermediate
17	CZH131011	WHYB-17	Intermediate
18	CZH132043	WHYB-18	Intermediate
19	CZH132045	WHYB-19	Intermediate
20	CZH132055	WHYB-20	Intermediate

Appendix 73 List of climate resilient maize trials being evaluated during Kharif 2015

No	Type of trial	Trial code	No of sets	No of entries	Kernel color	Germplasm source
1	Early maturing hybrid	EHYB14	4	55	White	Zimbabwe
2	Early maturing open pollinated varieties	EPOP14	7	30	“	“
3	Intermediate maturing hybrids	IHYB14	3	60	“	“
4	Late maturing hybrids	LHYB14	2	42	“	“
5	Tropical early to intermediate maturing hybrids	TTWCWL	7	15	“	Mexico
6	Yellow maize hybrids for lowland tropics	TTWCYL	3	12	Yellow	Mexico
7	Early maturing variety trial-streak resistant	EVT-LSR	3	16	White	IITA

8	Early maturing variety trial	EMVT	3	21	White	“
9	Extra early maturing variety trial	EEMVT	3	21	White	“
10	IITA white hybrids	IITA white	5	20	White	“
11	IITA yellow hybrids	IITA yellow	3	30	Yellow	“
12	Drought Tolerant inbred lines	DT lines	3	32	white	“
13	Low N tolerant OPV	Low-N	3	12	White / yellow	“
		Total	**52**	**381**		

Appendix 74 List of climate resilient maize trials being evaluated during Kharif 2015

Activity name	Livestock	Vegetables	Maize	Wheat	Agronomy	Rice	Perineal Horticulture	e-Pak Ag	HRD
Trainings	455	10242	1	4	4	4	15 trainings (650 participants)	1 training (65 participants)	0
Farmers' fields planted with new varieties/technologies	60	11382	48 acre		145	3097	23 farmers applied new technology on 410 acres	0	0
Awareness on IPM practices		539				-	0	0	0
Workshop participants	461	62	451	125	1 national meeting with 58 participants	150	4 workshops (107 participants)	3 workshops (205 participants)	2 workshops (53 participants)
Exposure visit to varietal trials	656	320	2	31		5	0	0	0
Distribution of seed (Hybrid/Basic/ Pre-basic)	146	1053	134kg			100000kg	145 plants in 30 growers	0	0
Farmer field days	8	1160	1	31 (955)	15 field day & 1470 participants	2	2 Field days (502 participants)	0	0

Demonstration of new technologies	1088	327	18 varieties			5	1252 stakeholders	270 stakeholders	53
Total	2874	25085			1677	13258	20 events (2564 beneficiaries)	4 events (540 beneficiaries)540 beneficiaries)	2 events (53 participants)