Agricultural Innovation Program for Pakistan (AIP)

Semi-Annual Report

October 1, 2016 to March 31, 2017

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Acronyms

AIP	Agricultural Innovation Program
AR	Adaptive Research
AJ&K	Azad Jammu And Kashmir
ARI	Agriculture Research Institute
ARS	Agriculture Research station
AVRDC	The World Vegetable Center
AZRI	Arid Zone Research Institute
AKRSP	The Agha Khan Rural Support Program
BARI	Barani Agricultural Research Institute
BARDC	Baluchistan Agriculture Research Development Center
BRSP	Balochistan Rural Support Program
CCRI	Cereal Crops Research Institute
CDRI	Crop Disease Research Institute
CGIAR	Cumulative Group of International Agricultural Research
CGS	Competitive Grants System
CIMMYT	International Maize and Wheat Improvement Center
DG	Director General
DVC	Dairy Value Chain
FQ&SRI	Food quality & Safety Research Institute
GB	Gilgit Baltistan
GOP	Government of Pakistan
Ha	Hector
HTMA	Heat Stress Tolerance Maize for Asia
ICARDA	International Center for Agricultural Research in the Dry Areas
ICI	Imperial Chemical Industries
IITA	International Institute of Tropical Agriculture
ILRI	The International Livestock Research Institute
IRRI	International Rice Research Institute
IRS	Internationally Recruited Staff
JPL	Jullundur Pvt. Ltd
KP	Khyber Pakhtunkhwa
KSK	Kala Shah Kaku
KWC	Khawateen Welfare Council
L&DDD	Livestock & Dairy Development Department
LDRC	Livestock Development Research Centre
MMRI	Maize And Millet Research Institute
MNFSR	Ministry of National food & Security
MSF	Mission Strategic Framework
NARC	National Agriculture Research Center
NARS	National Agricultural Research Scientist
NE	Nutrient Expert
NGO	Non-Government Organization
NIBGE	National Institute for Biotechnology and Genetic Engineering
NRS	National Recruited Staff
NRSP	National Rural Support Program

NSTHRI	National Sugar and Tropical Horticulture Research Institute
NUYT	National Uniformity Yield Trial
PARC	Pakistan Agricultural Research Council
PLD	Punjab Livestock Department
QAARI	Quaid-E-Awam Agriculture Research Institute
PPR	Peste des Petits Ruminants
RA RARI RMP RRI RSP	Research Associate Regional Agriculture Research Center Rafhan Maize Products Rice & Research Institute
SEP SPU	Socio Economics Program, CIMMYT Semen Production Unit
TASP TCS	Tropical Animal Science and Production Tara Crop Sciences
UAF UAP UVAS	University Of Agriculture, Faisalabad University of Agriculture Peshawar University of Veterinary & Animal Sciences
UC	Union Council
UC Davis	University of California, Davis
USAID VRI	U.S. Agency for International Development Vegetable Research Institute
WRI	Wheat Research Institute
ZT	Zero Tillage
ZTHS	Zero Tillage Happy Seeder
CCRI CDRI	Cereal Crops Research Institute Crop Disease Research Institute
CGIAR	Cumulative Group of International Agricultural Research
CGS	Competitive Grants System

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Summary

Agricultural Innovation Program for Pakistan (AIP) achieved the set targets and development objectives (DO) during the reporting period (October 2016-March 2017) through adoption of result based and participatory approaches to enhance agriculture productivity. The project is assisting farming community by focusing on diverse cross-commodity key themes includes new seed varieties, new technologies (mechanization, irrigation systems), value chain development (durum wheat, rice, vegetables, perennial horticulture and livestock) and human resource development. Engaging private sector in the project interventions is an important feature of the project and keep facilitating linkages of farmers and entrepreneurs with private sector to increase in household income. The project engaged more than 50 private sector companies/stakeholders across AIP portfolio. Women's participation and involvement in the project interventions were crucial part of the project. AIP achieved targets of a total 25,000 beneficiaries, men 21250 (85%) and 3750 (15%) women against a total target of 15000 set for Financial Year (FY), 2017. AIP primary partners included, the World Vegetable Center (AVRDC), completed their project interventions by March 31, 2017 and smoothly closed their project. Similarly University of California, Davis (UC Davis) closed their operation in Pakistan under AIP by March 7, 2017 and wind up project activities. the International Rice Research Institute, or IRRI), the International Livestock Research Institute (ILRI) and CIMMYT will continue to bring innovations in livestock and crop sectors.

AIP-Livestock, documented the record of more than 1300 Azikheli Buffalo from 40 villages in district Swat, Khyber Pakhtunkhwa (KP) province, with their Geo-referencing through an Azikheli Foundation Survey. Two Participatory Rural Appraisals (PRAs) were conducted with 69 female farmers in KP province for designing training programs. A total of 650 water troughs and milk cans were distributed among livestock farmers in Gilgit Baltistan (GB) and Punjab province. The improved forage seeds were distributed to a total of 141 livestock farmers in GB, Punjab, KP and Federally Administered Tribal Areas (FATA). A total of 40 moveable mobile animals housing units were established in AJ&K and GB as a coping strategy with disaster situation. The animal health camps were conducted in Sindh province for 64 small ruminant herders having 2019 goats and sheep. In Punjab province, 04 improved livestock housing structures were established and handed over to the female livestock farmers in district Jhang. A total of 1049 livestock farmers were trained on livestock feeds and animal nutrition in KP, Punjab provinces and GB. Training on modern reproduction, Artificial Insemination (AL) and ultrasonography techniques were imparted to 20 veterinary officers from Azad Jammu and Kashmir (AJ&K), livestock department.

AIP-Maize continued the multi-location testing of diverse maize products by engaging 22 public and private partners in Pakistan. As a result, partners identified improved maize hybrids and open pollinated varieties with relevant traits. These varieties were introduced from the International Institute of Tropical Agriculture (IITA) located in Nigeria. Three provitamin A enriched maize hybrids were allocated to the University of Agriculture Faisalabad (UAF) for further testing and seed scaling up by involving private sector for marketing in Pakistan. Furthermore, two Quality Protein Maize (QPM), hybrids officially released in Pakistan with approval of the Variety Evaluation Committee (VEC). AIP-maize inaugurated the first maize stem borer (*Chilo partellus*) mass rearing facility in Pakistan to evaluate and identify maize varieties that are tolerant to the insect attack. A total of 10 public and private partners produced 2377 kg of foundation and parental seed which will be further multiplied.

AIP-Wheat component conducted on farm demonstrations on Informal Research and Development (IRD) by involving 2970 smallholders' farmers including women from **36** districts of Pakistan. In addition to fast tracking genetic gains to the farmers' fields, the initiative has popularized **17** new wheat varieties suitable for irrigated and rainfed areas. Participatory Varietal Selection (PVS) trials

were conducted by involving **15** new high yielding, disease resistant wheat varieties on 58 farmer's field across KPK, Punjab, Sindh, and Baluchistan provinces. The project facilitated quality seed production and currently **322** seed growers are multiplying quality seed of **18** new high yielding, rust resistant wheat varieties covering about more than **174** ha land. A total of **281** researchers, students, seed company staff and seed growers were trained which will help to improve overall wheat productivity.

AIP crop management component reached to **4431** farmers with collaboration of **23** national partners and assisted application of improved techniques on **816** sites and provided **58** planters. Trainings were imparted to **324** stakeholders and disseminated improved techniques through field days to **3233** farmers. A total of **500** farmers used zero tillage wheat, ridge planting of wheat and LASER land levelling on their farms helped to improve 10-15% yield. Local partners assisted in distribution of **57** planters locally manufactured which were used by 95 farmers in Punjab and KP provinces which helped farmers in improving grain yield. AIP facilitated 200 farmers on improved nutrient management in wheat included crop sensor assisted urea application on **115** farms in Balochistan, Sindh, KP and Punjab provinces to assist farmers to save **76 kg** urea per hectare in wheat without reduction in yield.

Under AIP-Rice, 9 public and private institutions have evaluated 1127 advanced IRRI imported rice lines and selected **116** high yield lines for submergence tolerance. National Institute for Biotechnology and Genetic Engineering (NIBGE) developed one variety BR-1 and tested at different locations and recorded an increase of 27.8% yield over Super Basmati under Bacterial Leaf Blight (BLB) disease incidence. For up-scaling of new rice varieties, seed (1.1MT) was distributed to **1142** farmers and eight improved technologies were demonstrated at 1142 farms for increasing rice production. A total of 12 participants from Pakistan have received training at IRRI, Philippines on BLB management and development of BLB resistant rice varieties. Trainings were arranged for **765** researchers, extension officers, and farmers in Punjab, Sindh, and KP provinces on resource saving rice production, harvest and post-harvest technologies.

AIP Socioeconomics (SEP) component completed follow up surveys to document the Impact of AIP interventions on wheat, maize and Conservation Agriculture (CA), technologies in AJ&K and GB. The findings indicated that AIP interventions has positive and significant impact on the livelihood of the beneficiary households. For example beneficiary of the hybrid maize seed were getting a yield of up to 10 tons per hectare while the non-beneficiary were getting 5.7 tons per hectares only by planting open-pollinated varieties (OPV) varieties.

AIP-vegetable component conducted a total of 10 on-station trials of 32 vegetable varieties and 18 on-farm adaptability trials with 32 varieties vegetable under protected cultivation. Hands on trainings were provided on tunnel production technologies including Integrated Pest Management (IPM) that resulted in a 10-15 % drop in use of pesticide. Drip irrigation systems showed water and fertilizer savings of 30-40% with 20-30% increase in yield for vegetables. A Shuga-Bunir in KP province was declared as a Seed Village with the consultation of the Shuga Growers Association. Villages in Balochistan, Punjab, and Sindh were identified as new seed villages. Packing material included plastic bags were replaced by net bags and plastic cartons in DI Khan district in KP province and Khatha Saghral-Khushab in Punjab province for tomato transportation.

Under AIP-fruits, UC Davis, all 22 commissioned projects made good progress toward set objectives for the reporting period. A total of 1200 true to type nursery plants of 10 citrus varieties were distributed among 24 growers in Sargodha district, Punjab province. A post-harvest training center was established to regularly offer reasonably priced need based trainings on post-harvest handling of

fruits and vegetables for capitalizing on the post-harvest facility developed at AT Sakrand, Sindh province. The first Pistachio Growers Association of Baluchistan was registered. One of the female, AIP Scholar Ms. Maria Solangi, has completed her MS thesis defense in US at the Veterinary & Animal Sciences Department, University of Massachusetts, US. Mr. Habibullah, AIP Scholar has also defended his thesis in US. E-Pak Ag is a unique component of AIP to promote the use of Information Communication Technology (ICT) in agriculture extension. Under this component, UC Davis in collaboration with University of Faisalabad (UAF), conducted a day long workshop on "short video making" on October 10, 2016 at the University of Agriculture, Peshawar. A total of 65 students, faculty members and extension staff from the KP province were invited. A series of events were managed under the gender specific initiatives of AIP on the use ICT for the rural school girls to address the agricultural issues faced by their household.

The establishment of boards in the provinces and the execution of competitive grant system under those boards has been a challenge for the primary partners PARC. Therefore, PARC is progressing to strengthen national coordinated program to serve the provinces and fund competitive grants in provinces.

AIP communications, following the branding and marking guidelines of USAID, proactively highlighted the AIP's interventions through 15 persuasive success stories appearances on different web based media, five technical publications and maintaining media presence which included 16 press insertions. Similarly, AIP Monitoring and Evaluation (M&E), component collected data on MSF outcome indicators on quarterly basis and reported to USAID on Paknfo; the project has outperformed and achieved 40% above the target across various indicators.

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."

3 Livestock

3.1 Dairy Value Chain

3.1.1 Foundation Survey for Azikheli Buffalo: Geo-referencing of herders for further advancement in development of indigenous treasurers

Interviewing farmer

The dwindling indigenous dairy resources especially Azikheli Buffalo in the hilly terrain of Northern areas of Pakistan were producing the alarming buzz as the future of more than 1.5 Million local inhabitants directly and/or indirectly depends upon the Azikheli buffalo farming. The nascent step were initiated in January, 2017 to document >1300 Azikheli Buffalo farmers of 40 villages (including the outskirts of home track of Azikheli area, Khawazakhela) with their Geo-referencing through Azikheli Foundation Survey. This census survey covered 5139 total Azikheli buffaloes [Milking (2029), Dry (735), Bull (96), Heifers (905), Steers (266), Female-calves (679) and Male-calves (429)] along with categorical root causes of cross breeding as well as other important parameters. The survey highlighted the preferences of Azikheli buffalo farmers in relation with milk production and provides information for comparative evaluation with other buffalo breeds in Pakistan.

3.1.2 Sensitizing female livestock farmers for sustained dairy production.

The involvement of female in livestock is well-known fact and female livestock farmers required comprehensive on-farm trainings. Two Participatory Rural Appraisals (PRAs) were conducted by involving 69 female farmers in villages Kishowra and Baidara district Swat, KP province. The PRAs results indicated that 25% milk were consumed at home level as fresh and/or in terms of dairy products. In these villages no milk collection center available, therefore, farmers were selling their milk through informal milk marketing channels. There were lack of information about animal health and diseases, management of dairy animals under seasonal variations, availability of improve forage seeds and their impact on livestock productivity and milk hygiene. Female livestock farmers were still practicing outdated and primitive ways of handling sick animals. These PRAs identified major bottlenecks in dairy value chain in district Swat, KP province.


Farmer group discussion

3.1.3 Devising a community development action plan through reconnoitering the bottlenecks in restructuring of existing cattle markets in Punjab

The strategy plan implemented for restructuring and reform in management of cattle markets under the initiative of Government of Punjab province. The Cattle Management Company was established to discourage extortion, exploitation by middleman and outsourcing the facilities in the markets with complete overhauling of existing structure since 2014. AIP-livestock have initiated the preliminary assessment of the cattle markets in February, 2017 to devise a community development action plan through revitalizing cattle market infrastructure in Salam cattle market (Sargodha Division). These cattle markets are still in its infancy as various problems and constraints were identified including lack of improve infrastructure, incomplete information on marketing mechanism, traditional mindset of livestock producers and facilities to the livestock traders.

Cattle market in Sargoda

3.1.4 Knocking the Door of Innovation in Heart of Coastal as well as Deserted agro-ecologies of Interior Sindh

AIP-Livestock team in collaboration with the World Bank assisted Sindh Agricultural Growth Project initiated activities in the interior parts of Sindh province in coastal district Thatta (Habib Soomro Milk Producer Group (MPG) and deserted ecologies of district Tharparkar (Mithrya Soomro and Malenhar Khewra MPGs) especially with the rural minorities. These communities are unique in terms of their cultural and farm management practices, tradition and rear indigenous treasures of livestock breeds. Sindh livestock department invited AIP-Livestock to emanate their activities where rural communities are still practicing primitive methods of production. The snapshot survey was conducted covering a total of 191 livestock farmers in district Tharparkar, Thatta, having 139 milking Thari cattle, 193 Red Sindhi cattle and 164 Kundi buffalo. Survey revealed that 12% landless farmers-primarily dependent upon livestock, 44% small farmers (1-5 acres land), 27% medium farmers (6-10 acres) and 17% large farmers (≥11 acres). Based on the preliminary findings, the farmer's participatory trials in district Tharparkar is currently on-going to devise feeding strategies for milking animals under diverse and extreme climatic conditions.

Discussion with MPG members in Thatta & Tharparkar

3.1.5 A pragmatism of young veterinarians on modern feed analytic perspectives for their professional career and future endeavor.

AIP-Livestock in collaboration with University of Agriculture Peshawar (UAP) organized a five days training program on February 13-17, 2017, to place young veterinarians at the forefront of change and development, on *in vitro* and *in sacco* digestibility measurements. The aim of this training was to carve and equip the young veterinarians according to the needs of the professional market and its oriented trends. The training has provided the required experience on proximate analysis and the relative tests required to check the feed quality, rate of digestibility, protein and fiber contents.

Training of DVM students

3.1.6 Inauguration of Model cum Training Farm for Female Livestock Farmers:

AIP-livestock inaugurated the four newly established model cum training farms for female livestock farmers on January 14, 2017 in district Jhang. An awareness programs were conducted for a total of 150 participants including livestock farmers from adjacent villages, private sector representatives, academia and Livestock and Dairy Development (L&DD), Department Punjab officials. Livestock farmers were sensitized on current bottlenecks of dairy farming systems in rural economy and its aftermath on rural livelihoods. They were briefed on the performance of rye grass under fruit orchards in relation with milk production.

Inauguration of model farms in Jhang

3.1.7 Water Troughs and Milk-in Cans Distribution among Livestock Farmers of GB

To ensure the free excess to water for milking animals, and to improve the milk production and milk quality in the hilly territory of Pakistan, AIP-ILRI distributed 350 water troughs and milk-in cans on March 22-23, 2017, to poor-female livestock farmers from five different villages of Danyore valley. Moreover in collaboration with the L&DD Department, Government of GB two days training organized on the disease and farm management practices in two villages included Majukal and Oshikhandas for 90 farmers. The training focus was on enough water- essential for sustenance of livestock farming. Moreover, 100 water troughs and milk-in cans were distributed among the participants to ensure better farm management practices for the sustained hygienic milk production.

Distribution water troughs &milk cans in GB

3.1.8 Strengthening Female livestock farmer's through innovative and cost effective targeted interventions in GB

AIP-ILRI in collaboration with L&DD & Poultry Production, GB and Local Support Organization (LSO) organized an awareness raising program on March 19, 2017 for the livestock farmers of Danyore valley of district Gilgit. More than 400 farmers participated in the event, out of which nearly 95% were females. Improved mesh-walled housing unit was inaugurated to introduce modern principles of livestock management under changed scenario of climatic irregularities. Training was also provided on balance feeding under various feeding regime.

Inauguration of mesh wall housing in

3.1.9 AIP for Pakistan Waved Flag at the International Livestock Nutrition Summit, Lahore

AIP-livestock have become torch bearer during the International Livestock Nutrition Summit, Lahore on February 21-22, 2017. AIP-livestock displayed the maiden, modern and innovative livestock industry solutions and/or equipment to improve the livestock productivity and act like a catalyst to disseminate the livestock farmer's centered research for long term development in Pakistan. Immense responses and appreciation were received from various stakeholders of livestock industry representatives from national and international organizations, research organizations and academia.

3.1.10 Outsourcing feeds and forage analysis services through portable AgriNIR analyzer to the private sector companies and dairy farmers

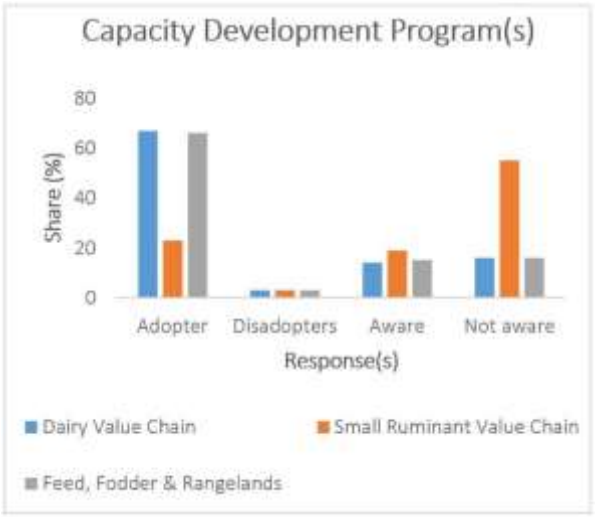
AIP-livestock have initiated the step of outsourcing services for analyzing the feeds and forage sample analysis through-first ever portable AgriNIR analyzer to the Maize hybrid producer companies especially involved directly and/or indirectly in Maize silage production and dairy producers. A total of 254 samples (silage plus concentrates) were analyzed till now. The feedback

Demonstration of the AgriNIR feed analyser in UVAS

mechanism were for cost effective, least cost ration formulation for dairy production and ideal crop for silage production provided to the respective personnel.

3.1.11 Self-Assessment of AIP-livestock Targeted Interventions: Technology Diffusion Rates across Provinces in Pakistan

AIP-livestock conducted self-assessment of AIP-livestock targeted interventions across the provinces of Pakistan through Technology Adoption Census Survey (TACS). Analyses revealed that milk utilization/production is a good indicator which shows that farmers are always primarily fulfilling their family nutritional demands and the remaining amount would be available for others. Moreover, this would be a good indicator for gauging progressiveness of farmer as they are more concerned about getting higher milk production from their animals. Adoption rates calculated based on milk utilization categories revealed that >60% share of adopters were reported in Dairy Value Chain (DVC) and Feed Foger and Rangelands (FFR) components as compared to 24% adopters in Small Ruminant Value Chain (SRVC) component. The analysis of TACS based on AIP-livestock capacity development program have provided the quite similar results in which highest adopters were from DVC (67%) and FFR (66%). Detail reports will provide the information to crystalize the AIP-livestock action plan before the project phase out.



3.1.12 Futuristic Path for Livestock-Crop System Development and its Role in Reclaiming and/or Utilizing Saline Soils of Pakistan

AIP-Livestock participated in the 'National Policy Dialogue on Salt-Affected Soils' organized by FAO-Pakistan and USDA on March 7, 2017 in Islamabad. A total of 45 eminent soil scientists/ academia from provinces of Punjab, KP, Sindh, and Balochistan provinces participated and discussed the current status and on-going efforts to assess the extent of salinity issues of soils of Pakistan. They discussed the possibilities to reutilize parcels of the barren salinity affected soils, which at present is estimated as 7 million hectares.

Policy dialogue on Saline

AIP-Livestock co-led the session on 'Extent of salt-affected soils & Assessment Methodologies' and was requested to lead the session on 'Financial mechanisms for re-assessment'. One of the conclusions of the days endeavor was the recognition of the crop-livestock interface as a pioneer enterprise to start the reclamation process to ensure reversion of saline soils to productive soils.

3.1.13 Farmers Training on Classification and Nutritive Value of Feed Resources for Ruminants

Farmer trainings on Feeds & Feeding

AIP-livestock conducted a training for 80 livestock farmers in February and March, 2017 in three districts included Jhang, Nankana Sahib and Sadiqabad of Punjab province. The objective of the training was to equip farmers with the applied knowledge of dairy husbandry and better utilization of available feed resources leading to optimum production level and increase in farm profitability. Training program included integrated, supportive and coaching arrangements, covering the core task of feeding the dairy animals. The training covered the key aspects like rumen function, various types of feeds and their nutritive value and combining different feeds to make a balanced ration.

3.2 Small Ruminant Value Chain

3.2.1 Small ruminant health camp for awareness creation on prevention and control of PPR and internal parasites in goats at Umerkot, Sindh

Internal parasites are a major animal health constraints, and lowers the growth and production of animals up to 30%. Farmers often face the challenge of vaccine availability and there are difficulties in maintaining an appropriate cold chain for the vaccine. Upon the request of farmers from Umerkot Sindh province, in collaboration with ICARDA, AZRI, Umerkot and officials from the Provincial Livestock Department Govt. of Sindh in January 2017, organized a small ruminant health camp. During the camp, farmers were trained on typical clinical signs of PPR, prevention and control measures of major internal parasites including the life cycle of major parasites, economic losses and infection process in the animals. A total of 64 farmers participated in the awareness program followed by administration of PPR vaccine and de-worming of 2,019 head of goats with broad spectrum anthelmintic (Nilzan Plus). Farmers responded very positively to the activity undertaken by AIP.

Small ruminant health camp at Umerkot

3.2.2 Training of Master Trainers on Modern Reproductive Techniques in Ruminants

Training on Reproduction Techniques forAJ&K staff

AIP-livestock in collaboration with Animal Reproduction and Genetics Program, Animal Sciences Institute (ASI), NARC, Islamabad organized a one week training on March 6 -10, 2017 for 23 veterinarians of AJK on modern reproductive technologies and Artificial Insemination (AI) in ruminants. The training was focused on practical techniques to ascertain the delivery of quality AI services to the poor farmers of the hilly areas. These tools would provide the way to increase their income through healthy, productive and genetically improved livestock with lesser risk of disease transmission. The main motive of the

program was to get the practical hands on semen collection, freezing, storage, thawing and AI technique along with pregnancy diagnosis via rectal palpation, ultrasonography and modern kits method. Feed, Fodder and Rangeland.

3.3 Feed, Fodder and Rangeland

3.3.1 Training on rangeland management - Quetta, Baluchistan

Two days training on November 29-30, 2016 was organized in collaboration with ICARDA, Forest and Wildlife Department. The objectives of the training was to discuss the state of rangeland ecosystems and its services in each province, and train the in-service officers in basic methodologies of rangeland data collection, interpretation and conclusion for rangeland management. The training was attended by 20 in-service young forest officers. The trainers emphasized that involvement of the community is needed for successful range management. At present, rangelands only produce less than 30 % of the feed biomass of their original potential because of drought, climate change, overgrazing, cutting of fuel wood, etc. The new concepts of rotational grazing with the collaboration of farmers were introduced. Other topics covered were; biomass measurements in rangelands and integrated range-crops and livestock management systems.

Training on Rangeland s in Quetta

3.3.2 Promotion of improved forage varieties with high yield potential with appropriate agronomic practices

In collaboration with ICARDA and the Provincial Forest Department, an improved Alfalfa variety (KS777) was established on eight acres land belonging to 10 farmers in Dargai Saifullah, in district Loralai. The planting was completed on November 15, 2016 and the productivity of the introduced variety will be compared with existing local varieties by the Provincial Forest Department. In Chakwal site, improved variety of Alfalfa (KS 777) was planted on two acres at Dhulli (five farmers) and Berseem (KS 999) on 1.5 acres at Begal (three farmers) site; sowing was completed in November 2016.

3.3.3 Establishment of Atriplex nursery at Islamia University of Bahawalpur

In collaboration with ICARDA, Islamia University of Bahawalpur (IUB) and Cholistan Institute of Desert Studies, at IUB Atriplex nursery (*Atriplex canescens* and *Atriplex lentiformis*) seedlings was established in November 2016 for the rehabilitation of degraded rangeland in Cholistan desert. A total of 10 staff members of IUB were trained on the establishment and maintenance of the nursery. In 2017 more than 4000 seedlings of Atriplex spp. will be ready for transplanting and will be handed over to the Cholistan Institute of Desert Studies which is responsible for the improvement of desert rangelands in Bahawalpur.

Atriplex seedling nursery at IUB

3.3.4 Establishment of Arboretum of cactus spp. at Islamia University of Bahawalpur (IUB)

In October 2016, an arboretum of 15 imported cactus ssp. from Italy and 25 spp. from Brazil were established at IUB. The main objective was to explore cactus as a potential animal feed during drought periods in Cholistan desert. The growth performance of the different accessions will be evaluated under the Cholistan desert conditions in collaboration with the Cholistan Institute of Desert Studies**.**


Pads of cactus varieties and the planted cactus at

3.3.5 Evaluation of spring wheat lines as ruminant feed

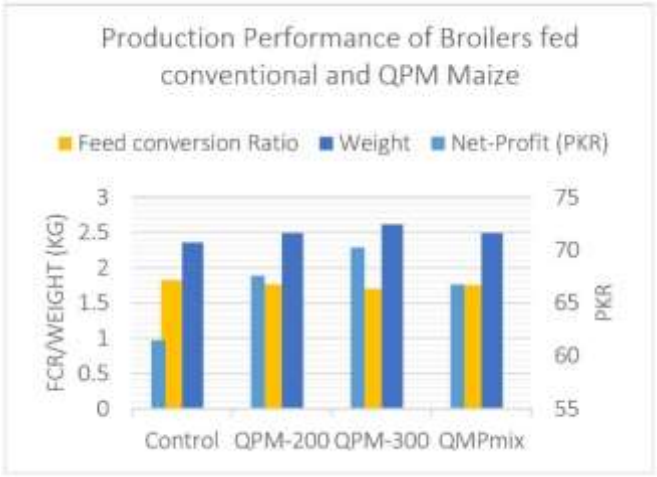
In collaboration with University of Agriculture Peshawar (UAP), in October 2016, 335 spring wheat lines supplied by CIMMYT are being grown to assess their nutritive value as a forage and for straw quality for ruminants. Spring wheat genotypes comprising of the commonly grown traditional cultivars and novel germplasm developed by CIMMYT and other breeding institutes of Pakistan, is being evaluated in field trials. The field trials were conducted at the research field of the UAP. Two field trials were conducted simultaneously to evaluate all 335 genotypes for (1) forage associated morphological characteristics, nutritive value and digestibility; (2) grain yield and straw nutritional quality characteristics.


Pads of cactus varieties and the planted cactus at

3.3.6 Evaluating nutritional quality of silages from novel Maize genotypes for dairy production

AIP-ILRI through collaborative research agreement (CRA) with UAP, KP province evaluated the nutritive value of traditional and novel feeds in an effort to optimize their utilization as animal feed. The study started in January and completed in December 2016. Six traditional and novel spring maize cultivars, coded as QPM-200, QPM-300, P3025, ASS9633 and 95W34 were evaluated for silages production in terms of Dry Matter (DM), starch and crude protein (CP) yields; fermentation quality; and nutritive value under the local environment conditions. The results showed that compared to local (Azam) variety, QPM-300 had higher content of CP (8.05 vs. 6.44%) and starch (28.9 vs. 23.2%) and lowest content of NDF (41.5 vs. 47.1%), indicating that QPM-300 had the highest metabolizable energy content and will support high DM intake (DMI) and milk production in dairy cows. In terms of CP, starch contents and yields, the QPM-300 was closely followed by QPM-200, while lowest values were recorded for the local Azam variety.

3.3.7 Study on conventional maize versus the Quality Protein Maize (QPM) in broiler rations



A study was conducted by AIP-Livestock in collaboration with UAP, KP province indicated that the two QPMs (QPM 200 & QPM 300; introduced to Pakistan by CIMMYT under AIP) excels the conventional maize grains currently used at all growth stages of the broiler rations. Feed intake did not differ in response to the replacement of conventional maize grain with both varieties. However, the live weight (2.6 *vs*. 2.4 g) was significantly higher and the feed conversion ratio (1.70 *vs*. 1.82) was significantly lower for QPM-300 as compared to the conventional maize. The net profit was higher for QPM-300 (PKR 70), followed by QPM-200 (PKR 67) and lowest was with conventional maize (PKR 61). As compared to QPM 300 the conventional maize lacks adequate levels of the essential amino acids (methionine, 0.12 *vs*. 0.24; lysine, 0.21 *vs*. 0.24; tryptophan, 0.05 *vs*. 0.07), thus reducing the overall biological value of its protein.

3.3.8 Farmer's Awareness Program on Sustained Dairy Production:

AIP-livestock in collaboration with Farm Dynamics Pakistan organized a farmer's awareness program to share the outcomes of farmer participatory trials on strategic feeding on March 21, 2017. A total of 193 farmers participated from various surrounding villages of Sindh and Punjab provinces. Comprehensive knowledge on the production technology about the Rhodes grass and its hay making were disseminated and propagated. The practical feeding guides were provided to all the dairy farmers for balancing the feed for their dairy animals with proper explanation and its usage under various animals' type categories. Moreover, a total of 150 water troughs and milk-cans were also distributed to the dairy farmers. This is the first ever activity on a larger scale in the neglected but livestock rich riverine belt of Punjab and Sindh provinces.

3.3.9 Mobile mesh wall housing to combat disasters in hilly terrains

Inauguration of mesh wall model farms in GB & AJK

In collaboration of Livestock Department in GB and AJ&K, in September and October 2016 AIP-ILRI team surveyed different villages and probe out, that people are not aware about the appropriate animal housing for Improved and hygienic milk production. The reason was harsh weather and areas are prone to disaster. The team identified 39 farmers with inappropriate animal housing or no housing. Keeping in view the problems of areas and importance of appropriate housing, AIP-ILRI established 40 mesh-wall animal housing (20 each) which were especially designed for disaster prone areas. As a whole AIP-ILRI covered six and four villages in GB and AJ&K, respectively. In addition to this one model cum training mesh-wall animal housing was established in LDRC farm Muzaffarabad to serve as a demonstration model.

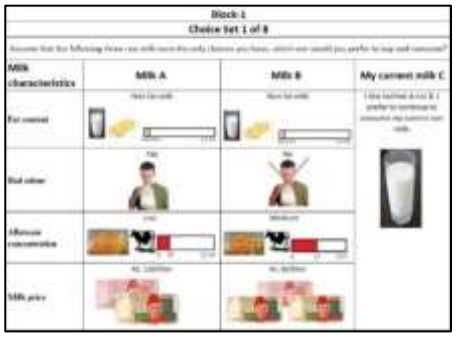
3.3.10 Nutritive value of Silage produced in Punjab

Silage can be a good option in situations of feed shortage/scarcity. AIP-ILRI first time in the history of Pakistan surveyed in January 2017, producers on the silage production capacity, quality and physical characteristics in Punjab province. Samples collected were analyzed for pH (Digital pH meter), and proximate using portable AgriNIR (First Portable NIR machine in Pakistan to analyze samples in field conditions). Color aroma and quality of packing material was observed. A total of 140 silage producers were identified in Punjab province out of which only 54 were available. The result indicated that majority of the silage producers were producing Bunker silage (80%) whereas the noticeable silage producers were also making Bailed (13%) as well as (7%) are mixed categories of Maize silage producer. The majority of the farmers in Central Punjab province were buying standing crops from the Maize producers as compared to South Punjab Producers. The high level variability in the silage quality is due to harvesting stage as well as different Maize varieties used.

Bale silage | Bunker silo | Measuring pH

3.3.11 Willingness to Pay (WTP) for safe milk consumption in Pakistan

AIP-Livestock conducted a study to investigate the consumers' preferences for aflatoxin free milk in Pakistan. A discrete choice experiment study was conducted with a random sample of 360 raw milk consumers from ICT and Faisalabad Punjab province. The attributes including in the study included; fat content, bad smell, aflatoxin concentration and milk price. Study clearly indicated that consumers are willing to pay a higher premium of PKR 125/liter for milk having low concentration of aflatoxin. Moreover, consumer were willing to accept a discount of PKR 44/litter for milk having bad smell. Based on these findings, there is considerable scope for the dairy industry and researchers to invest in the production of quality/safe milk, especially aflatoxin-free raw milk. For brevity, consumers' demand led mechanism adopted in this study may improve milk quality and safety along with entire supply chain.

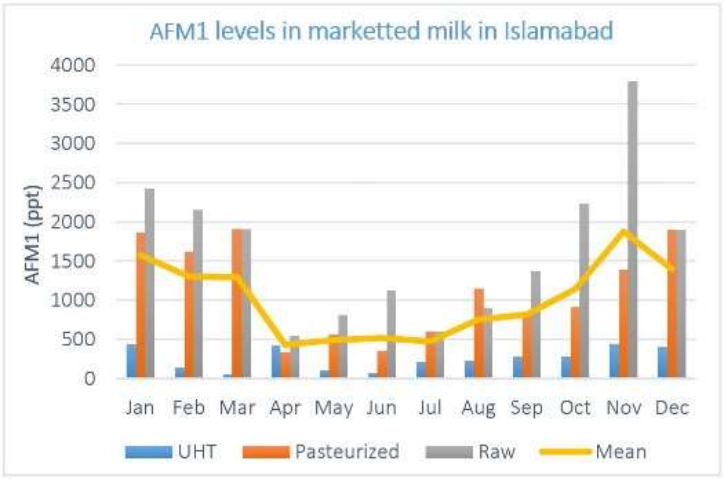


Example of choice set

3.3.12 Constraint Analysis for Dairy Production in Bagh, AJ&K

AIP-ILRI in collaboration with Islamic Relief conducted a snapshot survey in January 2017, for constraint analyses for dairy production in Bagh and AJ&K. Survey conducted in six villages (Suden Gali, Bangran, Hothala, Sural, Kacha Chirhan and Dhundar) including more than 200 dairy farmers. Majority of the farmers keep Nili-Ravi buffalo, while some keeps cross-bred cattle. The biggest constraint in this area regarding dairy production is non-availability of fodder crops. Animal housing lacks appropriate standards i.e. ventilation, clean bedding, availability of feed trough etc. There is need to introduce dual purpose crops, that we can get animal feed without disturbing human food.

3.3.13 Study on prevalence of Aflatoxin (AFM_1) in (un) processed milk in ICT and all provincial capitals in Pakistan



In collaboration with NARC (through a CRA), two studies were conducted to ascertain the AFM_1 levels in the milk. The first study was on milk being marketed in the twin cities of Islamabad-Rawalpindi during the year 2016. AFM_1 in UHT was below 500 ppt throughout the year, whereas the other two sources tested were above the level except in the months of April & June. The second, was a cross sectional study from milk and feed samples collected from dairy farms around Islamabad and all provincial capitals included Lahore, Karachi, Peshawar - KP GB, Quetta-Baluchistan, Muzaffarabad - AJ&K. AFM_1 levels in milk are alarmingly high and way above the safe levels of 500 ppt. This study also indicated that there is a high correlation between cotton seed cake (CSC) and aflatoxin in fresh milk.

4 Maize

4.1 Development or introduction of climate resilient maize

Under AIP-Maize the following climate resilient maize trials harvested and across location data were collected from most of the sites to facilitate selection process:

- A total of **50 yellow kernel** climate resilient maize hybrids and OPVs (n=20) sourced from the International Institute of Tropical Agriculture (IITA) were harvested from 12 sites
- A total of **161 white kernel** climate resilient maize hybrids and OPVs (n=14) sourced from IITA and CIMMYT were planted and harvested from 36 sites
- Heat stress tolerant hybrids consisting of **16 entries plus four local checks** were harvested from seven sites in Pakistan. The germplasm were accessed from the Heat Tolerant Maize for Asia (HTMA) project, another USAID's project implemented in four South Asian countries Viz: Pakistan, Bangladesh, Nepal and India. This effort targets to deploy best performing heat stress tolerant maize hybrids from the HTMA project in Pakistan and create synergies among the two USAID's funded projects (HTMA and AIP).

The evaluation of these trials will help partners of AIP maize to identify climate resilient maize hybrids adapted to specific testing environments. 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 analyzed to check entries' performance across locations.

Evaluation of IHYB-16 at CCRI during trials harvesting time, Dec 2016

4.1.1 Evaluation of low soil nitrogen stress tolerant maize

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 from the soil micro climate. Under the AIP maize program CIMMYT introduced low nitrogen (low N) stress tolerant open pollinated maize varieties from the IITA for evaluation in Pakistan. A total of 10 low N stress tolerant maize varieties evaluated in Kharif 2016 season along with two local check varieties. Based on the subsequent evaluation, AIP partner has requested the variety LNTP-W C4 to be allocated for further testing and deployment in Pakistan. The trails were planted at CCRI, MMRI and NARC and managed by applying zero nitrogen fertilizer (UREA) with the record of relevant data.

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

List of low soil nitrogen stress tolerant maize varieties

4.1.2 Evaluation of drought stress tolerant maize inbred lines

Under the AIP maize program, CIMMYT introduced 35 maize inbred lines developed for drought (water stress) tolerance from International Institute of Tropical Agriculture (IITA) for evaluation in Kharif 2016. The inbred lines are white grain and adapted to mid altitude ecologies. The trial evaluated for the second season at CCRI, MMRI, NARC and entry number 29 (TZMI1169) selected by AIP partners for further testing and deployment in Pakistan.

No	Name	No	Name	No	Name
1	TZMI878	13	TZMI861	25	TZMI903
2	TZMI860	14	TZMI1164	26	TZMI1240
3	TZMI754	15	TZMI1165	27	TZMI407-Short
4	TZMI909	16	TZMI1162	28	TZMI765
5	TZMI889	17	TZMI751	29	TZMI1169
6	TZMI1161	18	TZMI869	30	Check
7	TZMI1167	19	TZMI764	31	TZMI1163
8	TZMI753	20	TZMI407-Short	32	TZMI868
9	TZMI1241	21	TZMI407	33	TZMI748
10	TZMI763	22	TZMI863	34	TZMI882
11	TZMI757	23	TZMI1255	35	TZMI755
12	TZMI747	24	TZMI870	36	TZMI886

List of drought tolerant maize inbred lines under evaluation during Kharif 2016

4.1.3 Evaluation of heat stress tolerant maize hybrids

Climate change related weather extremes are being experienced by farmers in Pakistan leading to yield loss and changing of traditional farming practices. Hence, to develop maize germplasm that can withstand higher temperatures (up to 45^0 c during flowering), CIMMYT is testing heat stress tolerant maize hybrids in Asia under the HTMA project where Pakistan is among the four South Asian countries included in the project. Under the AIP program, partners are also testing heat stress tolerant maize hybrids sourced from CIMMYT-Asia maize breeding program in Hyderabad. As a result, AIP partners identified six heat stress tolerant hybrids and requested for further testing and deployment in Pakistan.

No	Name	No	Name
1	CAH1521	11	ZH15381
2	ZH141592	12	ZH138088
3	ZH15445	13	VH12333
4	ZH169	14	VH12337
5	Sib	15	CAH151
6	ZH1621	16	CAH153
7	ZH15374	17	Check 1
8	ZH1622	18	Check 2
9	ZH15379	19	Check 3
10	ZH15383	20	Check 4

List of heat stress tolerant maize hybrids sourced from CIMMYT Asia hybrid maize breeding program (Hyderabad, India), Kharif, 2016

4.2 Development or introduction of biofortified maize

4.2.1 Quality Protein Maize (QPM) released in Pakistan

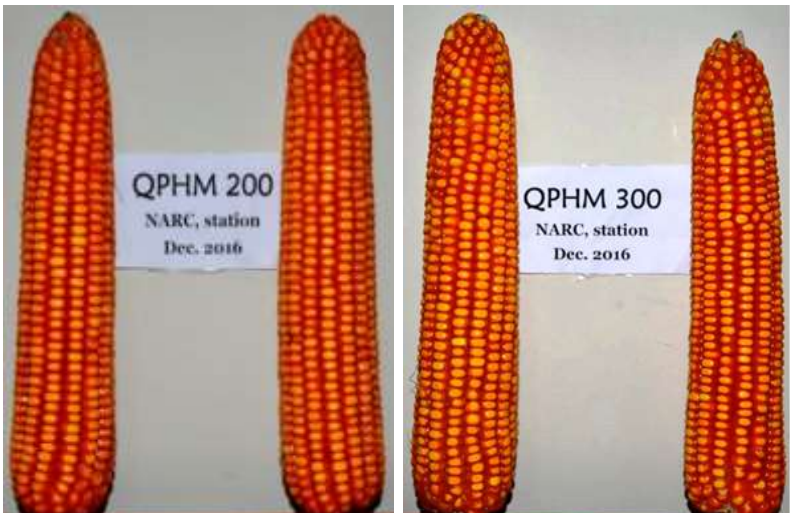
For the first time, Pakistan released QPM varieties for commercial consumption as food or feed, which is an important step towards improving the nutritional well-being of communities that consumes maize. In January 2017, Variety Evaluation Committee (VEC) approved two QPM hybrids – QPHM200 and QPHM300 – for large-scale cultivation in Pakistan. Developed

Heat stress tolerant maize hybrids field evaluation in Multan

Performance of IITA maize hybrids at Maxim International farm

by the CIMMYT, these hybrids identified after evaluation in Pakistan by the NARC. These hybrids can potentially yield up to 15 tons per hectare during well fertilized and irrigated conditions over three times the national average and can be provided to farmers on a very affordable price.The released and commercialization of the two QPM hybrids was aimed at boosting nutrition by alleviating essential

amino-acid deficiency, particularly in low-income communities. The QPM hybrids were primarily selected based on their yield advantage. Farmers were open to adopting them because they performed better than normal commercial hybrids in many locations.



Ear samples of the newly released QPM hybrids. Full seed setting is sign of good synchronization

4.2.2 Allocation of provitamin A enriched maize hybrids in Pakistan

Under the AIP Maize program, between 2014 and 2016 CIMMYT introduced and tested a range of biofortified improved open-pollinated varieties (OPVs) and hybrids containing high levels of provitamin A (PVA). The grain yield performance of the top 10 PVA hybrids (see attached table 1 under Maize annexure 20.1) shows the potential of PVA maize in Pakistan as compared to commercial checks or the national average yield. From the table 1, **n**o local check hybrid was able to be ranked among the top 10 during 2014 and 2015 at NARC and CCRI respectively. In the other two sites the PVA hybrids performed in better or equivalent position with the commercial checks. Based on these and additional data from UAF, CIMMYT has allocated three PVA hybrids for the first time in Pakistan to UAF according to their request. Once CIMMYT and UAF signed the licensing agreement, UAF will have access to the PVA parental lines. UAF will take lead in product registration, seed scale up and dissemination of these products in Pakistan (see table 2 under Maize annexure 20.1 for list of 10 biofertified maize evaluated or under evaluation in Pakistan).

4.3 Development or introduction of biotic stress tolerant maize

4.3.1 Evaluation of maize stem borer tolerant varieties

Under the AIP-Maize program twelve stem borer tolerant maize varieties were introduced from IITA. The varieties were evaluated at CCRI, MMRI and NARC based on artificial infestation and natural condition. A total of 10,000 newly hatched larvae mass reared from the new lab were used to infest all the entries during Kharif 2016.

At NARC, data on survival of plants, dead hearts and intensity of damage appeared on leaves of survived plants recorded two weeks after artificial infestation. The entries were observed on weekly basis for further damage and growth. The tillers from dead hearts were emerged and were removed. The same data at CCRI and MMRI was recorded during third and last week of September, respectively.

Some entries showed good survival rate which is an indication of tolerance for the stem borer attack (see table 3 under Maize annexure 20.1). On the basis of this data, the entries QPHM 300, BR-2, BR 9943-DMRSR C1, TZBR Comp 2-W C1, TZBR Eld.-4-W C2 an TZBR Comp 2-Y C2d performed well with survival percentage of 90, 80, 63.64, 62.50, 60.0 and 60.0%. The first two entries were not included in germplasm resistant to borer provided by CIMMYT and were planted only at NARC. Three entries BR 9928-DMRSR C1, BR TZL Comp 4 DMRSR and Ama TZBR-Y were also acceptable for performance with survival rate of 57.14, 55.56 and 50.0%. All the entries showed survival rate 94 to 100% under natural infestation of stem borer (see table 4 under Maize annexure 20.1). Natural infestation was comparatively lower this year and selection could be done on the basis of artificial infestation.

4.3.2 Inauguration of maize stem borer mass rearing facility

Under AIP first maize stem borer mass rearing facility was inaugurated on Oct. 2016 by chairman, Pakistan Agricultural Research Council (PARC) and attended by scientists and stakeholders from the public and private sector and USAID. Among the other objectives of the facilities includes:

- Efficient and quality mass rearing of maize stem borer (*Chilo partellus*) in the laboratory
- Screen maize varieties for tolerance against *C. partellus* to minimize pesticide use, improve natural balance and enhance the activity of bio-control agents.
- Observe the biological parameters of *C. partellus* for properly and timely artificial infestation, and for proper control measures.
- Compare the yield losses/reduction due to *C. partellus* in susceptible and resistant maize varieties
- Capacity building of scientists, students and technicians for mass rearing of *C. Partellus* on natural and artificial diets

4.3.3 Promotion of hermetic storage technologies (metal silo) to reduce post-harvest losses and aflatoxin contamination

Metal silo at NARC with the capacity of 600-700 kg

Traditional storage practices leading to 20-30% grain losses, particularly due to post-harvest insect pests and grain pathogens. Mycotoxin contamination makes grain unsafe for food and animal feed, thus adversely affecting food and feed safety. To address this problem, a metal silo was developed as a valid option and proven effective in protecting stored grains from attacked by storage insect pests. AIP is promoting the hermetic storage techniques in collaboration with National Agricultural Centre (NARC)-Integrated pest management program (IPMP) and providing training to the farmers on the proper use of metal silos. AIP is in the process to engage private sector particularly maize food and feed processors on the dissemination of the technology

4.4 Enhancing the Maize Seed Sector

4.4.1 Seed micro increase for the newly introduced maize varieties

One of the major activities conducted was the start of seed micro increase of the parental lines/breeder seeds of the new maize hybrids and OPVs distributed to partners under AIP. A total of nine AIP maize partners (JPL, ICI, AAG, PSC- private; NARC, MMRI, CCRI, ARI-GB, ARI-Quetta- public) have produced the list of pre basic and parental seeds. These seeds will be utilized for demonstration, further seed multiplication and hybrid formation. In addition some of the seeds will be planted as demonstration plot and for the soft launch of the new products in various locations in Pakistan.

OPV/Hybrid/Parent seeds	Amount of seed produced (Kg)
TP1222	176
TP1220	113
TP1217	404
ZM 521	125
ZM309	519
CZP132011	500
CZP132001	125
TP1221	137
QPHM200	40
QPHM 300	40
CZP132006	13
ZM401	12
Parental seeds	173
Total seed produced	2377

Breeder seed and inbred lines produced under the AIP maize during Kharif 2016

4.4.2 Public private partnership under AIP Maize

AIP Maize is partnering with 22 partners including 12 private and ten public institutions. These partners actively involved in maize variety evaluation and validation process. Partners shared performance data of the different trials through the AIP platform. In addition, three private companies extended their services to AJ&K, GB and Balochistan province through the partnership created under AIP. Rafhan maize Co. and Petal Seed Company start testing maize products in Balochistan province in collaboration with ARI-Quetta. Similarly, Jullundur Private Limited starts collaboration in maize products testing in AJ&K and GB in partnership with Directorates of Agriculture.

Activities visit at the maize stem borer lab

Field evaluation of maize stem borer attacks

4.4.3 Capacity building activities

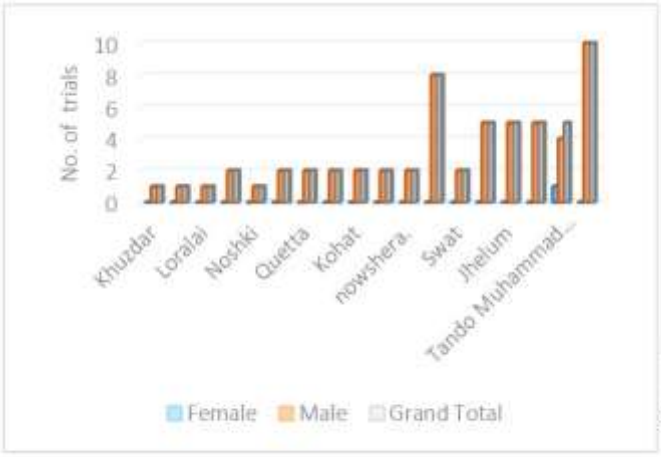
A total of 35 students included 17 female from different universities got on the job training in relation to maize trail management and data recording. These universities included UAF, Muhammad Nawaz Sharif University of Agriculture-Multan (MNSUA), Karakoram International University (KIU), UAP, Pir Mehar Ali Shah, University of Arid Agriculture-Rawalpindi (PMAS-UAAR),

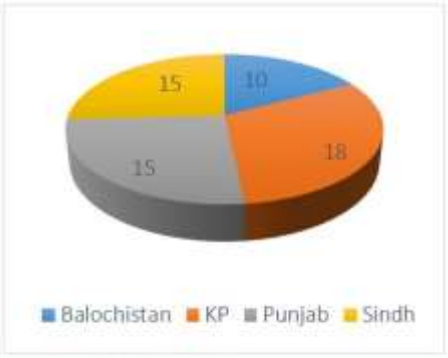
5 Wheat

5.1 5.1 Increasing Wheat Production through Rapid Diffusion of new High Yielding, Rust Resistant Wheat Varieties

5.1.1 Identification and validation of newly released wheat varieties through participatory varietal selection (PVS)

A total of 58 Participatory Varietal Selection (PVS) trials were conducted involving 15 new high yielding, disease resistant wheat varieties across KP, Punjab, Sindh, and Baluchistan provinces to validate their performances and farmers' preference locally (please see below pie chart and bar graph for district and province wise detail)





PVS trials 2016-17 wheat season across four provinces in Pakistan

The details of the PVS trails

Province	No. of farmers	Name of varieties	Name of Districts
Baluchistan	10	Umeed-16, Benazir-13, Phaktunkhawa-15, NIFA-Lalma	Khuzdar, Pishin, Quetta, Mastung, Killah Abdullah, Loralai, Noshki
KPK	18	Pirsabak-13, Pirsabak-15, Phuktunkhawa-15, NIFA-Lalma	Swabi, Chitral, Kohat, Swat, Nowshera, Lakki marwat
Punjab	15	Borlaug-16, Ujala-16, AAS-11, Zincol-16	Jhelum, Bhakkar, Sargodha
Sindh	15	NIA Amaber, Sunhari, Sarang, Benazir-13, Sindho-16, Zincol-16	Umerkoat, Tando Muhammad Khan

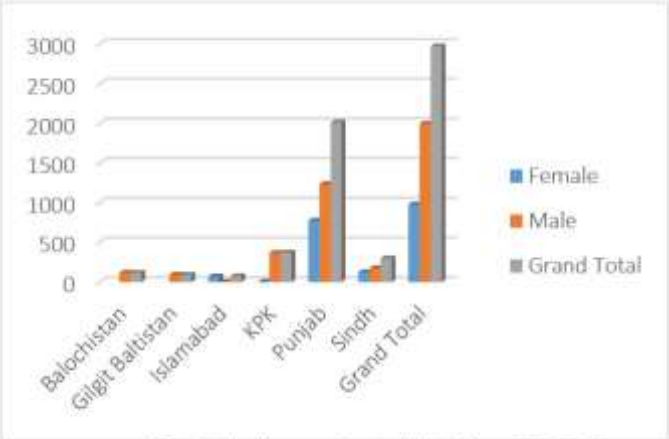
Distribution of number of specialized mother trials during 2016-17

The findings of the above research is being used to select best varieties for seed production stream and variety popularization, next crop season in 2017-2018. PVS Trial conducted in 2015-2016 proved very productive in validating new, high yielding and rust resistant varieties based on farmer's acceptance of these new wheat varieties. These PVS trials were instrumental in popularizing newly released wheat varieties and farmers preferred varieties in village-based seed production stream. It leads to increase access of farmers to new varieties rapidly in the far-flung areas where normally no formal seed sector is in operation. Ten wheat varieties out of 22 were evaluated in PVS and Diamond Trials during 2015-2016. Farmers demand increased for new wheat variety due to higher yield (5-30%) than currently grown varieties in the target areas. These varieties are resistance to rust and other diseases. They have good qualities for cooking and adaptation to rainfed or limited irrigation

conditions. Zincol-a zinc enriched wheat variety is one among those. Five Farmers Field days were organized to showcase PVS trails in Punjab and Sindh provinces in March 2017; a total of 150 farmers participated in these field days.

5.1.2 Fast tracking deployment of wheat varieties for delivering genetic gains to farmers fields and buffering possible incidence of wheat rust

A total of 2970 on farm paired plot demonstrations were conducted using Informal Research and Development (IRD) approach to fast track deployment of newly released, high yielding, rust resistant wheat varieties. The program focused on 2970 smallholders including 32% women farmers. The IRD were conducted in 33 districts include three districts of Sindh province, 16 districts of Punjab province, 11 of KP province and three districts in GB and Balochistan province. Each one engaged three Rural Support Programs (RSPs), included AKRSP, BRSP, NRSP, public and private sector partners. In addition to fast tracking genetic gains to the farmers' fields, this initiative has popularized 17 new wheat varieties suitable for irrigated and rainfed areas. These paired plot demonstrations created knowledge and increased demand for new varieties in far-flung areas of Pakistan.



Summary of IRD trials conducted during 2016-17 wheat season.

5.1.3 Creating knowledge on using new, quality seed and high yielding wheat varieties through Diamond Trials

Generally farmers limited access to newly released wheat varieties and not having opportunity to compare certified and farm saved seeds. Farmers (non-users of certified seeds) perceive that they may be growing best available wheat varieties in the country and does not see much value in fetching seeds from distant markets by paying higher price. Since quality seeds are not available to the farmers in their local areas in right time, and having high cost; as a result, their use is increasing at only a slow pace. For demonstration 50 Diamond Trials (2x2 factorial on farm trials) were conducted to establish the importance of new high yielding and disease resistant varieties with or without certified seeds (see box showing Layout of Diamond trial). Out of the 50 trials, 30 demonstrations plots are in Punjab 10 in KP and 10 are in Sindh Province by involving 50 farmers. This will create knowledge about the value of replacing old and obsolete wheat varieties

New variety with certified seed T1	Farmers' popular variety certified seed T3
New variety farmer saved seed T2	Farmers' popular variety farmer saved seed T4

Diamond trial and farmer field day at Barani Agricultural Research institute, Chakwal

by quality seed of new high yielding, rust resistant varieties . Most widely grown but rust susceptible varieties in each province were compared with new wheat variety with the objective of replacing the former by the later ones. Two farmers Field Days were organized on two diamond trials for popularizing new wheat varieties.

5.1.4 Production and provision of seeds of recently released wheat varieties through public-private partnership

Currently, 322 seed growers including 10% women are multiplying quality seed of 18 new high yielding, rust resistant wheat varieties covering about more than 174 ha (see below table). Keeping in view Pakistan national average wheat yield if we assume 3 t/ha production on an average for 2016-2017, its estimated average production will be 520 ton seed of new wheat varieties that will be available for the next wheat growing season.

Province	Female seed growers	Male seed growers	Grand Total
Baluchistan	0	50	50
Islamabad	3	5	8
KPK	0	81	81
Punjab	16	115	131
Sindh	14	38	52
Grand Total	**33**	**289**	**322**

Summary of province wise seed growers during 2016-17

A total of 322 seed growers given in above table and lead farmers are trained on hands-on skills of producing and handling quality wheat seeds in the villages. .

Seed production plots of new wheat varieties at farmer's field of Gujjar Khan

5.2 Effective Fungicides Introduced, Evaluated and Registered for Controlling Wheat Rusts

5.1.5 Yield loss Assessment of wheat due to rust disease using fungicides

A total of three fungicides included Folicur, Nativo and TILT approved by US Federal law for crop protection are being evaluated by AIP to establish the yield losses of wheat due to rusts that can be reduced using any of these fungicides in the event of sudden outbreak of wheat rusts in Pakistan.

Following up on two year studies by AIP in 2014-2016 during cropping seasons on reducing grain yield losses of wheat due to rust using fungicides, a total of 31 on-farm demonstrations on two most efficacious fungicides Nativo and Tilt were conducted. In Nowshera district, ten fungicide demonstration were conducted in collaboration with CCRI while one demonstration was conducted

at NARC. Similarly, 20 fungicides demonstration were conducted in Faisalabad and Bahawalpur districts with the support of WRI, Faisalabad and RARI Bahawalpur. The trails were conducted as superimposed trials. Farmers known to have grown one of the most susceptible varieties to one of the wheat rust were identified first. One acre plot of the farmers were divided into three equal portions and two of which were sprayed with either Nativo or Tilt while this plot was maintained as unsprayed control.

5.3 Development of durum wheat value chain

5.1.6 Durum Wheat National Uniform Yield Trial (DWNUYT)

Durum wheat is a new crop in Pakistan. Existing national initiatives on durum wheat will be capitalized for fast tracking durum wheat research for variety identification, possible release of new varieties, seed production and scaling up in most suitable areas for growing an economical crop of durum wheat. Producing adequate quantity of seeds and their dissemination in most appropriate regions for cultivating durum wheat will be in place.

AIP introduced durum wheat germplasm and tested for third year as DWNUYT which is conducted by National Wheat Coordinator, PARC in partnership with stakeholders in all four provinces. In the current season this trial is conducted at 11 locations across Pakistan. A total of 11 durum wheat lines were evaluated along with one bread wheat check (see below table). Field observations of the trial indicated that two to three durum wheat entries could be competitive with the best check varieties in the trial. Relatively there was less disease pressure on durum wheat lines compared to bread wheat.

S. No.	Locations of NUDWYT 2016-17	Name of entries included in NUDWYT 2016-17	Source of entries
1	NARC	D-13202	AARI, Faisalabad
2	NIA Tandojam	D-13206	AARI, Faisalabad
3	ARI, Quetta	D-13207	AARI, Faisalabad
4	NIFA Peshawar	D-13219	AARI, Faisalabad
5	WRI, FSD	NRD-03	NARC, Islamabad
6	AZRI, Bhawalpur	PRD-8	CCRI, Pirsabak
7	BARI, Chakwal	PRD-9	CCRI, Pirsabak
8	CCRI, Pirsabak	PRD-10	CCRI, Pirsabak
9	BARDC Quetta	PRD-11	CCRI, Pirsabak
10	WRI, Sakrand	PRD-12	CCRI, Pirsabak
11	RARI, Bhawalpur	PRD-13	CCRI, Pirsabak
Detail of entries included in NUDWYT 2016-17 and locations Detail			

All data of the trial will be available by the middle of June 2017 when the crop harvesting and threshing completed.

5.4 Identify best wheat varieties through laboratory analysis for product based wheat and popularize those among stakeholders in Pakistan

One of the emerging concerns of the stakeholders in Pakistan is identifying wheat varieties for processing, industrial utilization for baking, making biscuits, pizza and other products. The AIP project has initially capitalized on most recently released wheat varieties for the purpose. Higher-value application in nutrition, processing and end-use quality of most recently released bread wheat varieties will be identified to meet the requirement of industries using most efficient laboratory analysis techniques and organoleptic assessment involving public and private sector actors.

The objective of this above output was to identify wheat varieties with better nutritional and processing qualities for specific utility ultimately supporting wheat-based industries and business

communities. Processing and end use quality of at least 20 recently released bread wheat varieties (released after 2010) were analyzed to find out their gluten strengthens and extensibility along with other nutritional qualities. Two grain quality laboratories are working on the laboratory analysis included Food Quality & Safety Research Institute (FQSRI), Pakistan Agricultural Research Council (PARC), Karachi, Pakistan and Grain quality laboratory, Wheat Research institute, Faisalabad, Pakistan.

Laboratory analysis at Grain Quality Laboratory Faisalabad completed while in FQSRI Karachi is in progress. As soon as a results from both the laboratories are available a national workshop will be arranged to share all the findings from the research and would classify wheat varieties currently under analysis based on their suitability for different commercial products (Biscuits, Cakes, and Chapati etc.). The research protocols used will be useful for conducting similar research in future in Pakistan.

5.5 Capacity building Training

A total of 281 participants were trained representing Rural Support Program (RSP) staff, private seed company staff, seed growers, other farmers collaborating on various on farm research and demonstrations. Training of Trainers (ToT) was imparted on quality wheat seed production, wheat rust management, farmers' fields and exposure visits.

Training of trainers on quality wheat seed production, storage and marketing at BARI Chakwal March 22-23, 2017

6 Agronomy

6.1 Dissemination of Conservation Agriculture (CA) Technologies

AIP agronomy disseminated zero till wheat planting, ridge planting of wheat and LASER land leveling through **816** on farms demonstrations. A total of 225 national partners' agriculture professionals and farmers were trained. Moreover, a total of 33 farmer field days were organized for 3233 farmers in 32 districts of Pakistan that provided an opportunity to farmers to observe benefits of LASER land leveling, Zero tillage and ridge planting on their farms or fellow farmer fields.

6.1.1 Partnership for out scaling CA technologies:

AIP continued collaboration with 23 national partners for dissemination of ridge planting and ZT planting of wheat, local production of new planters, and efficient fertilizer management techniques for wheat in Pakistan. It includes partnership with 16 public sector agriculture research and extension organizations and seven private sector seed & fertilizer companies, machinery manufacturers and NGOs. These national partners are from the province included Punjab, Balochistan, Sindh and KP. These partners were trained on improved techniques and provided multicrop bed planter, zero tillage

drills and planters, zero till happy seeders, ridgers, green seekers & both technical and financial support for dissemination of technologies to farming community.

6.1.2 Demonstration of CA technologies:

National partner's collaboration namely AZRI Bhakkar, ARS Bahawalpur, NRSP, BARI Chakwal, Adaptive Research Punjab and WRI Faisalabad in Punjab; ARI DI Khan, CCRI Nowshera, Miankhel Seeds and MFSC – KP; Department of Balochistan Agriculture Research, ARI – PARC Jaffarabad in Balochistan and WRI – Sakrand, AZRI Umerkot and NSTHRI, Thatta in Sindh province assisted a total of 521 farmers in application of technologies like ZT wheat planting, Ridge planting of wheat and LASER land levelling in the project area.

a. In collaboration with national partners, farmers planted wheat with Zero Tillage (ZT) drill on 269 sites in Punjab, KP, Sindh and Balochistan provinces. Farmers experienced ZT wheat planting after rice on 215 sites in the districts of Jhal Magsi, Jaffarbad in Balochistan province, Thatta, Sujawal, Jacobabad in Sindh province, DI Khan in KP province, Faisalabad in Punjab province. ZT wheat planting after rice is expanding in Balochistan province and its potential area could be around 0.13 million ha in rice-wheat area of the Balochistan province. In addition ZT wheat planting after mung / guar crop was experienced by 54 farmers in districts of Bhakkar, Chakwal and DI Khan of KP province. Farmers have used ZT drills through service providers, community organizations and their own. ZT wheat planting technology after rice / legume crop has helped farmers in saving cost of land preparation and better yield.

Ridge planting of wheat at farmer field in Umerkot, Sindh

b. AIP facilitated 224 farmers to use ridge planting of wheat on their farms in the following districts;

- **Punjab province:** Jhelum, Sargodha, Bhakkar, Khushab, Bahawalpur, Mianwali, Bahwal Nagar, Lodhran, Vehari, Sheikhupura, Gujrat, Narrowal and Pakpattan
- **Sindh province:** Tando Allahyar, Mitiari, Shaheed Benazir Abad, Noshero Feroz, Umerkot and Thatta
- **KP province:** Mansehra, Kohat, Buner, Nowshera, Swabi, DI Khan and Lakki Marwat.

  Adoption impact of CA technologies and nutrient management at farm level survey indicated that farmers adopting ridge planting of wheat got PKR. 4000/acre profit mainly from saving in irrigation cost and yield improvement. Results also indicated that farmer in Punjab province had 10% or 0.35 t/ha and 16% or 0.58 t/ha more wheat yield in comparison with farmer practice of broadcasting.

c. LASER land levelling technology was demonstrated at 35 farms in DI Khan of KP province in partnership with MFSC–KP on more than 250 acres. In addition Mung –wheat demonstration on six sites in Rawalpindi area were also conducted. LASER land leveling benefit survey from Mardan, Nowshera and DI Khan indicated that farmer were leveling their field after two years and experienced improvement of 16% in grain yield and 29% in water saving. Maize growers and sugarcane growers adopting LASER land levelling in KP province earned benefit of PKR 8900 / acre and PKR 24000/ acre benefit in comparison with farmers not leveling their field.

6.1.3 Training of stakeholders on CA techniques

A total of five trainings were organized on November 4, 8, 10 and 11, 2016 in collaboration with national partners included ARS Bahawalpur, NRSP, AZRI Bhakkar and MFSC-KP in the districts of Bhakkar, Mianwali, Bahawalpur and Nowshera. More than 225 farmers, NRSP and MFSC staff attended these trainings with focus on Zero till wheat planting, ridge planting of wheat, wheat production technology including nutrient management for wheat. The trainings helped staff to guide farmers for adopting these technologies at their farms.

Dissemination of technologies through field days

National partners organized a total of 33 farmer's day provinces included two in Balochistan, four in Sindh, 3 in the KP and 24 in Punjab. The purpose was to disseminate improved techniques such as; LASER land leveling, ZT Happy seeder planted wheat, Zero till wheat planting after rice / mung / guar, Ridge planted wheat, Bed planted wheat, maize planting through push row planter and multicrop bed planter and Green Seeker nitrogen management in wheat. More than 3233 farmers attended these field days in districts of Jaffarabad in Balochistan, Mardan, Nowshera and DI Khan in KP province, Bahawalpur, Bhakkar, Rawalpindi, Sheikhupura, Lodhran, Sahiwal, Vehari, Gujrat, Nankana Sahib and Faisalabad in Punjab province and Shaheed Benazir Abad, Matiari and Tando Allahyar in Sindh province. Participating farmers had opportunity to observe field under improved practices, learn from adopters and technical experts that would help them in adoption of better management practices, improve wheat and maize productivity and save resources.

Farmer day on ridge planted wheat in Hala, Sindh

Farmers in field day on LASER land levelling in DI Khan, KP

6.2 Pilot Testing and Refinement of New CA-Based Implements and Technologies

AIP in collaboration with Petal Seeds Company and Sharif Engineering Works assisted in providing **55** planters that included **45** push row maize planters and **12** Zero till Happy seeders for wheat planting to farmers in Pakistan. A total of 95 Farmers planted maize and wheat with these **locally manufactured** planters in the Punjab, Sindh and KP provinces that included 66 Zero Tillage Happy Seeder (ZTHS) farmers, 13 bed planters and 16 push row planter farmers. More than 35 personnel were trained on use of small push row planter for maize planting and ZTHS for wheat planting in Punjab province that assisted partners to help farmers in experiencing these technologies at their farms.

6.2.1 Local manufacturing of new CA planters and evaluation

a. After successful evaluation of ZTHS at farmer fields during 2014-15 & 2015-16 wheat season, AIP, technical and financial support to Sharif Engineering resulted in manufacturing first local ZTHS that was also successfully evaluated in 2015-16 in Nanakana Sahib. On the recommendation of 2016 National Partners Meeting, AIP CIMMYT collaborated with Sharif Engineering Works, Faisalabad, and developed further refined lightweight ZTHS with nine rows. This locally manufactured ZTHS was demonstrated at RRI Kala Shah Kaku (KSK) on November 4, 2016 in a rice-wheat area national partners meeting. With the AIP support, Sharif Engineering manufactured and provided 12 ZTHS to 12 farmers on cost sharing basis in district Sheikhupura, Gujranwala, Sialkot, Lahore, Faisalabad, Jhang and Nankana Sahib in rice – wheat area of the Punjab province. Farmers shared 52% of the

cost whereas project support was 48 %. This technology enabled rice-wheat farmers to plant wheat in combine harvested rice fields through one operation without **burning of rice** residue.

b. AIP-CIMMYT in collaboration with Petal Seed Company continued for local production of this planter in district Mardan of KP province. With AIP financial and technical support, Petal Seed, a local private seed company in the province of KP, provided 45 push row planters to small farmers and MFSC in province of KP on cost sharing basis bringing total to 100. Farmers paid 20% of the cost of planter whereas project and Petal Seed contribution was 60 and 20% respectively. AIP provided 10 planters to Model Farm Services Centers located in districts of Nowshera, Swabi, Buner, Mansehra, Chitral and Swat in KP province. MFSC will provide these push row planters to small farmers for maize planting in autumn 2017.

Locally manufacture ZTHS tested in Sheikhupura

Figure 1Push row planter distributed to MFSC in Nowshera

6.2.2 Demonstration of New CA planter at farmer fields

Farmers used multicrop bed planters on 13 sites for maize and wheat planting. In addition, 16 small farmers planted spring maize with push row planter in the districts of Mardan, Swabi and Charsada in KP province. In rice-wheat area of the Punjab province, 66 farmers planted wheat with ZTHS in districts of Nankana Sahib, Sheikhupura, Gujranwala, Sialkot, Jhang, and Lahore of the Punjab province.

a) During 2016 wheat season, ZTHS technology was demonstrated on 66 farmer fields in collaboration with AR Farms Gujranwala & Sheikhupura, RRI–KSK, Engro Fertilizers and WRI – Faisalabad in the districts of Gujranwala, Sheikhupura, Nankana Sahib, Jhang, Lahore and Sialkot in rice-wheat area of the Punjab province. During impact assessment survey, 170 farmers including 56 ZTHS farmers in districts of Nankana Sahib, Sheikhupura, Gujranwala, Sialkot, Jhang, and Lahore of the Punjab province.

b) 2016 survey suggested that 89% ZTHS farmers were leaving rice residue in their fields whereas 92 % ZT farmers were burning and removing rice residue. In addition, farmers using conventional practice of wheat planting were burning and plowing rice residue in fields. Zero till Happy seeder adopter saved PKR 4065/ acre in land cultivation and planting cost and obtained 0.2 t / acre additional wheat grain yield in comparison with farmer practice of burning residue and heavy tillage. Furthermore farmers and service providers indicated that they saved 14 liter diesel per acre with ZTHS technology in comparison with farmer practice. Most of ZTHS farmers planted two acre with ZTHS, 7.5 through FP and 9.5 acre with ZT that showed that ZTHS farmers were mostly ZT technology adopters and they have shifted from ZT to ZTHS.

Planting of wheat with ZTHS in combine harvested rice residue

c) During 2016 rice season, 55 DSR farmers planted rice with Multi Crop (MC) ZT planter in the districts of Jafarabad in Balochistan province, Shikarpur in Sindh province; Sheikhupura, Sialkot, Gujranwala, Nankana Sahib, Multan, DG Khan and Jhang districts in Punjab province. Farmer planting rice with MCZT planter had 4.0 t/ha of rice grain yield in comparison with 3.8 t/ha with DSR drill. However, rice yield with transplanted rice was 3.5 t/ha. Results also supported that better rice plant population was achieved with MCZT planter and reduction in basmati seed breakage. DSR farmers had PKR. 5000/ acre of profit in comparison with traditional practice of rice transplanting. DSR farmers has PKR 714 per acre higher cost for seed and herbicides, however lower labor cost for planting operation and saving in irrigation cost that resulted in this profit.

Maize planting with push row planter in Mardan, KP

d) Around 206 smallholder farmers used push row planter on 400 acres in the districts of Banuu, Bunir, Charsada, Dir, Dir Bala, Hazara, Malakand, Mardan, Nowshera, Peshawar and Swabi in the KP province for autumn maize 2016. The farmers using push row planters, planted more area in less time, better plant population and received 3.2 t/ha maize grain yield.

6.2.3 Training of Stakeholders on New Seeders

Training cum demonstration on ZTHS wheat planting was organized at RRI – KSK on November 4, 2016 that was attended by 21 agriculture professionals and operators. AIP-CIMMYT in partnership with Sharif Engineering trained 10 operators / farmers at their farms regarding operation and maintenance of ZTHS.

Training on wheat planting with ZTHS at RRI, Kala Shah Kaku

6.3 Evaluation of Conservation Agriculture-Based Crop Management Techniques Methods in Different Cropping Systems:

6.3.1 Field trials in wheat based cropping systems in Pakistan

Field trials have completed two cropping system cycle (two years) and being continued in rice-wheat, maize-wheat, cotton-wheat and rain fed wheat cropping systems in partnership with national partners namely ARS Bahawalpur, BARI Chakwal, RRI Kala Shah Kaku, and CCRI Nowshera. These trials supported validation of new techniques, improved understanding on planting techniques effects in a particular cropping system perspective. After two years, finding are as under:

1. **Evaluation of Different Planting Methods/Techniques in Cotton-Wheat System at ARS Bahawalpur, Punjab Province:** Wheat planted as relay crop in standing cotton on beds or ridges had grain yield of 5.0 t/ha in comparison with 4.0 t/ha with farmer practice of wheat planting in prepared land after cotton harvesting.

2. **Effect of Planting Techniques on the Productivity of Different Rain-Fed Cropping Systems at BARI Chakwal, Punjab province:** Wheat planted after mung bean and incorporated green manure crop had 2.7 t/ha of grain yield. However, addition of 1 t/ha of mung bean from mung - wheat system resulted in 1.0 t/ha higher system productivity in comparison with green manure –wheat and fallow – wheat system with ZT and conventional planting techniques.

3. **Evaluation Of Different Residue Management and Planting Techniques Under Heavy Residue Environment Of Rice-Wheat Cropping System at RRI KSK, Sheikhupura, Punjab province:** After two year trial, direct seeded rice (DSR) followed by ZTHS wheat in residue had highest system productivity of 7.4 t/ha in comparison with other planting systems that included 3.7 t/ha of rice and wheat yield. Basmati Rice yields were higher with transplanted rice in comparison with DSR. Wheat yield were 3.7 t/ha in plots planted with ZTHS in residue in comparison with 3.2 t /ha with conventional planting.

4. **Effect of Planting Techniques such as ZT, Bed Planting and Farmers' Practice on The Productivity of Irrigated Maize-Wheat Cropping System in Nowshera District of KP Province:** Maize grain yield with bed planting and farmer practice was 4.3 t/ha, there was 25% of saving water with bed planting in comparison with farmer practice. Wheat grain yield was 3.5 t/ha with ZT in comparison with 2.9 t/ha of bed planting and farmer practice. Water use efficiency in bed planting was higher in comparison with farmer practice and ZT.

5. **Evaluation of mung – wheat cropping system in rainfed area of KP province:** Results indicated that mung bean - wheat system had higher system productivity in comparison with fallow – wheat system. Inclusion of mung bean in rain fed system added 0.8-1.4 t/ha of mung bean in system productivity. Wheat planted after land preparation and with Zero tillage had grain yield of 3.1 and 2.8 t/ha.

6.4 Nutrient Management

During wheat season of 2016, national partners facilitated 200 farmers in demonstration of improved nutrient management in wheat on their farms. AIP provided 14 Green Seekers to national partners in Balochistan, Sindh, KP and Punjab provinces and trained 64 agriculture professionals on use of Green Seeker for Nitrogen management in wheat. The technologies would help in promotion of balanced and site specific fertilizer management among farming community leading to reduce input cost and improve wheat productivity.

6.4.1 Evaluation and demonstration of Site Specific Nutrient management (SSNM) in collaboration with national partners

a. **Green seeker use for N management in wheat:** After evaluation of crop sensor use for N (nitrogen) management in wheat during 2014-15 & 2015-16, CIMMYT expanded its partner network from 04 to 20 for 2016-17 wheat season. Under this activity, eight partners from Punjab, six from KP, three from Sindh and two from Balochistan provenience established demonstrations on 115 farmer fields on use of Green seeker for N management in wheat in 22 district in the project area (given in below table).

Crop sensor managed urea application in Mureedkai, Sheikhupura

Province	Partners	District
Punjab	ARS – Bahawalpur, AZRI- Bhakkar, RRI – Kala Shah Kaku, NRSP, Wheat - NARC, Adaptive Farms Punjab; Engro Fertilizers and WRI – Faisalabad	Nankana sahib; Sheikhupura; Gujranwala; Mandi Bahauddin; Faisalabad; Chiniot; Vehari; Sahiwal; Jhelum; Mianwali; Hafiz Abad; Sargodha; Bhakkar;
KP	ARI – DI Khan; CCRI – Pirsabak; Miankhel Seed – DI Khan, MFSC – KP and NIFA – Peshawar, NRSP	Nowshera, Peshawar, Swabi and DI Khan

Sindh	AZRI – Umerkot; NTSHRI – Thatta; WRIS – Sakrand	Umerkot, Shaheed Benazir Abad, Thatta
Balochistan	DAR – Balochistan; ARI – BARDC	Jaffarabad
National partner's collaboration on Green Seeker use for N management in wheat		

Use of crop sensor in combination with android application on more than 35 farmer fields in 2016 results showed that 35 kilograms of nitrogen per hectare could be saved without any loss in grain yield. This saving would be 76 Kg of Urea fertilizer per hectare and farmer can save PKR 3000 / ha in fertilizer cost without reduction in yield.

b. During autumn 2016, use of Leaf Color Chart (LCC) for nitrogen management in rice was demonstrated and LCC were provided to more than 800 farmers Gujranwala, Sheikhupura, MB Din, Hafiz Abad, Nanakana Sahib, Sialkot, Narowal, Gujrat and Jaffarabad. Results from farmer fields in Sheikhupura, Faisalabad and Gujranwala showed that farmer had 4.3 t/ha of rice yield that was at par with farmer practice. Farmers also saved **38 Kg N per hectare** that was equivalent to 82 Kg of Urea per ha (33 kg of urea per acre) in LCC managed rice plot in comparison with farmer practice of general recommendation.

6.4.2 Training on precision nutrient management in wheat

CIMMYT-India and the Borlaug Institute for South Asia (BISA) have developed the application "urea calculator" for cell phones. In this process, a Green Seeker handheld crop sensor quickly assesses crop vigor and provides readings that are used by the urea calculator to furnish an optimal recommendation on the amount of nitrogen fertilizer the wheat crop needed. AIP-CIMMYT initiated widespread evaluation of this technique in four provinces of Pakistan, providing 16 Green Seekers and training to AIP research, extension and private partners. AIP-CIMMYT in collaboration with national partners organized trainings on precision nutrient management in wheat at WRI Sakrand, Sind Province on 28 December 2016, Rice Research Institute KSK in Punjab Province on 05 January 2017 and the Model Farm Service Center, Nowshera, KP province on 12 January, 2017. In these training events, 64 agriculture professionals of national partners were trained on use of green Seeker for NDVI recording and use of Android application urea calculator for calculation of nitrogen fertilizer dose. These trainings and new partnerships will help national partners to demonstrate and disseminate sustainable farming practices to wheat farmers across Pakistan.

Green Seeker use in wheat training in Nowshera, KP

Training on Green Seeker use in wheat in Sakrand, Sindh

7 Rice

7.1 Breeding Program for Improved Indica and Basmati Rice

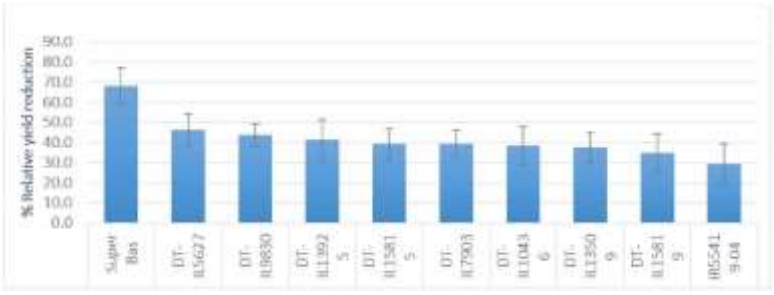
7.1.1 New Generation of High-Yielding, Stress-Tolerant, High-Quality Basmati Varieties

A total of **187** lines were selected out of 824 lines which were evaluated at Rice Research Institute (RRI), Kala Shah Kaku against biotic bacterial leaf blight (BLB) and abiotic (flood/submergence, drought, salinity and heat) stresses tolerance, yield potential and grain quality. Of the selected lines, 101 were high yielding elite, 53 were Super Basmati bacterial leaf blight (BLB) resistant, 23 tolerant to drought and salinity, and 10 lines of IR-6 Sub1 for submergence tolerance. These lines were used to develop 42 new fresh crosses during 2016 for BLB resistance and submergence and salinity tolerance, high yield at RRI-KSK.

From IRRI breeding lines (117), NIBGE, in Punjab province has selected 23 breeding lines (9 from Irrigated, three from Drought, four from Magic, three from BLB and four from SB-BLB Super Basmati) with good agronomic characters which were selected on the basis of good performance in 2015 and use in breeding program for developing new varieties in 2016. From the 23 lines selected, six lines were with high yield and identified desirable characters and were selected for further agronomic trials in rice growing area of Punjab province.

NIBGE has developed one BLB resistant **variety BR-1** by using IRRI breeding material and tested through coordinated yield trials by the Rice Research Program. The different trial locations included NARC, RRI-Dokri, Sujawal, Tandojam, adaptive research farm Gujranwal, RRI-KSK, and NIBGE, Faisalabad. They observed an increase of 27.8% over the average yields by BR-1 against Super Basmati. NIBGE has developed 49 BLB resistant backcross inbred lines (BILs) with different combinations of three *Xa* genes for BLB resistance by using IRRI breeding material.

NIBGE is developing climate-smart crops or lines with combined bacterial leaf blight resistance, drought, and salt tolerance genes in Basmati background, through marker assisted backcross breeding approach. Eight lines are currently being evaluated for their yield performance and grain quality parameters (see below figure). For salinity tolerance, Basmati quality parameters are being estimated for the F3 lines developed from the cross of FL478 salt tolerant donor line (non-Basmati) and the BLB resistant lines in Super Basmati background (developed from the cross Super Basmati x IRBB57).



Percentage of relative yield reduction of drought-tolerant inbred lines

The RRI, Dokri, Sindh evaluated the IRRI breeding materials having submergence (submerged 15 days under water and then receded the water), drought, salinity, and heat tolerance genes or QTLs. The results of 2016 evaluation indicated that many lines carrying submergence tolerance in the background of Sabitri Sub1 (Nepal) and IR6-Sub1 showed higher yield potential of 6200-7250 kg/ha than the local check varieties; DR-83 showed yield of 5000 and 5825 kg/ha, respectively. From the IRRI breeding materials carrying heat tolerance, all lines showed higher yield potential (5000-7750 kg/ha) than the local check variety IR-6 (5250 kg/ha) except one line having the lowest yield of 4250 kg/ha.

7.1.2 Up-scaling of High-Yielding New Rice Varieties

Seed Distribution for Up-scaling of High-Yielding New Variety Sawati 14 in KP, Province

Under this activity, 200 kg seed of new variety **Sawati-14** were distributed among 50 farmers, adapting new resource saving Direct Seeded Rice (DSR) as a rice production method of Batkhela, Malakand

2014 **2015** **2016**

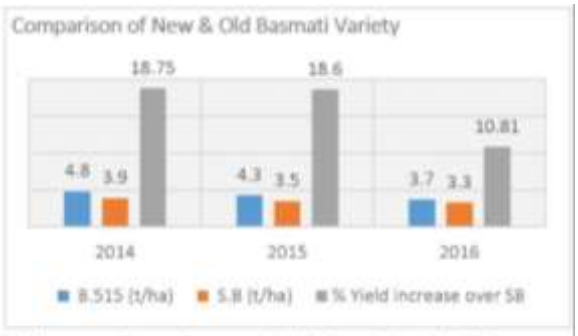
Basmati-515 seed distribution

Comparison of different rice planting methods

Agency, and Aligrama Swat, in KP province. DSR Training sessions were arranged for the beneficiaries. All processes of rice cultivation using DSR method was explained to farmers before sowing of plots.

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

A total of 1 MT Certified Seed of Basmati 515 were distributed among 1142 rice growers in Basmati Rice Core Area in 2016 in districts Sheikhupura, Lahore, Sahiwal, Kasur, Gujranwala, Mandi Bahauddin, and Sialkot, Punjab province. Comparison of new basmati variety (Basmati 515) with old Basmati variety (Super Basmati) was demonstrated at 1475 farmers' field in basmati areas included Sheikhupura, Sialkot, Mandi Bahaudin & Gujranwala in Punjab province to determine the yield difference. The average data of 50 supervised sites/plots in 2014-2016 were reported as given in the figures.



Yield comparison of new and old Basmati variety (Source: Mr. Mumtaz Ahmad, Engro Fertilizers Ltd.)

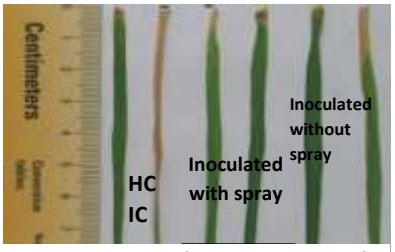
Yield demonstration on OPPM

Less than 80,000 plants/acre was identified as a major constraint in yield potential of basmati varieties under transplanted/conventional rice systems. Survey conducted by Engro and RRI-KSK during 2014-2015 showed that average number of plants were 50,000-60,000 per acre. However, Optimum Plant Population Management (OPPM) was included in AIP Project to enhance the basmati yield. For this purpose, 1042 farmers, and 100 transplanter-laborers were trained on OPPM (as given in below photos). These demonstrations were conducted at 225 sites. Average yield data of 10 directly supervised demonstration sites (plots) in the vicinity of Engro Seed and research and development farm were taken under AIP Project.

7.2 Improved Crop Management

7.2.1 Use of bacterial growth promoting biocontrol agent to increase grain yield and suppression of BLB in rice

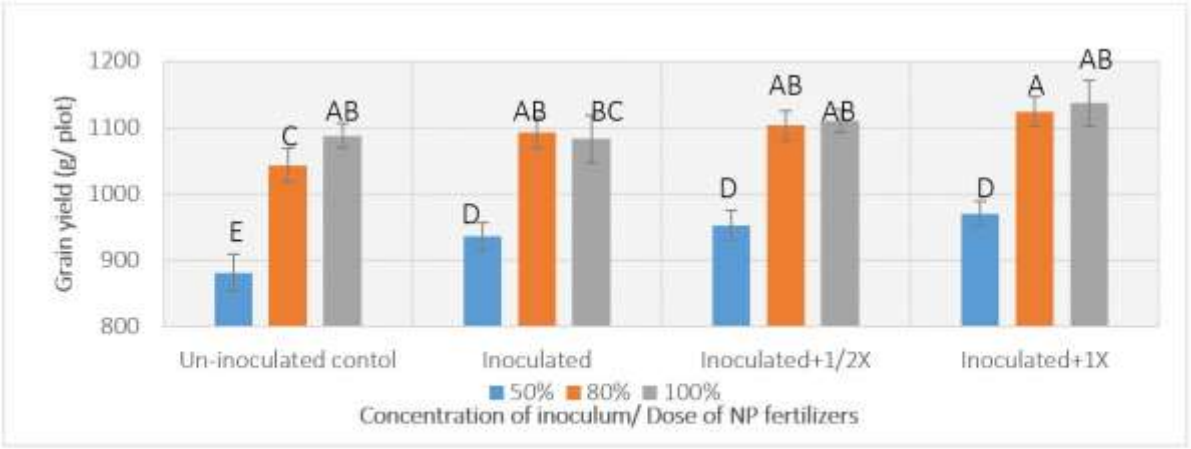
Assessment of antagonistic strain BRp3 0.1% was done at booting stage of rice variety Super Basmati in 2016 at NIBGE, Faisalabad. BLB pathogen *Xoo* was used for clip-inoculation at booting stage. Application of bacteria-based formulation significantly reduced diseased leaf area (DLA) ranging from 19 to 31% with infected control (39%). Maximum reduction in disease severity was recorded by foliar application of full strength bacteria-based formulation with 19.6 % DLA. The results of *in vivo* evaluation of biocontrol activity suggested that plants inoculated with bacterial antagonist showed reduced disease incidence against *Xoo* pathogen compared with infected control (39%). Maximum reduction in disease severity was recorded by foliar application of full strength bacteria-based formulation with 19.6 % DLA.



Suppression of bacterial leaf blight in rice in response to different treatments of antagonistic bacteria

The results of *in vivo* evaluation of biocontrol activity suggested that plants inoculated with bacterial antagonist showed reduced disease incidence against *Xoo* pathogen compared with infected control.In addition to suppressing the disease, the bacterial inoculant was also studied for different growth parameters. Grain weight per plot was maximum with inoculation i.e. 1130 g/ plot applied with one time (1X) formulation and recommended doses of nitro-phos (NP) fertilizers followed by plants treated with 1X formulation and 80% NP. Minimum grain yield (881.6 g/ plot) was observed for non-inoculated control plots supplemented with 50% NP.

The product designation, *BioPower*, with biocontrol potential and BLB resistant line BR-1 were evaluated to enhance the plant growth promotion with reduced disease incidence of bacterial leaf blight (BLB). Field evaluation was carried out at NIBGE, adaptive research centers of Shiekhupura and Gujranwala and RRI, Kala Shah Kaku, Lahore. Antagonistic *Pseudomonas* sp. BRp3 applied as foliar spray in combination with a binding agent CMC showed 5% increase in grain yield of Super Basmati at Gujranwala with reduced (20%) application of chemical fertilizer. Field evaluation of BioPower with biocontrol potential and BLB resistant line BR-1 showed 2-13% increase in grain yield with reduced (20%) application of chemical fertilizer of N P.



Effects of bacteria-based formulation on grain yield of rice in the presence of Xoo pathogen (Micro-plots experiment)

7.2.2 Pathotyping of 300 *Xanthomonas oryzae* pv. oryzae isolates in Punjab

Types/Isolates were evaluated on a set of six rice differentials IRBB-4 (*Xa4*), IRBB-5 (*xa5*), IRBB-10 (*Xa10*), IRBB-11 (*Xa11*), IRBB-62 (*Xa4*, *Xa7*, *Xa21*) and IR-24 (parent) and categorized into 29 pathotypes on the basis of their virulence levels. This identification of pathotyping will help in developing BLB resistant lines against any specific or combination of pathogens. A set of 12 Near Isogenic Lines (NILs) and 18 pyramid lines along with their parent IR24, provided by IRRI HQ (Philippines), was evaluated at BLB hotspot area of district Gujranwala under natural field conditions. All the NILs and gene pyramids expressed resistant reaction. Among those, 12 were resistant and 18 were moderately resistant against *Xoo* while the parent IR24 was found moderately susceptible. In case of single genes, *Xa*21, *xa*13 and *Xa*23 were found more effective while among the pyramids, IRBB57 (*Xa4+xa5+Xa21*) was found most effective against BLB disease.

7.2.3 Demonstration of Resource Conservation Techniques (RCTs) in Rice Alternate Wetting & Drying (AWD),

A resource conservation technology in rice, was demonstrated at 500 farms in different districts of Punjab province, to save water–a vital input of agriculture. For this purpose, 500 farmers were trained on AWD Pipes installation and water measurement through the use of flume, water level measurement in AWD Tube and on water application methodology along with provision of free AWD water tubes. Average yield data of 10 demonstration plots were compared, the yield of AWD plots with conventional system of irrigation. Advantages of AWD include water saving, lodging prevention, synchronized maturity, increased yield and therefore increase profit.

Measuring the depth of water level in AWD pipe

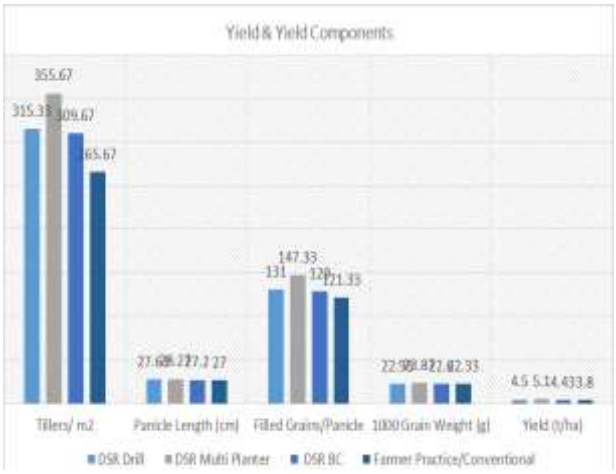
7.3 Direct Seeded Rice (DSR) in KP Province

In KP, 81% of the rice acreage lies in high altitude, cold and mountainous areas where cold damage to rice crop is a problem to growers. Mostly coarse varieties (Fakhre Malakand and Swatai 2014) are grown in the cold climates. The farmers in these areas normally use transplanting as method of cultivation in rice. DSR is cost effective and less time consuming method, thus giving enough time to sowing of subsequent wheat. Also 75% less labor is consumed in DSR over transplanting and most importantly water which is getting a scarce commodity in these areas is saved. Farmers can save up to PKR 15,000 per acre in DSR over transplanting with comparatively less or no reduction in overall production.

Free distribution of input for DSR demo

In KP province demonstration of DSR were conducted at 50 farmers' field with Fakharay Malakand and Swatai 2014 in the rice growing belt of Malakand Agency and Swat district. For adoption of DSR, inputs were distributed among 50 farmers with package per plot included, rice seed 4 kg, urea 1/2 bag (25 kg), ssp 1 bag (50 kg), karate 1 bottle (350 ml), furadan 4 kg, vinsta 1 pack (weedicide)

A total of 50 plots produced excellent yields of about 7-10 maunds (350-500 Kg) paddy seed per kanal. Most of the farmers were enthusiastic about the new method of cultivation and were intending to grow rice with DSR method next year. A total of 40 multi-crop planter seeding drill for DSR and 20 Rubi Drills used for wheat and rice were purchased by farmers during the year 2016. In the year 2017, up to March 31, a total of 102 farmers have purchased this new inclined plate multi crop seeder from Green Land Daska, District Sialkot. This Drill became successful and popularized, not only in AIP Project Area but also in Sind and Baluchistan Provinces. DSR demonstrations were conducted at 3500 farmers' field in eight districts included Sheikhupura, Nankana Sahib, Lahore, Sahiwal, Kasur, Gujranwala, Mandi Bahauddin, and Sialkot, Punjab province . DSR crop established by varying DSR methods, such as DSR by DSR drill, by multi-crop planter, by broadcasting (BC) was compared with farmer's conventional method of rice transplanting. Average farmer yield is higher in DSR plots than conventional method of transplanting



Yield and yield components of DSR established by varying DSR methods

(given in the figure). Furthermore, farmers have got benefit of PKR 10000-15,000 per acre by saving the fuel, labor and water.

Farmers Field Day on rice crop using DSR method of rice cultivation at ARI, Mingora, Swat.

Farmers' Field Day on using DSR method at

A field day was conducted at the ARI, Mingora on October 3, 2016. A total of 82 farmers were briefed on production technology, benefits and constraints of direct seeding method in rice cultivation, proper management of soil and judicious use of fertilizers, insect pests and diseases occurring on rice crop and control measures. The farmers visited field where different activities conducted under rice AIP component. Another Field day at farmer's field of Mr. Zarawar Khan was conducted on September 26, 2016 at Khar Batkhela, Malakand Agency and was attended by 60 farmers. The farmers were briefed about the benefits, constraints of DSR method of rice cultivation and farmers visited fields as well.

The third Field day was conducted at the field of Mr. Qajeer Khan, Aligrama Kabal Swat, attended by 64 farmers. The farmers were briefed about the benefits, modern rice production technology and constraints of DSR method of rice cultivation.

7.3.1 Capacity Building: Training Imparting to Extension Officers

Group photo of Participants

Training was organized for 90 Rice Researchers and Extension Officers on January 19, 2017 on Resource saving improved rice production technologies to prepare them as master trainers for Punjab province. Punjab is the only province suited for producing and exporting the Basmati rice. Rice dry-seeding drill with inclined plates, specifically designed for DSR and plastic pipe for AWD, were displayed at the venue for introduction.

7.3.2 Workshop on harvest, post-harvest operations of quality paddy production

A one-day training-workshop was organized on March 4, 2017 on the Role of Quality Paddy Harvest

Farmers' Field Day program on rice crop using DSR method at Khar Batkhela, Swat

and Postharvest Processes in Alleviation of Poverty, and Aflatoxin contamination and Enhancing Quality Basmati Export. Training was organized in collaboration with Engro Fertilizer Ltd. Sheikhupuram Punjab province. The objective of the training was to emphasize the role to be played by the farmers, farm support workers, harvester owners and buyers (Millers /Exporters) and to improve grain quality and maintain the standard for Basmati exports. A total of 114 stakeholders

attended workshop to serve as master trainers to train other farmers of their respective fields to produce good quality paddy with limited resources. Wheat combine harvester's owners shared their views on the importance and role of standard rice kit in reducing the grain falling/losses in the field, broken grains and de-husking. Combine harvester's owners, operators, and rice buyers highlighted upon the importance of machine speed (should be slow) and time of harvesting (should be between 11 am to 5 pm) to avoid the grain and quality losses. Over all, the participants have developed consensus, that the Government and buyer should fix the paddy price according to the paddy moisture percentage to assure the farmers that they will get the proper and higher price for dry paddy.

7.3.3 Capacity Building Training program

AIP-IRRI organized a training on March 10, 2017 for a total of 80 Researchers, Extension Officers, and Progressive Growers on Resource Saving Rice Production Technologies in collaboration with RRI, Dokri, Sindh Province. It is anticipated that farmers will adapt new and improved resource saving rice production technologies and more land area can be brought under rice cultivation with same water and labor resources.

7.3.4 Workshop on Management of Bacterial Blight in Rice

Workshop was organized on March 27-31, 2017 to equip young researchers from partner institutions with knowledge and techniques to build and maintain a strong breeding program for improving indica and Basmati rice in Pakistan. A total of 11 participants from RRI, NIAB, NIBGE, NARC; SSRI and Engro

Identification and collection of leaf sample infected with bacterial blight.

Participants performed techniques in working with the rice

Fertilizer Ltd attended the workshop. The researchers gained experience in field disease diagnosis and assessment pathogen isolation, culture collection and maintenance. They also learned about molecular approaches for detection of pathogens, advanced breeding technologies for indica and Basmati rice for enhanced resistance to diseases (BB) and tolerance to abiotic stresses (submergence, drought, salinity). Additionally, the accomplishments on improving crop management, dissemination of resource-saving rice production technologies (DSR & AWD) in different rice ecologies in Pakistan, and dissemination of drum seeder rice production technology was consolidated and presented at the workshop by all AIP partner-participants.

8 Vegetables

8.1 Protected Cultivation of Vegetables

Protected cultivation focus was to improve cultivation under plasti-culture (protected cultivation) in Punjab, KP and Balochistan provinces. Six partner research institutes included ARI in Mingora; VRI, Faialabad; ARI, DI Khan; ARI, Quetta; Nuclear Institute for Agriculture and Biology (NIAB) Faisalabad

and Vegetable NARC, Islamabad are evaluating vegetable varieties on-station and on-farm in collaboration with farmers and the private sector.

Farmers were trained on the use of plastic tunnels, improved production and integrated pest management practices under four activities;

- Identify and promote the best varieties of crops commonly grown under protected cultivation
- Improve insect and disease management to reduce pesticide use in protected cultivation
- Identify and promote new crops for protected cultivation with higher economic returns
- Identify and promote improved protected cultivation systems.

8.2 Identify and promote the best varieties of crops commonly grown under protected cultivation

This activity included the following sub activities.

8.2.1 On-station Validation Trials

A total of 10 trials with 32 varieties and hybrids under two different planting conditions at 10 locations carried out in collaboration with provincial partners. Advanced lines of tomato, cucumber, sweet pepper, chili, and onion were planted last year and sufficient quantity of seed was produced for further trials. This material and commercially available varieties /hybrids are being evaluated for adaptability, yield and disease attack through on-station validation trials in different institutes in Punjab, KP and Balochistan provinces. Details are given in below table.

Crops	**Protected Cultivation**			**Normal Growing Season**		
	Variety / hybrid	Trial	Location	Variety / hybrid	Trial	Location
Tomato	7	5	5	5	1	1
Cucumber	6	1	1			
Sweet pepper	1	1	1			
Chili	3	1	1			
Onion				10	1	1
Total	17	8	8	15	2	2
On-station validation trials of vegetable varieties and hybrid						

a) Protected cultivation under plastic tunnels

Tomato is grown in different growing seasons across Pakistan. The seven best performing indeterminate hybrids; Sahil, Deenar, Anna, Sallar, APCL, Lima, Yanki were planted in Islamabad, Faisalabad, DI Khan and Quetta. A few fruit pickings completed in Islamabad, Faisalabad & DI Khan but nursery seedlings are just transplanted in March, 2017 in Quetta. The best determinate hybrids were evaluated at NIAB, Faisalabad on station yield trials for last 2-3 years (2014-15 &2016-16) followed by multilocational trials conducted by the Vegetable Research Institute, Faisalabad in Punjab province. The candidate hybrids; NBH-2, NBH-25, NHB-7 and NBH-3 scored the top four positions in yields compared to the standard commercial hybrid T-1359 over the last two year (2015-2016). The hybrids NBH {2, 3, 7 & 25} were classified as moderately resistant to early and late blight diseases. Hybrid NBH-3 registered the minimum (1.2 %) fruit borer attack, followed by NBH-25 (1.5 %), NBH-15 (1.8 %) and NBH-7 with 3.4 % against T-1359 that was affected at a level of 5.1 %. These hybrids and their inbred parents have already been registered with the FSC&RD in Islamabad after two years of required specialized testing known as Distinctness Uniformity and Stability (DUS) testing.

Currently, the hybrids **NBH-2** and **NBH-25** grown at NIAB, Faisalabad and in farmers' fields for spot examination before the technical members of the Punjab Seed Council to get approval for general cultivation in Punjab province. Six cucumber hybrids/varieties; Beauty Queen, Yousaf, Waleed, DS-

Indeterminate tomato hybrids; Sahil & Deenar at NARC, Islamabad

Determinate tomato hybrids; NBH-2 and NBH-25, NIAB, Faisalabad

9786, Charmain and Mehran were planted during February, 2017 in Quetta, Balochistan province. Nurseries of varieties/hybrids of Sweet pepper (California wonder) and chili (Red Devil, PARC, Talhar) are in the field and will be transplanted later in March, 2017 in Quetta Balochistan province.

b) Normal season

A total of 10 advanced onion lines (AVON 1073, AVON 1301, AVON 1013, AVON 1014, AVON 1016, AVON 1037, AVON 1028, AVON 1027, AVON 1067, AVON 1056) acquired from WorldVeg headquarters are being evaluated by the Directorate of Vegetables, NARC, and Islamabad. A nursery was raised in October, 2015 and used to grow a crop for seed production in autumn 2016. Seeds were sown in November 2016 for a nursery and the crop will be ready in late June, 2017.

8.2.2 On Farm Adaptability Trials

A total of 18 on-farm adaptability trials with 32 varieties / hybrids of tomato, cucumber, sweet pepper, chili, bitter gourd and vegetable marrow conducted in collaboration with provincial partners (ARI in Mingora; VRI, Faialabad; ARI, DI Khan; ARI, Quetta; NIAB, Faisalabad and Vegetable NARC, Islamabad) under protected structures and natural off-season conditions at 18 locations.

Crops	Protected cultivation under plastic			Natural off- season		
	Variety / hybrid	**Trials**	**Locations**	**Variety / hybrid**	**Trials**	**Locations**
Tomato	6	6	6	4	2	2
Cucumber	7	3	3			
Sweet pepper	3	2	2			
Chili	3	2	2			
Bitter gourd	3	2	2			
Vegetable marrow	6	1	1			
Total	28	16	16	4	2	2

On farm adaptability trials of different varieties /hybrids of vegetable crops

a) Protected cultivation under plastic tunnels

Tomato: In continuation of the previous years' trials, six tomato hybrids (two public hybrids; Sallar& Sandal and four commercial hybrids; Anna, APCL, Deenar&Sahil) were planted at different location of Punjab, KP and Balochistan provinces. All trials are still in the fields in Bhikhi-Sheikhupura, Chevanda-Faisalabad, Noorpur Thal, Islamabad, Haripur, Mingora-Swat and Quetta, Balochistan province.

Cucumber: Seven commercial hybrids (Yousaf, Saad, Waleed, Yala, Nobel F1, Charmain, and Mehran) were tested for yields and other horticultural traits at three locations across Balochistan and Punjab provinces.

Sweet Pepper: Four hybrids; Orobelle, Bonus, Extra-2 and California wonder were the best

Tomato hybrids Sahil at KallarSyeda

Cucumber hybrids Waleed at Chevanda- Faisalabad

Women are picking sweet peppers at Chevanda-

performers across locations and years. While Extra-2 yields better than Orobelle, it is late maturing and receives a lower price. Like Sweet pepper, **hot chili** is also planted by 27 farmers in potential cropping areas of Bhikhi-Sheikhupura and Gojra of Punjab province. Based on pickings, the best performers were P6, P-410 and Golden heart.

Bitter gourd: Three hybrids; Palee, BG-034, TS-222 were evaluated against the local variety Kala Karela in Bhikhi-Shiekhupura, Gojra-Faisalabad, Punjab province.

Vegetable Marrow: Six hybrids (Sanam, liza, Jalal, Starex, Charisma) were planted in DI Khan, KP province and the maximum fruit pickings were recorded in Sanam as compared to others.

b) Natural Off Season

The adaptability of commercial tomato hybrids to natural off-season cultivation was evaluated in two locations; ThohaMehram Khan-Talagang and KhathaSaghral-Khushab. Tomato pickings were completed in mid-December, 2016 and the performance of Hybrid T-1359 was very encouraging (26.6 t/ha) compared to the local variety Simiti (22.5 t/ha) and Tarnab (21.2 t/ha) at ThohaMehram Khan-Talagang. The local varieties; Simiti and Tarnab were susceptible to late blight attack. This area has a very short period for tomatoes to complete their life cycle before frosts start in winter therefore farmers picked their whole crop before the frost and keep it in rooms to ripen before selling.

AIP-WorldVeg introduced a mini tunnel concept to extend the growing period for few more weeks to fetch a good price in this lean period and this innovation is being adapted by farmers. AIP-WorldVeg partner Vegetable NARC introduced a potential determinate tomato hybrid "Savera" along with T-1359 and compared these against the local variety Tarnab at KhathaSaghral-Khushab. Fruit picking is just being completed in March, 2017 before the main Punjab crop comes into the market, therefore farmers received a very good price (PKR 38-45 per kg), once main crop from Punjab comes in the market in April prices goes down to PKR 15- 20 per kg. Savera yielded best at 51.2 t/ha, followed by T-1359 with 34.0 t/ha and the local variety Tarnab that yielded only 17.2 t/ha.

Determinate hybrid at Khatha Saghral-Khushab

Tomatoes kept in room at Talagang

The impact by adopting increase plant population, improved hybrids to overcome Orobanche a parasitic weed of these yield enhancing innovative technologies on hybrid tomato cultivation have greatly changed the ideas of growers at Katha Saghral-Khushab and they are ready to adopt the use of the recommended plant populations, and using improved hybrids instead of the local variety of tomato to overcome the problem of "Orobanche", a parasitic weed that is a major problem in the area.

8.2.3 Improved insect and disease management to reduce pesticide use in protected cultivation

Pest management is most crucial from mid-March to mid-May and from mid-July to mid-October.

Through trainings in Thoha Mehram Khan-Talagang, Khatha Saghral-Khushab, Chevanda-Faisalabad, and Mingora farmers were provided technical knowledge and skills to avoid the excessive use of pesticides and to control the growing temperature and humidity under protected cultivation in December and January. Now farmers are well aware about IPM and the usefulness of biocontrol. However, healthy nursery raising is not a top priority for farmers, therefore, the emphasis was on the capacity building of farmers in healthy nursery raising techniques using multi pot trays and sterilized media. The most common techniques are drip irrigation system, insect net provision, kairomone and yellow sticky traps. The use of drip irrigation is very helpful to control humidity inside the plasticulture structure, reducing the incidence of downy mildew attack, a serious threat to cucumber. A nursery grower, Malik Sharif from Chevanda-Faisalabad shared his views that he did not only reduced the number of sprays but also saved on labor costs by using yellow sticky traps. He observed yellow sticky traps kept his nursery very healthy and it was free of aphids and flies throughout the season.

8.2.4 Identify and promote new crops for protected cultivation with higher economic returns

Spinach and coriander raised under green shade net at NoorpurThal

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, they remain unutilized from May to September. There is a need to maximize the use of tunnel structures year-round and to increase the supply of fresh vegetables. Spinach and coriander sown in summer as off-season crops were successfully grown under green nets over the last two years despite problems of rising temperatures in May and inconsistent rains in the early monsoon period. Three varieties of coriander (Irani, Kandhari and Ramses) and spinach (Desipalak, Lahori palak and Indian palak) were evaluated in the selected clusters. Farmers were provided with the necessary inputs (seed, green shading net) and trainings.

8.2.5 Identify and Promote Improved Protected Cultivation Systems

A total of **30 drip fertigation** systems and seven flumes for furrow irrigation measurements were installed in the provinces included KP, Balochistan and Punjab that worked efficiently last year (September 2016). However, emitters are prone to clogging from deposits of calcium carbonate, algae or bacteria, so the irrigation lines require maintenance for better and longer service. Drip fertigation systems were cleaned using nitric acid and 30 farmers were trained in maintenance of the system so that they may clean it themselves at the end of each year. Farmers were interested in extending their systems and one farmer from each province included Punjab (Bhikki-Sheikupura), KP (Barikot-Mingora) and Balochistan (Khanozai-Pichin) have extended their systems this year.

Cucumber raised with a drip fertigation system in

Drip fertigation system technology were demonstrated in Sheikhupura, Haripur, DI Khan, Mingora and Pishin and were adopted either through installing new systems or by extending with more laterals pipes to service other tunnel structures. With the growing importance of protected cultivation of vegetables, the Government of Punjab started providing a 60% subsidy (farmer 40:60 GOP) for drip fertigation systems to the farmers during fiscal year 2015-16. Project innovations have been widely taken up by 271 direct beneficiaries under this activity. These included the use of improved varieties/hybrids, the removal of old and lower leaves of cucumber to encourage more flowering and good quality fruit, using vertical structures and trellises for tomatoes and cucurbits have become common practices among protected cultivation vegetable growers.

8.3 Improved Mungbean Production

The sub-project has completed its three years' field activities. Since mungbean is a spring/summer crop, there were almost no field activities during the winter season.

Vegetable Value Chains

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

8.3.1 Conduct evaluation trials for improved varieties of vegetables (onion, chili and tomato)

10 advanced onion lines (AVON 1073, AVON 1301, AVON 1013, AVON 1014, AVON 1016, AVON 1037, AVON 1028, AVON 1027, AVON 1067, AVON 1056) acquired from WorldVeg headquarters were sown in November 2016, in nurseries and transplanted in February 2017.

A total of 13 WorldVeg advanced chili lines (AVPP 0506, AVPP 0705, AVPP 0903, AVPP 9701, AVPP 9804, AVPP 1236, AVPP 1346, AVPP 9704, C04878, C05573, PBC 518, TC06050 and TC06472) were sown in nurseries for transplanting in Umerkot and Islamabad. A famous chili variety, Loungi with unique taste, locally known as Dandicut. Farmers revealed that its yields are declining partly due to poor quality seeds with a high degree of impurity and segregation.

During the last cropping season, true-to-type plants were grown to obtain about five kg of pure seeds which were distributed to 16 growers in Kunri to raise nurseries in collaboration with AZRI, Umerkot, Sindh province. This season, the growers from Sindh themselves have started the purification process. The seed supplies of 16 selections were purified up to 50-60 %, increasing dry weight yields from 3.2 to 3.8 t/ha this year. The selection and purification process will continue. 14 WorldVeg advanced lines of tomato (AVTO 9601, AVTO 9802, AVTO 9803, AVTO 9001, AVTO 1002, AVTO 1003, AVTO 1004, AVTO 1007, AVTO 1008, AVTO 1009, AVTO 1130, AVTO 1219, AVTO 1311 and AVTO 1315) were raised in nurseries at ARI (N), Mingora, Swat, for field planting in March and April 2017.

Facilitate seed production of improved varieties of major vegetables

Summer crop data on fresh and dry weight of chili was received from the Kunri area of Sindh province. A total of 5.4 tonnes of dry seed of the common chili variety "Loungi" of was produced on two hectares by contract farmers.

Shuga Seed Association members in onion field, Shuga-Bunir

Meanwhile onion seed crops were being grown from mid-October to the end of November further north in Shuga-KP province. An attack of purple blotch disease was observed in Shuga-Bunir and timely sprays of Lorsban insecticide (3 ml/liter of water) and Iliatte fungicide (3 gm/liter of water) were recommended. Crops are still standing in the field, and will mature by April and July 2017. A private partner ARCO Seeds, Gujranwala produced 400 kg of seeds of the okra variety "Alina" through contract farming in Punjab province. Other seed crops in KP, Punjab and Balochistan provinces are still in the field and details are shown in below Table.

Partners (Institutes /Seed Companies)		**Crop Areas (ha)**	
	Onion	**Peas**	**Total (ha)**
ARI (N), Mingora, KP	1.0	-	**1.0**
ARCO Seeds, Gujranwala Punjab	-	2.0	**2.0**
ARI Quetta, Balochistan	2.0	-	**2.0**
Total (ha)	**3.0**	**2.0**	**5.0**
Acreage under seed production for the year; October 2016 to March 2017			

8.4 Linkages Development of farmer-seed producers with private seed companies, seed markets, technology providers and business development services

Through a series of consultations and coordination meetings, contract farmers and seed companies were linked up for a sustainable relationship. The Shuga Seed Growers Association was linked with Zamindar Seeds Mingora and the Farm Service Centers of the Agriculture Extension Department, Mingora; farmers in Faisalabad, Chiniot and Nankana Sahib with Siddique & Sons, Faisalabad; and farmers in Sahiwal with ARCO Seeds. Moreover, Beacon Seeds in Kunri, Sindh province and Kashmala Seeds company in Quetta, Balochistan province, are helping seed growers in these respective project areas.

8.5 Establish seed villages in Punjab, Sindh, Balochistan and KP provinces

Shuga-Bunir in KP province was formally declared as a Seed Village with the consultation of the Shuga Growers Association. Villages in Kuchlaak, Balochistan provice, Tadlianwala-Faisalabad in Punjab province and Agha &Janhero farms in Umerkot, Sindh province have also been identified for this purpose.

8.5.1 Evaluate value chains for major vegetable crops to assess and promote improved postharvest and value adding technologies

a) Identify and introduce new varieties of 2 major crops testing for improved quality, shelf life and processing attributes

Tomato: A set of 12 WorldVeg advanced lines (AVTO 1418, AVTO 1288, AVTO 1426, AVTO 1289, AVTO 1455, AVTO 9802, AVTO 1405, AVTO 9708, AVTO 1409, AVTO 1003, AVTO 1429 and ATVO 1430) was planted in a nursery in ARI (North), Mingora on 24 February 2017 for transplanting in March and April 2017 and will be evaluated for shelf life, storage and processing attributes by partners.
Onion: A set of 9 local and exotic onion varieties; Chiltan-89, Sariab Red, Trich Mir, NasarPuri, Swat 1, Red Malbec, Deep Red, Red Couch, and Red Amposta was selected for trials at the Directorate of Vegetable Seed Production, ARI, Quetta in March and April 2017 and will be evaluated by partrners

b) Development of postharvest and value adding technologies for the priority vegetables
Storage and Shelf Life for Tomato: Among 11 WorldVeg tomato advance lines, AVTO-1288, AVTO-1418 and AVTO-1429 resulted significantly in higher yields up to 14.4 t/ha while the varieties AVTO-9708 and AVTO-1420 survived for seven days in storage at ambient temperatures. Tomato samples treated with Potassium Metabisulphite and untreated fruits packed in plastic crates showed the maximum quality characteristics.

Storage and Shelf Life for Onion: The bolting percentage was high in the onion varieties; Chiltan-89 and Sariab Red while shelf life was longer (140-160 days) in the varieties; Swat-1 and NARC-2 at ARI (North), Mingora. Yields were highest for the varieties Swat-1, Phulkara, Chaltan-89 and Sariab Red. The bulbs of 9 varieties; (Chiltan-89, Sariab Red, Trich Mir, Red Malbec, Deep Red, Red Couch, NasarPuri, Swat 1 and Red Amposta) were stored on 13 September 2016 to assess their Sprouting percentage qualities at the Directorate of Vegetable Seed Production-ARI, Quetta, balochistan province. Sprouting was highest (100%) in the varieties; Red Couch, NasarPuri and Swat 1. It was lowest in Red Amposta (16.7%), followed by Trich Mir with 48.3% sprouting with 50% rotting. It was concluded that the onion varieties; Chiltan 89, Sariab Red, Trich Mir and Red Amposta could be stored for 140-160 days satisfactorily in the environment of Quetta, Balochistan province.

c) Uptake of postharvest and value adding technologies

As part of technology promotion, the use of 6-10 kg-capacity nylon net bags for transporting tomatoes were compared with plastic bags and demonstrated in two locations; Mingora-Swat and DI Khan. Plastic bags were replaced by plastic cartons at KhathaSaghral, district Khushab.

9 UC DAVIS

9.1 Perennial Horticulture

UC Davis continued to make efforts towards achieving the objective of addressing the research and extension issues of Pakistan's major fruit crops to produce economic benefits through the perennial horticulture component. During April and June, 2016, all 22 commissioned projects were making good progress toward both technical and outreach objectives. However, the funding cuts slowed project, progress in July and September, 2016. Even with the cuts, seven trainings/workshops/field days with a total of 367 beneficiaries were successfully conducted during this reporting period. A total of 24 farmers farming 30 acres adopted innovative agricultural practices. Other key achievements over the period (October-March 7, 2017) are given below:

- 1200 true to type nursery plants of 10 citrus varieties were distributed among 24 growers in Sargodha district, Punjab province.
- Though tested, better media for citrus nursery project's results could not be complied because authentication required revision of experiments at least for two more years.
- Efficient irrigation systems have been installed at two demonstration sites (one each for pistachios at ARI Quetta and for grapes at Koont farm, AAUR).

- Information for project completion reports was collected from partners.
- A post-harvest training center was established to regularly offer reasonably priced need based trainings on post-harvest handling of fruits and vegetables for capitalizing on the post-harvest facility developed at AT Sakrand. The revenue generated will be used to sustainably operate the post-harvest lab after project completion.
- The first Pistachio Growers Association of Baluchistan was registered.
- A clear set of verified guidelines for harvesting, field handling, transportation, cleaning, sorting, packing, storing and marketing citrus have been drafted and will be available in both hard copy and digital format for literate and non-literate audiences.

- Base line survey reports have been developed and shared with AIP, CIMMYT.

Training and workshops organized by AIP-Perennial Horticulture

9.2 Human Resource Development (HRD)

9.2.1 Graduate studies

The Mississippi State University, USA recently held its Second Annual Graduate Students Poster Presentation Contest at campus. Naqeebullah, AIP-PhD scholar secured the third place for his poster presentation on "Screening Indica Rice Lines for Salinity Tolerance at Early Stages Using Root and Shoot Morphological Traits". In his poster presentation, Naqeebullah duly acknowledged the financial and moral support of USAID and exhibited his commitment to serve Pakistan upon the completion of his degree program.

AIP Scholars

Maria Amir Solangi, AIP Scholar has successfully completed her MS thesis defense on November29 and is filing her thesis at the Veterinary & Animal Sciences Department, University of Massachusetts, USA. Her research focused on the identification of genetic pattern of immune response in domesticated animals which will help design veterinary care for improved animal and human health. She travelled back to Pakistan on December 5, 2016. Upon her return, Maria is committed to provide outstanding veterinary care to the underprivileged communities of rural Sindh province.

Mr. Habib Ullah an AIP Scholar has also defended his thesis on Feb 16, 2017. He thanked USAID for funding this scholarship. He also thanked CIMMYT, Pakistan, PARC and UC-Davis for the collaboration to make this a success. The performance of the scholars was regularly monitored by the component leader.

9.2.2 Vocational Training

Feedback on the usefulness of the trainings and workshop were collected from a subset of each workshop. The responses of the participants have been documented in the form of report. The component was closed in December 2016.

9.3 E-Pak Ag

E-Pak Ag is a unique component of AIP to promote the use of Information Communication Technology (ICT) in agriculture extension. Under this component, UC Davis in collaboration with UAF, conducted

a day long workshop on “short video making” on October 10, 2016 at the University of Agriculture, Peshawar. A total of 65 students, faculty members and extension staff from the KP province were invited. Such videos can be easily used on smartphones and have the advantage to effectively communicate the extension messages to the masses of small holder farmers where face to face interaction is practically not possible. Such training was also organized at Tando Jam University Sindh province for 56 stakeholders with focus on the preparation of short extension messages through short videos.

During the first week of December 2016, a series of events were managed under the gender specific initiatives of AIP on the use ICT for the rural school girls to address the agricultural issues faced by their household. The events included competition among the project trained school girls (one at each of the three project sites including Okara, Faisalabad and Chakwal) followed by the concluding ceremony at Arid Agriculture University Rawalpindi (AAUR), in which prizes were distributed among the top 100 school girls out of 300 total trained. Prof. Dr. Rai Niaz Ahmad, Vice Chancellor of AAUR chaired the concluding ceremony. Dr. Muhammad Azeem Khan, DG NARC talked present on the occasion talked about the importance of rural school girls in promoting the use of ICT for agriculture. Telenor Pakistan Institute of ICT for Development (PIID) and E-Pakistan partnered at the event. It was a great success of the project that PIID and E-Pakistan formally took the responsibility to further train the top 100 girls for promotion of the ICT based solutions to the agricultural issues of their community.

10 Socioeconomics (SEP)

AIP-SEP completed follow up surveys across Pakistan to document the impact of AIP interventions. The main objective of the follow up surveys was to document the impact of the AIP wheat, maize and conservation agriculture (CA) technologies across Pakistan. Following surveys were completed;

- Follow up survey to document impact of selected CA technologies across Pakistan
- Evaluation of agronomic performance and adoption implication of QPM hybrids among small holders in AJ&K and KP
- Follow up survey to identify preferences, uptake and outcome from AIP wheat activities conducted across various districts of Pakistan
- Follow up survey to estimate the impact of access to improved maize seed among rural households in AJ&K, GB, KP and Punjab province.
- Assessing the impact of pre released seed multiplication of wheat varieties to shorten seed availability of new varieties on farmer’s field
- Follow up survey to document the Impact of laser land leveling technology adoption on household income and food security in Pakistan
- Follow up surveys to document the Impact of ZT technology adoption across various districts of Pakistan

10.1 Evaluation of the Agronomic Performance and Adoption Implications of the QPM hybrids among small holder farmers in Pakistan

The main purpose of the study was to document the agronomic performance of the QPM maize varieties as compared to traditional maize varieties. Data were collected from 17 farmers, cultivated QPM maize varieties. The seed of the QPM maize varieties was provided by the AIP-Maize to 17 farmers and in next season the number of farmers will be increase to 100. The salient findings of the study are as under

- Nearly 80% farmers lack awareness about QPM maize and its added benefits. They need guidance on maize production technology. The farming community should be provided information through flyers, brochures, and pamphlets etc.
- This was introductory year of QPM in Pakistan, therefore farmers initially allocated less area to QPM that is 0.5 acres per farmer. It is expected that in the coming seasons the area under QPM maize will increase up to 1 acre per farmer and the QPM seed will need to be distributed to approximately 100 farmers. Currently the seed availability of QPM maize is a challenge as seed is produced on limited scale. It is expected that in the coming season the seed production will increase up to 8-10 tons and thus increasing the availability of QPM seed to farmers.
- The agronomic performance of QPM is very much similar with that of conventional maize and in some aspects like grain color and cob taste it was rated even better.
- The survey findings indicated that QPM was liked by farmers for fodder due to its palatability as compared to conventional maize.
- The QPM maize is quite compatible to conventional maize. The cost benefit ratio of the QPM maize was 2.10 while that of conventional maize was 1.58 which mean by planting QPM maize farmers can fetch even higher net returns as compared to conventional maize and the enhanced nutritional value is an added incentive.

10.2 Impact of Improved Maize Seed among Rural Households in KP and Punjab Provinces

The objective of the study was to document the impact of improved maize seed on the livelihood of small farmers. AIP-Maize distributed improved maize seed i.e. mostly hybrids to 500 small maize growers in Punjab and KP provinces. Comprehensive questionnaire was developed for survey included questions on a number of household, farm level characteristics of maize seed, access and affordability. The data was collected from districts included Charsadda, Nowshera, Peshawar and Swabi in KP province and districts Okara, Pakpatan, Sahiwal, and Vehari in Punjab province. These surveyed districts are the main maize producing districts in KP and Punjab provinces. Out of the 100 surveyed farmers 51% were beneficiary farmers and 49% were non-beneficiary farmers.

- The impact of AIP maize seed indicated that majority of the farmers i.e. 82% were satisfied with the seed quality and 62% were satisfied from the quantity of seed provided while 38% demanded for increase in seed quantity According to the farmers the quantity of the seed distributed through AIP needs to be increased. The estimated demand was 40-160 Kg and the average quantity distributed through AIP was 19 Kg.
- The comparative economic analysis of maize hybrids and OPV varieties indicated that the farmers having access to and can afford hybrid maize seed were getting about 10 tons per hectare and the other farmers i.e. non-beneficiary planting OPV varieties were getting about 5.7 tons per hectare. The beneficiary farmers were getting about 4.3 tons per hectare more maize yield as compared to non-beneficiary farmers. Besides seed there was no significant (up to 5 %) difference in the application of other inputs i.e. irrigation, fertilizer etc.

- As the price of hybrid (USD 7 /kg) is high in Pakistan therefore the majority of the farmers cannot afford the hybrid seed and mostly plant OPV varieties.
- The cost of production of OPV was PKR 25890 per acre while cost of production of hybrid was PKR 34981 per acre. The difference in cost of production was 26 % higher for hybrids as compared to OPV. The cost of hybrid is high mainly due to expensive seed cost, the rest operational costs is almost the same both for OPV and hybrids. The cost benefit ratio from OPV varieties was 2.10 while for the hybrids was 2.51. The net profits for the OPV cultivation is PKR 28562 while from the cultivation of the hybrids is PKR 52519 per acre. Based on these findings it can be concluded that yield can be doubled if farmers adopt maize hybrids.

10.3 Impact of zero tillage and Zero Tillage Happy Seeder technologies adoption in the Rice wheat area of Pakistan

The main objective of the study was to document the impact of zero tillage as well as zero tillage happy seeder technologies in the rice wheat area of Punjab province. The data was collected from five districts of rice wheat area in Punjab with comprehensive questionnaire. A total of 170 farmers were interviewed, included zero tillage adopters and zero tillage happy seeder adopters. The data was collected from the zero tillage manufacturers from the Daska and Faisalabad districts. The results indicated that cost benefit ratios from zero tillage happy seeder is highest i.e. 1.69 followed by the zero tillage i.e. 1.67 and conventional tillage i.e. 1.24 respectively. Zero tillage happy seeder technology is a worthwhile substitute to field burning of rice residue and heavy tillage for wheat planting in Punjab province and by adopting this technology farmers can save almost PKR 5000 per acre and reduce damage to environment. Although the yield are not significantly different, however saving in costs and environment friendly make these technologies profitable as compared to conventional tillage.

10.4 Workable Strategy of Durum Wheat in Pakistan

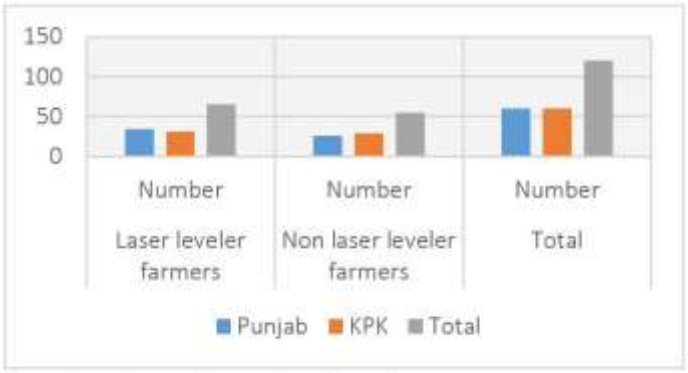
There are many major challenges in the functionality of the durum wheat value chain in Pakistan. First is the linkages among different stakeholders in the value chain; second no local production of durum wheat mainly due to non-availability of durum wheat varieties and third most importantly no incentives from the public side. Currently Pakistan import semolina and after processing exports to other countries. In country mostly the available pasta products are made from the bread wheat.

Demand of durum wheat derived products i.e. pasta products is increasing in Pakistan as during 2014-15 Pakistan has imported 500,000 tons of wheat for pasta products. Durum wheat has the potential to grow on less favorable growing conditions to some of the highest yield potential. This Study was designed to provide the roadmap/workable strategy to all stakeholders involved in the value chain of durum wheat in Pakistan. Major constraints related to durum wheat are stipulated in the figure on

the right. Direct export from Pakistan, strengthening local processing industry and research on durum cultivars are the key areas to focus for the development of durum wheat value chain in Pakistan.

10.5 Adoption and Impact of Land LASER Levelling at Farm Level

For documenting the impact of the LASER land leveling technology, data was collected from 120 farmers, in three districts of KP province and four districts of the Punjab province. The surveyed districts included Nowshera, Mardan and D.I.Khan in KP province, Vehari, Okara, Sahiwal and Faisalabad in Punjab province. The sampling details are presented in figure on the right.



Sampling frame of Laser Land Leveling

The cost benefit ratio in Punjab province is 1.057 for LASER land leveling adopters and 0.592 for non-adopter i.e. non-beneficiary farmers. The empirical results indicated that cost benefit ratio for the LASER land leveling is higher as compared to conventional leveling both in Punjab and KP provinces. Similarly in KP province cost benefit ratio for maize sown on non-adopters fields was estimated as 0.866 and that for LASER leveling adopter was noted as 1.107.

10.6 Wheat Follow up Survey in Punjab

The objective of the AIP wheat follow up survey was to document the impact of wheat interventions included preference, uptake and outcome of the AIP wheat. Comprehensive questionnaire was developed for data collection. Data were collected during November and December, 2016 from eight districts of Punjab included Attock, Rawalpindi, Chakwal Mandi Bahauddin, Hafizabad, Sargodha, Bhakkar and Rahim Yar Khan. The survey was carried out in the rainfed and irrigated areas. In total 273 farmers were interviewed including both beneficiaries as well as non-beneficiaries. The respondents include 202 beneficiaries (IRD, Mother Trial and Seed production), 40 non beneficiaries and 31 baseline farmers. The initial results indicated that adopters have 5 -15% higher wheat yield, higher household income levels as well as higher food security, and less poverty levels.

AIP SEP team carrying out wheat follow up survey in Punjab Province

10.7 Adoption and Impact of CA Technologies and Nutrient Management at Farm Level

For impact analysis of the CA technologies data was collected from 115 farmers from seven districts included Faisalabad, Gujaranwala, Sheikhupura, Okara, Sahiwal, Sialkot, Vehari in Punjab province and four districts of KP province included Mardan, Nowshera, Peshawar, Mardan. The objective of survey was to collect data from

AIP-SEP team carrying out Wheat Follow up Survey in Sindh Province

the farmers who adopted raised bed planting, ridge planting of wheat, and direct seeding of rice, nutrient management technologies and to compare it with the non-adopters of these technologies. The cost benefit ratio for DSR farmers and transplanted rice growers was estimated as 1.14 and 0.72 respectively. Similarly the benefit cost ratio for raised bed planting was calculated as 0.93 for beneficiary farmers and 0.76 for non-beneficiaries. These results are significant at 10% level of significance. However the benefit cost ratio for ridge planting of wheat was determined as 1.04 and that for broadcasted wheat growers was estimated as 0.83. Similarly the results regarding nutrient management at farm level indicated that beneficiaries applied less amount of fertilizers and received higher profit. The beneficiary farmers were having higher benefit in the range of PKR 937-1245 as compared to non-beneficiary farmers.

10.8 Wheat Follow up Survey in Sindh

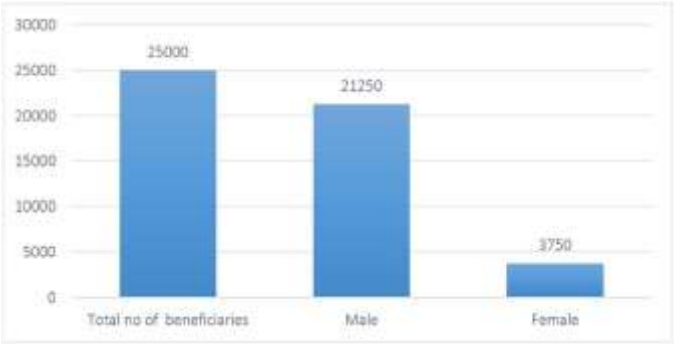
The data was collected from six districts included Mitiari, Tando Allah Yar, Tando M. Khan, Umerkot and Benazirabad in Sindh province. A total of 150 farmers were interviewed from the Sindh province. Detail comprehensive questionnaire was used for data collection. The initial results indicated that beneficiary farmers have 5 to 10% higher wheat yield as compared to non-beneficiaries. The household income levels are higher in the range of PKR 25000 to PKR 35000 per year.

10.9 Capacity Building

A workshop entitled “Orientation to SPSS and STATA” software was organized in collaboration with BUITEMS, Quetta from 24-25 November, 2016. A total of 45 faculty members were trained. The training on SPSS and STATA will help the scientists in their future research work.

11 Monitoring and Evaluation (M&E)

AIP Monitoring and Evaluation unite is committed to ensure monitoring and evaluation of the project activities. The project has outperformed and achieved 40% above the target. AIP-M&E collected data on MSF outcome indicators on quarterly basis and reported to USAID on PakInfo. AIP targeted a total of 25,000 beneficiaries (as shown in below graph chart); men 21250 (85%) including 3750 (15%) women against a total target of 15000 for FY 2017. Furthermore, data on component outcome indicators were collected and reported to higher management, given in the below table.



Total Number of Beneficiaries

Furthermore, data on component outcome indicators were collected and reported to higher management (see M&E annexure 20.2 for detail).

Third party midterm evaluation of AIP is in progress. For the purpose MSI, USAID contractor was assisted in the process by AIP-M&E. Project data was provided as per requirement of MSI. Data was

cleaned and district, province and implementing partner's details were shared for sample selection. Moreover, data was supplemented with partner's subgrants.

Microenterprise Results Reporting (MRR) required by USAID was completed. In the report, required information was filled up and submitted to USAID.

12 Competitive Grants System

The establishment of boards in the provinces and the execution of competitive grant system under those boards has been a challenge for the primary partners PARC. The main bottle neck is the requirement of legislation at the provincial assembly's level and the frequent change in the government official at the agriculture ministry's level. The provinces are in the favor of competitive grant system, however, want to have a flexible system which facilitate the researchers to execute research projects. AIP transferred the first tranche of funding (USD 818,611) to PARC for the establishment of board and competitive grant system through the government of Pakistan channel (assignment account). This system is not allowing the use of fund and till to-date PARC being a primary partner unable to utilize the allocated fund. CIMMYT is working with PARC to find ways for implementing CGS in the provinces and find the way forward to spend the fund received. After agreement with PARC that the fund will be utilized to strengthen PARC national coordinated programs and also fund competitive grants in the provinces directly with the support of CIMMYT to have some flow of fund to provincial partners. The work-plan for 2017 has provided details for this activity and progress has been made to short-listed competitive grant proposal from provinces and fund those in the coming six months.

13 Personnel Management

AIP-livestock has appointed three RA's for Sindh, Gilgit Baltistan and Khyber Pakhtunkhwa. Under UC Davis Two AIP Scholars including one female and one male completed their MS thesis at the US Universities. The AIP-Vegetable component activities were in the process of downsizing, therefore the field offices and staff were kept to a minimum to carry on the remaining activities in the field. Most of the staff left the project on or before 30 September 2016. These included two senior staff namely; Dr Asghar Ali, Legume Agronomist and Mr Asrar Sarwar, Horticulturist. Seven Research Associates also left. These were Ms Anam Fatima- Faisalabad, Ms Faiza Mushtaq-DI Khan, Ms Tabbasum Zaman-Gilgit, Mr Ali Raza-Sheikhupura, Mr Ali Imran-Khushab, Mr Iqbal Hussain and Mr Rizwan Sheikh-Quetta.

Under AIP CIMMYT office M. Asif one of the accountant, and Ms. Mariam Muzammal, Database Analyst left AIP-CIMMYT due to personal reasons during the reporting period. The replacement of accountant for AIP office Islamabad is in process. Mr. Kashif Communication Specialist joined AIP-CIMMYT in October 2016. The probation period of one Maize research associate at CIMMYT-Yousafwala office was completed.

Two components of AIP, vegetable and Perennial horticulture implemented by AVRDC and UC Davis Pakistan office respectively were closed in March 2017 after completion of their project interventions. Two branch offices of AVRDC under AIP in Swat and Sarghoda were also closed. The contracts of the two primary partners extended by CIMMYT included IRRI and ILRI. TraiNet was also successfully managed by Dr. Md. Imtiaz AIP-COP working as an R2 for USAID. Student's data studying in US under AIP-UC Davis project were uploaded by COP. Additionally, under the another USAID funded project UC Davis agreed to continue with AIP-funded students handling in the Trainet.

Dr Shahid Masood, ex- member plant science division PARC joined CIMMYT as consultant to assist on the implementation of competitive grant in the provinces and strengthen PARC coordinated program.

14 External Factors

- Favorable environment in all provinces to execute livestock activities, except FATA (only minor activities such has forage seed distribution and monitoring). No issues with IRS getting NOC from MOI to visit these provinces.
- Long time in finalization of decision about continuation of UC Davis activity has badly affected the project targets achievements.
- Getting visa for Maize resource persons coming from outside of Pakistan remains as a hurdle to conduct planned trainings under various components.
- Harvesting machinery may not available at the time of harvesting.

15 Challenges / Risks

- Security risks particularly in Sindh and Balochistan remains a concern.
- The sudden budget cut posed a great challenge and in achieving the targets of the annual work plans.
- The pending INGO issues have created the hindrance which would result into failure of being materialize the dream of AIP-livestock to work into the FATA regions. Although, AIP-livestock has started their activity through the collaborators and/or aligned departments to reach the small herders in the most difficult of part of Pakistan.
- During data collection for the study enumerators encountered certain limitations which includes time constraint as beneficiaries were scattered and living in remote areas enumerators had to spend two to three hours in order to trace single respondent. Most of the farmers were illiterate having no written records related to crop production.
- Some of the wheat crop this year in rainfed areas is not as good due to late planting, delayed winter rain that affected date of planting, plant stand establishment and crop growth. In some areas there are reports of lodging of wheat crop that may result in low and poor quality grain yield.
- A potential risk of pest attacks on tomato during the months of February and March. Orobanche parasite weed that feeds on the roots of tomato.
- Adverse climatic conditions (frost & moisture), therefore picking of unripe tomatoes was done in Thoha Mehram Khan to avoid damage from frost.
- Severe attack of fruit borer, and a physiological disorder of tomatoes occurred at Thoha Mehram Khan and Chevanda.

16 Contribution to USAID Gender Objectives

AIP encourages the participation of women in all possible ways.

AIP-livestock have conducted the awareness campaign for 500 females on sustained dairy production in collaboration with livestock department, AJ&K. Afterwards, 300 food graded plastic water troughs and milk-in cans were distributed among the female livestock keepers.

The specialized and modern five day training were conducted in collaboration with UAP Peshawar on in vitro (Tilley & Terry/gas production) and in Sacco digestibility measurements. AIP-livestock inaugurated the four newly established female livestock model cum training farms in Punjab. AIP-ILRI have distributed total of 500 water troughs and milk-in cans to the poor-female livestock farmers in Gilgit. AIP-ILRI organized an awareness raising program for 400 farmers participated in the event, out of which nearly 95% were females.

AIP UC Davis provided trainings to domestic women and school girls in Sargodha, Chakwal, Faisalabad and Okara and technical and material support to five women training institutes in Sargodha.

- Under AIP agronomy, 05 female participants were trained on use of Green Seeker N management in wheat and 46 women beneficiaries were included in wheat season 2016.
- Participation of women as direct beneficiary and in training of wheat activities rose to 32% compared to just 12% during 2014-15.
- AIP, SEP organized a training for a total of 45 with 35% women participants in collaboration with BUITEMS.
- Two female scientists, has participated in international training-workshop on Bacterial Blight of Rice, aimed at harmonizing tools and strategies for disease resistance improvement. Women laborer were trained, for rice nursery uprooting and transplanting.
- AIP maize is evaluating protein and vitamin A enriched maize varieties in Pakistan. In kharif 2016, the evaluation included Zn enriched maize varieties. Apart from their grain yield advantage these germplasms will provide protein and other crucial micronutrients with particular importance to women and children to mitigate malnutrition and attendant diseases. In this regard three ProA enriched maize hybrids have been allocated to University of Agriculture Faisalabad for commercial production. The various AIP maize activities also created job opportunities for women during the reporting period. A total of 17 female students from various Universities got practical training in relation to maize.

17 Environmental Compliances

- AIP agronomy is disseminating improved techniques like Zero tillage, ridge planting of wheat, bed planting, new CA seeders and site specific nutrient managements which helped farmers to reduce tillage, reduce water and fertilizer use, avoid burning of residue and ultimately improve environment through reduced GHG emissions.
- AWD the rice field can reduce water use by up to 30%. AWD is assumed to reduce methane (CH_4) emissions by an average of 48% compared to continuous flooding (IPCC, 2006). Direct seeding of rice can reduce CH_4 emission from 24 to 79 per cent with 40-44 per cent decline in GWP.
- 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 agriculture, nitrous oxide is emitted when people add nitrogen to the soil through the use of synthetic fertilizers and it is volatized into the atmosphere. The impact of one pound of nitrous oxide is 300 times as potent as one pound of carbon dioxide. AIP is evaluating nitrogen efficient maize to reduce the need for fertilizer. The target is to reduce the use of chemical nitrogen fertilizers by 75% and to get a comparable grain yield with well fertilized soils. Similarly, varieties included under the stem borer tolerant trials will have significant environmental impact by avoiding or reducing chemical pesticides.
- AIP wheat popularized newly released, rust resistant and high yielding wheat varieties, which will minimize the use of pesticides. Several of the varieties have drought tolerance and require less water. Similarly, Zincol, a zinc enriched wheat variety recommended for irrigated areas is also becoming popular in the rainfed areas due to its drought tolerance and excellent adaptation in the rainfed areas. There will no adverse environmental impact of growing these wheat varieties in Pakistan.
- Under AIP, Vegetable, Insect nets and black plastic mulching sheets have been implemented at various locations to reduce the use of pesticides. IPM practices including yellow sticky bands and Kairomone traps were introduced to avoid excessive pesticide usage. Women field

workers were trained at various locations to take protective measures during pesticide handling and spraying

18 Communications:

In this reporting period AIPs' Communications highlighted the AIP's interventions which included arranging successful events, persuasive stories and maintaining media presence. 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. Some of the mediums used to communicate the AIP activities are listed below:

- Publications (newsletters , brochures, souvenirs, banners, standees, back-drop)
- Social Media (Flicker, Facebook, Twitter)
- CIMMYT's Blog and e-newsletter
- Events

Branding material of Maize, Wheat, Agronomy, and Livestock was produced according to USAID branding and marking guidelines. These include banners, backdrops and standees for various events under these components.

Giveaways and souvenirs were developed and printed for AIP visibility and publicity. These include badges, T-shirts, Mugs, Caps, pens, notepads, goodie bags, Keychains. This material is currently being used in expos, events and other meetings which supports in publicity of the program.

Wheat:

Exclusive story in the Innovation Edition with the title "**Seeds of Changes"** in U.S Embassy bi-monthly Khabor o Nazar Magzine was published regarding successes of AIP under wheat component.
CIMMYT Global Wheat Director visited Pakistan and coverage was given in internal staff newsletter: http://inside.cimmyt.org/corporatecommunications/group%20blog//Lists/Posts/Post.aspx?ID=646&
Eight press insertions were monitored & recorded in local newspapers regarding quality wheat seed distribution in Punjab.
Following technical publications were also appeared in scientific journals during the reporting period:

a. Joshi, K. D., A. U. Rehman, G. Ullah, A. Baloch, M. Hussain, J. Ahmad, M. Ishaq, G. Ahmad, N. Ahmad, S. H. Abbas, M. Qamar, M. Ahmad, A. I. Dar, B. Khokhar, M. Sajid, A. Hussain and M. Imtiaz. 2016. Yield and profits from new and old wheat varieties using certified and farmer-saved seeds. Journal of Agricultural Science and Technology B 6 (2016) 141-150.

b. Joshi, K.D., Rehman, A.U., Ullah, G., Nazir, M.F, Zahara, M., Akhtar, J., Baloch, A., Khokhar, J., Ellahi, E., Khan, M., Suleman, M., Khan, A. and Imtiaz, M. 2017. Evaluating the acceptance and competitiveness of new improved wheat varieties by smallholder farmers in Pakistan. Journal of Crop Improvement (in press).

Socioeconomics:

Appeared on CIMMYT webpage under *Breaking Ground* - a regular series featuring staff at CIMMYT: http://www.cimmyt.org/breaking-ground-akhter-ali-helps-transform-agriculture-sector-in-pakistan
The story also posted on Facebook page under this series:
https://www.facebook.com/CIMMYT/photos/a.333170283394.157061.28893663394/10155193076463395/?type=3&theater

Agronomy:

The use of green seeker for nitrogen management in crops highlighted: http://www.cimmyt.org/crop-sensors-sharpen-nitrogen-management-for-wheat-in-pakistan

Maize:

Under AIP maize project, activities to local and international stakeholders following the communication guidelines of USAID:

- CIMMYT *News (*http://www.cimmyt.org/water-saving-maize-holds-potential-to-boost-farmer-resilience-to-climate-change-in-pakistan/)
- CIMMYT News (http://www.cimmyt.org/radio-broadcast-highlights-maize-improvement-in-pakistan/)
- CIMMYT News (http://www.cimmyt.org/pakistan-releases-first-quality-protein-maize-varieties/)
- http://leadpakistan.com.pk/news/first-maize-stem-borer-mass-rearing-lab-in-pakistan-inaugrated/
- SeedQuest News about the release of QPM: http://www.seedquest.com/news.php?type=news&id_article=85685&id_region=&id_category=&id_crop=
- APAARI news about the release of QPM in Pakistan : http://www.apaari.org/network/new-nutrition-knowledge-bank.html

Maize stem borer laboratory inauguration in NARC, Islamabad has wide coverage in press. 8 insertions in local newspapers were monitored & recorded.

Livestock:

The work AIP-Livestock has done in collaboration with Farm Dynamics Pakistan on Rye and Rhodes grass; produced as a Technical Bulletin.

Vegetable:

Success story "Protected cultivation-the future of Pothwar region, Punjab (Pakistan)" was published in WorldVeg FEED BACK Issue December, 2016.

AIP promotional articles published in the WorldVeg international newsletter included, now performing – Bitter Gourd, Pakistan grows drop by drop, success in Mungbean harvesting, tools for onion seed production, training on-farm and on-station in November and October, 2016.

Technical Publications

- Ahmad RF, Ahmad QB, Abbas H, Khan A, Ahmad A, 2016, Vegetable diseases/insects and their control USAID/AIP, World Vegetable Center-Pakistan. (in Urdu).
- Bhatti SR, Abbas H, Ali M, Easdown W, (2016) Protected Cultivation – The Future of Pothwar Region, Punjab, Pakistan. World Vegetable Center, "Feedback from the Field", Issue 32, December, 2016, (in English)
- Hugo Despretz, Warwick Easdown and Mansab Ali 2017. Development of smallholder protected cultivation of vegetables in the subtropics: innovations from South Asia, Chapter in book " Global Food Security: technology, society and policy innovations".

19 Lessons Learned

The following are the lesson learned during the reporting period:

- AIP collaborated with private partners for distribution of push row planter and ZTHS among farmers on cost sharing basis. Maize planting with push row planter has gained acceptance among smallholders farmers in KP province. This was successful experience and AIP is planning

to provide ZTHS and MC planter to farmers and service providers on cost sharing basis in the project area.

- The follow-up of the previously managed vocational trainings indicated high demand that such courses should be organized regularly and the young students should be given more chances to be a part of such activities. Local experts should also be engaged with foreign experts to make training more useful.
- Indeterminate hybrids of tomato grown on trellises are expected to give better returns to the growers of Thoha Mehram Khan and Katha Saghral. The use of tomato side shoots as juvenile plants has become an alternative means of getting more plants from one expensive hybrid seed to help make protected cultivation of tomatoes more economic. The removal of the lower and older leaves in cucumbers up till half a meter from ground level helped in flowering and improved fruit quality. Farmers found the use of trellises under tunnels increased productivity and the quality of tomato and cucumber fruits and prevented crops from lodging.
- Quality wheat seed produced & marketed by a few private seed companies partnering with AIP wheat showed an encouraging opportunity for disseminating new wheat varieties in rural areas.
- Lines / varieties having BLB resistance genes produced 27.8% higher rice yield than the varieties having no BLB genes under disease incidence occurrence.
- Farmers can save 10,000-15,000 rupees per acre in DSR over transplanting with comparatively no reduction in yield.
- Kahrif season is more preferred than spring season for seed production due to the thermal heat that affects pollen shading and viability during spring season.

20 Appendices

20.1 Maize Annexures

Table 1: Performance of the top 10 biofortified maize hybrids as compared to local checks in Pakistan

NARC 2014 (n=24)	Grain yield (t ha^{-1})	CCRI 2015 (n=24)	Grain yield (t ha^{-1})	ICI-Pakistan 2016 (n=36)	Grain yield (t ha^{-1})	MMRI 2016 (n=36)	Grain yield (t ha^{-1})
HP1060-8	9.55	HP1100-21	9.7	HP1097-2	9.9	Local Check 1	15.4
HP1060-6	9.44	HP1097-10	9.0	HP1100-46	9.3	HP1097-2	13.3
HP1060-1	9.30	HP1100-27	8.8	Local Check 2	8.9	HP1100-22	13.2
HP1060-22	9.21	HP1100-11	8.7	HP1100-31	8.8	HP1100-28	12.9
HP1060-9	8.88	HP1100-46	8.6	HP1100-27	8.8	HP1100-25	12.8
HP1060-15	8.81	HP1097-1	8.4	HP1100-28	8.7	HP1097-10	12.6
HP1060-5	8.57	HP1097-2	8.4	HP1100-24	8.6	HP1100-37	12.5
HP1060-14	8.56	HP1097-4	8.4	HP1097-1	8.5	HP1097-16	12.4
HP1060-4	8.28	HP1100-8	8.3	HP1097-7	8.4	HP1100-46	12.2
HP1060-11	8.11	HP1097-8	8.3	HP1100-21	8.3	HP1097-8	12.1
Mean	7.76	Mean	7.34	Mean	7.88	Mean	11.67
LSD (0.05)	1.96	LSD (0.05)	2.49	LSD (0.05)	1.51	LSD (0.05)	1.55
CV	12.00	CV	16.70	CV	9.17	CV	6.40
p	**	p	*	p	*	p	***

Table-2: List of biofortified maize varieties evaluated or under evaluation in Pakistan (spring and Kharif, 2016)

No	Trial Name/code	Trial description	No of entries	No. of sets	Trial seeds source	Crop stage
1	14TTWCWQZN	Zinc and protein enriched white maize hybrids	12	3	Biofortified maize (QPM+Zn) from Mexico	Harvested)
2	16EIHYBPROA	Early to Intermediate maturity ProA hybrids for tropical/subtropical environment	36	10	New Provitamin A enriched trials from Mexico	Harvested
3	15AEIRHPVA	New set of ProA hybrids adapted to lowland tropics	10	3	CIMMYT Colombia	Harvested
4	15AEIRHZN	Hybrids selected for high Zinc	10	3	CIMMYT Colombia	Harvested
5	M16-15	Extra-Early Multiple Stress Tolerant Pro-Vitamin A Hybrid Trial	11	2	IITA, Nigeria	Flowering

Table 3: Screening of maize germplasm resistant to stem borer under artificial infestation of stem borer before harvesting autumn 2016

ENTRIES	SURVIVED PLANTS (%)			
	NARC	CCRI	MMRI	Mean
TZBR Eld.-3 C6	30.00	80.00	84.62	64.87
TZBR Eld.-4-W C2	60.00	25.00	33.33	39.44
TZBR Eld.-4-Y C2	22.22	33.33	100.00	51.85
BR 9928-DMRSR C1	57.14	83.33	60.00	66.82
BR 9943-DMRSR C1	63.64	16.67	60.00	46.77
BR TZL Comp 4 DMRSR	55.56	28.57	80.00	54.71
Ama TZBR-W C4	30.00	75.00	33.33	46.11
Ama TZBR-Y	50.00	17.65	92.86	53.50
TZBR Comp 1-W C1	40.00	56.25	87.50	61.25
TZBR Comp 2-W C1	28.57	14.29	50.00	30.95
TZBR Comp 1-Y C2	62.50	20.00	71.43	51.31
TZBR Comp 2-Y C2	60.00	76.92	92.31	76.41
QPHM 200 (Check-1)	30.00	50.00	88.89	56.30
HN GOLD (Check-2)	40.00	53.33	50.00	47.78
QPHM 300	90.00	-	-	90.00
BR-2	80.00	-	-	80.00
HN GOLD	35.36	-	-	35.36

Table 4: Screening of maize germplasm under natural infestation of stem borer before harvesting autumn 2016

ENTRIES	SURVIVED PLANTS (%)			
	NARC	CCRI	MMRI	Mean
TZBR Eld.-3 C6	100.00	94.46	92.23	95.56
TZBR Eld.-4-W C2	94.12	96.36	82.09	90.86
TZBR Eld.-4-Y C2	97.92	96.33	92.88	95.71
BR 9928-DMRSR C1	97.10	94.10	92.29	94.50
BR 9943-DMRSR C1	97.62	98.96	98.28	98.29
BR TZL Comp 4 DMRSR	97.33	94.44	94.81	95.53
Ama TZBR-W C4	92.78	89.76	95.61	92.72
Ama TZBR-Y	96.83	98.33	88.94	94.70
TZBR Comp 1-W C1	100.00	89.19	97.11	95.43
TZBR Comp 2-W C1	100.00	81.11	95.37	92.16
TZBR Comp 1-Y C2	100.00	94.81	94.09	96.30
TZBR Comp 2-Y C2	100.00	97.73	93.45	97.06
QPHM 200 (Check-1)	97.22	93.21	91.86	94.10
HN GOLD (Check-2)	98.89	98.96	89.06	95.64
HYBRID-1	100.00	-	-	100.00
HYBRID-2	97.44	-	-	97.44
HYBRID-3	100.00	-	-	100.00
HYBRID-4	100.00	-	-	100.00

20.2 M&E Annexure

Progress on output indicators during the reporting period

Indicator	Beneficiaries
Number of farmers linked with/benefiting from agriculture extension services through scaled up extension system	3469
Number of improved production and agriculture management technologies/practices transferred/made available to farmers	2100
Number of demonstration plots/farms/trials established for farmers' awareness on improved agriculture technology and management practices	5337
Number of farmers received information on improved agricultural management practices through demonstrations/field days/trials	2797
Number of farmers and others getting assistance (sperm,) ruminants up take and , seed villages, seed partners, new seed varieties/cultivars/rootstock of cereal, horticultural and agronomic crops transferred to farmers) supported/established to disseminate seed of improved high yielding varieties.	9000
Number of farmers linked with input/service providers for improved production services/inputs	2555
Number of new breeding lines/cultivars/rootstock of cereal and horticulture crops at development stage	1050
Number of partnerships developed with input suppliers/companies for development of production inputs/services (PPR vaccine, Semen, new varieties)	89
Number of value chain assessments carried out to identify value chain constraints and opportunities (best bet interventions)	05
Number of training events arranged for interventions under different value chains	19
Number of farmers linked with public/private business development service providers (Input supply facilities, industries) through established partnerships	1654
Number of farmer selling products (cereals, vegetables, fruits, milk and small ruminants) value added , production cost decreased a as a result of Project interventions	1434
Number of workshops carried out to disseminate new and improved agricultural products	8
Number of new/improved products identified and disseminated through value chain interventions	18
Number of training events arranged on concepts of value chain and value chain assessment/analysis	4
Number of entities (including national scientists, academics, value chain actors etc.) received training on concepts of value chain	1763
Number of tools designed and utilized for carrying out value chain assessment	2
Number of training events arranged in agriculture production and management (livestock, cereals and horticulture) on skill improvement of farmers, NARS scientists, extension workers and others	31