Agricultural Innovation Program for Pakistan (AIP)

Semi-Annual Report

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ACRONYMS

AI	Artificial Insemination
AARI	Ayub Agriculture Research Institute
AIP	Agricultural Innovation Program
AR	Adaptive Research
AJK	Azad Jammu And Kashmir
ARI	Agriculture Research Institute
ARS	Agriculture Research station
AVRDC	The World Vegetable Center
AZRI	Arid Zone Research Institute
BARI	Barani Agricultural Research Institute
BARDC	Baluchistan Agriculture Research Development Center
CA	Conservation Agriculture
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
DAP	Diammonium Phosphate
DG	Director General
DQA	Data Quality Assessment
DSR	Direct Seeding of Rice
DSS	Decision Support System
DWNUY	Durum Wheat National Uniform Yield Trial
DVC	Dairy Value Chain
FQ&SRI	Food quality & Safety Research Institute
GB	Gilgit Baltistan
GOP	Government of Pakistan
HRD	Human Resource Development
HA	Hector
HTMA	Heat Stress Tolerance Maize for Asia
ICARDA	International Center for Agricultural Research in the Dry Areas
ICT	Information and Communication Technology
ICI	Imperial Chemical Industries
IITA	International Institute of Tropical Agriculture
ILRI	International Livestock Research Institute
IPM	Integrated Pest Management
IPMP	Insect Pest Management Program
IRD	Informal Research and Development
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
LCC	Leaf Color Chart
MARC	Mountain Agriculture Research Center
MC	Multi Crop
MFSC	Model Farm Services Center
M&E	Monitoring and Evaluation
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
NRS	National Recruited Staff
NT&HVCRI	National Tea & high Value Crop Research Institute
NRSP	National Rural Support Program
NSTHRI	National Sugar and Tropical Horticulture Research Institute
NUYT	National Uniformity Yield Trial
OPV	Open Pollinated Variety
PARC	Pakistan Agricultural Research Council
PVS	Participatory Varietal Selection
PLD	Punjab Livestock Department
QAARI	Quaid-E-Awam Agriculture Research Institute
QPM	Quality Protein Maize
RA	Research Associate
RARI	Regional Agriculture Research Center
RMP	Rafhan Maize Products
RRI	Rice & Research Institute
RSP	Rural Support Program
SARC	South Agriculture Research Center
SEP	Socio Economics Program, CIMMYT
SPU	Semen Production Unit
SSNM	Site Specific Nutrient Management
TASP	Tropical Animal Science and Production
TCS	Tara Crop Sciences
UAF	University Of Agriculture, Faisalabad
UAP	University of Agriculture Peshawar
UVAS	University of Veterinary & Animal Sciences
UC	Union Council
UC Davis	University of California, Davis
USAID	U.S. Agency for International Development
VRI	Vegetable Research Institute
WRI	Wheat Research Institute
ZT	Zero Tillage
ZTHS	Zero Tillage Happy Seeder
AI	Artificial Insemination
AARI	Ayub Agriculture Research Institute
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1 Summary

Agricultural Innovation Program for Pakistan (AIP) achieved the set targets and development objectives during the reporting period (April 2016-September 2016) by adopting the result based and participatory approach to enhanced agriculture productivity. The project is implemented across Pakistan and assisted farming community 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. Facilitating linkages of farmers with private sectors helped in increase of household income. Women's participation and involvement in the project interventions was crucial part of the project. Competitive Grants System for provinces introduced and held extensive discussion with national and provincial stakeholders to come up with an alternative to the initially proposed creation of Provincial Agricultural Research Boards for Development (AR4D) in three provinces.

Farmer participatory trials on hay and silage was conducted in Sindh, KPK, Punjab and AJK with 102 farmers and the benefits of feeding hay/silage was disseminated through awareness/training programs to 1700 livestock farmers from 20 villages. Improved forages (Rye grass, Rhodes grass, sorghum, millet, maize) was introduced in Swat, GB, Sindh, AJ&K and Punjab planted on 21 hectares. Two village based seed enterprises (Rye grass) in GB and input supplier (Silage) in Bahawalnagar was established. Four rotational grazing trials (Chakwal, Lorali, Ahamadun and Umerkot) with goats/sheep and 2 fattening trials in Umerkot and Lorali were conducted. Thirty livestock assistants from all provinces were trained on AI in goats, and 40 NRS from all provincial and state livestock departments were trained on the use of ultrasonography in small and large ruminants. In district Khuzdar (Balochistan), a health camp was conducted and 10,603 goats and sheep belonging to farmers were drenched with anthelmintics. The first ever 'Khawateen Goat Show' was conducted in Bahawalpur where more than 700 women participated.

Significant achievements of the AIP-Maize component were the extensive evaluation of diverse maize germplasm in the country. The evaluation included specialty maize including Vitamin A, Zinc and protein enriched hybrids. Demonstration seed of the newly launched two QPM hybrids were also distributed to farmers in KPK, AJ&K and Punjab province. Enhancing local seed production of hybrids and OPVs remained the lynchpin of the AIP maize efforts. As a result, ten partners started the seed increase of parental lines of hybrids and breeder seed of open pollinated varieties. Eleven AIP derived maize germplasms are under the national and provincial variety registration process which will help the country to gain maize seed in sufficient quantity in the foreseeable future. Forty Pakistani scientists received training on data management and statistical software that will help to run efficient new varietal development programs. The public-private partnership was enhanced particularly in joint variety evaluation and promotion of AIP maize products.

AIP agronomy collaborated with 23 national partners and reached to 3200 farmers through assisted application of improved techniques on 411 sites, provision of 92 planters and 800 LCC, training to 267 stakeholders and dissemination of technologies through field days to 1732 farmer in the project area. AIP-CIMMYT collaboration with private sector Greenland Engineers and Petal Seeds resulted in production and distribution of 92 planters including 37 Multicrop (MC) Zero till planter for DSR and 55 push row maize planters to farmers in Pakistan and 291 farmers used locally manufactures planters for planting of maize, cotton and rice in the provinces of Punjab, KP, Sindh and Balochistan. These planter helped farmers in

reducing labor cost, reduced planting time, improved plant population and grain yield 10-20 percent. The distribution of 800 LCC charts among rice farmers helped farmers to save 65 Kg Urea per hectare without reducing rice yield.

AIP-Wheat conducted on farm demonstrations- Informal Research and Development (IRD) involving 7,200 smallholders' farmers including women from 53 districts of Pakistan compared newly released, high yielding and rust resistant wheat varieties with their existing ones. Post-harvest assessment of new improved wheat varieties indicated that 82% will grow new varieties next season, 81% saved on average 321 kg seeds sufficient to plant >6 acres. This effort alone will result in replacing old and obsolete varieties by new ones substantially. Participatory Varietal Selection (PVS) trials involving 255 farmers from KP, Punjab and Sindh reveled that new improved varieties gave on average 13% yield advantage over local checks. Increase in wheat yield due to new varieties can feed to 2 to 3.3 persons per year contributing to household food security. The project facilitated Public-Private Partnership produced and sold more than 900 tons of quality wheat seeds (including basic and certified seeds) during last autumn generating a gross incremental income of $ 390135. . Capacity building of 4181 participants including researchers, students, seed company staff and seed growers will help improve overall wheat productivity at large. AIP-vegetable carried out 62 trials, comprising of 187 varieties of six different vegetables, and 1,865farmers have participated in on-site trainings to adopt improved packages of production technologies. The promotion of off-season spinach and coriander under green shade nets in six locations showed major opportunities for extra income, with an average spinach yield of 43.9 t/ha worth US$ 14,647, and an average coriander yield of 14.6 t/ha worth US$ 15, 979. Average net profits from protected and off-season tomato for Sindh and Punjab provinces were US$ 5,483/ha in 2015 and US$ 9,484/ha in 2016. AIP-Vegetable component has identified varieties for open-field off-season frost-free production environment. The yield of tomato public sector hybrids is higher or at par with commercial hybrids. Over 21 ton of certified seed of five vegetables has been produced and farmers in three provinces linked with seven seed companies to market their produce. Moreover, AIP-Vegetable has made discernible achievements; declared and forged the first national onion seed production village Shuga, district Buner of KPK province & provided onion seed thresher to seed grower association that will save up to $1.30/kg in processing cost and will have a major impact on lowering seeds costs to farmers.

AIP-perennial horticulture disseminated good agricultural practices through 67 trainings, workshops and field days with a total of 1302 beneficiaries. A total of 203 farmers farming 2781 acres adopted innovative agricultural practices. The production on pistachio demo plots was increased 2-3 times the base year. Under E-Pak Ag, the working paper launch identified the needs and major opportunities to advance the use of ICT in better reaching farmers. In Human Resource Development component AIP Scholar's Conference and need based vocational trainings strengthened the skills of Pakistani scientists.

The AIP project has outperformed and a total of 35,000 beneficiaries were provided assistance including 4,000 women. To meet the targets a rigorous monitoring was under taken in different project areas to ensure that activities are on track with the monitoring plan. AIP-CIMMYT DQA for 10 MSF outcome indicators was conducted by MSI. Based on DQA experience, AIP Monitoring Unit carried out DQA of implementing partners with a purpose to ensure data quality in the project..

Security risks particularly in Sindh and Balochistan provinces has caused delay in carrying out some of the activities, however, AIP is incessantly committed to improve the Pakistan's agricultural productivity and increase the livelihoods of farmers in partnership with all stakeholders.

2 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.

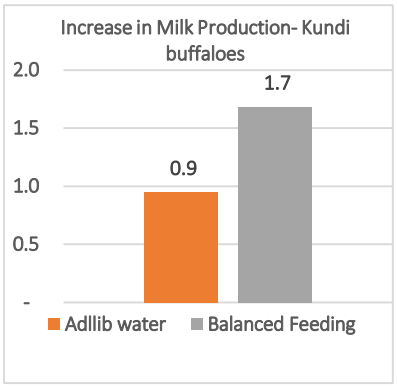
AIP operates through three Activity Windows: commissioned projects, a competitive grants system and human resource development (HRD). Work within these activity windows addresses complex agricultural systems which is divided into four 'Science Windows' – cereals and cereal systems, livestock, vegetables 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

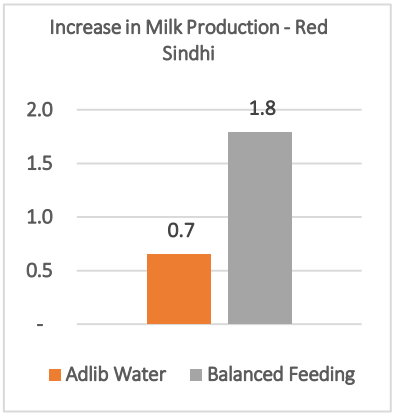
3.1 Dairy Value Chain

3.1.1 Feeding strategies to enhance milk production of red Sindhi cattle and Kundi buffaloes in Sindh province

As a continuance of a previously conducted trial aimed at enhancing livestock production, farmer participatory dairy production trial was conducted to study breed-specific effects and improvements on Kundi buffalo in village Musa Khatian, Hyderabad District and Red Sindhi cattle in village Taj Muhammad Laghari, Matiari District. Seven farmers from each village having 22 buffalo and 27 cattle respectively, participated in the trial.



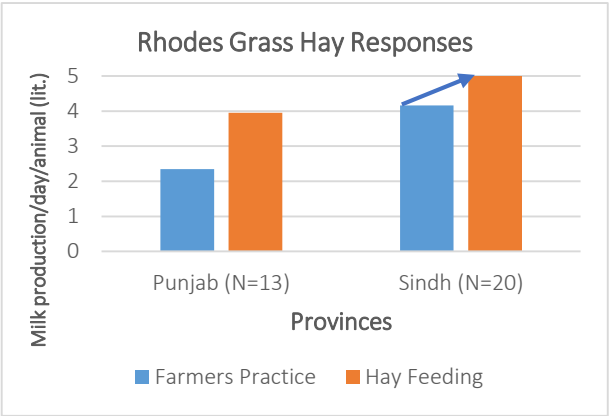
As a result of free access to water, the average increase in milk production per animal per day was 0.95 litres (buffaloes) and 0.65 litres (cattle) and increase in milk production due to free access to water and balanced feeding was 1.7 and 1.8 litre/animal/day in buffalo and cattle, respectively. Also the body condition score of the animals increased noticeably. These daily increments in milk production resulted in additional income of 61 and 110 PKR due to free access to water and balanced feeding. While in Red Sindhi cattle additional income produced was 29 and 80 PKR respectively.



Following the trial, AIP-Livestock conducted a farmers' awareness program to disseminate results and overall impacts. There was an overwhelming response from livestock farmers in the village and more than 500 farmers attended the dissemination program. At the close of the program, water troughs and milk can were distributed to the 389 selected farmers of these villages. Farmers who obtained the highest milk response were awarded with 06 bags of concentrate feed.

3.1.2 Alternative solution to overcome extreme fodder shortage periods through Rhodes grass hay

AIP-ILRI has also been conducting series of farmer's participatory trials in different agro-ecologies (hilly terrain etc.) under different feeding regimes. These trials have provided the baseline to quantify the breed specific potential of dairy animals in Pakistan. AIP-ILRI has conducted the trial in collaboration with Farm Dynamics Pakistan Pvt. (Ltd.) on the introduction of Rhodes grass as an alternative feed at Tehsil Ubauro (Sindh) and Sadiqabad (Punjab). AIP-ILRI compared the two different production systems (Intensive to semi-intensive) at two different localities representative of Punjab (Basti Jamu) and Sindh (Sikander Chachar) provinces.

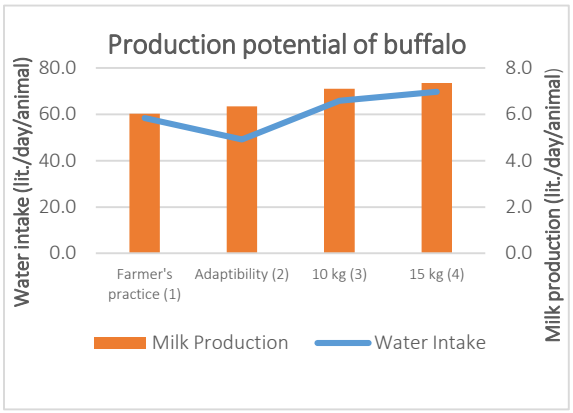


A comprehensive farmer participatory dairy trial on local cattle was conducted in 02 villages of Sadiqabad and Ubauro Tehsils. Nineteen small holder dairy farmers owning 40 milking cattle participated in this trial. The objective of this research trial was to check the economic viability of the Rhodes grass hay as compared to straws and stovers especially in fodder scarcity periods.

The result shows that Rhodes grass hay served as an alternative feed in both provinces where wheat straw has been replaced in Punjab (66%) and Sindh (37%). Moreover, the result revealed that the extra milk would be collected every day from this rural cluster in Punjab (2400 liters) and Sindh (1500 liters) areas under Rhodes grass feeding regime. This can improve the food security conditions as well as substantial marketable surplus milk would also be available in this dairy pocket (identify by the livestock and dairy development department, Punjab).

3.1.3 Silage as alternative feed during lean period in Southern Punjab

Silage is an excellent nutritional feed for dairy animals as compared to dry roughages during lean periods. AIP-ILRI has introduced silage as alternative feed in dairy hub of Southern Punjab (district Bahawalnagar) through farmer's participatory trial comprising 16 dairy buffaloes for 25 days trial length to get direct benefits in terms of higher milk production (US$ 470) and indirect benefits from reduction in usage of other feed resources (US$ 208). Silage feeding not only provided quantitative benefits but also resulted into quality improvements in terms of removing foul smell from milk and improve the end product.



AIP-ILRI has assisted Rafique Agrico, Sahiwal (Punjab) on the use of an inoculant to enhance the ensiling process and storage life of baled silage, and in return the collaborator provided a special price rebate on ultimate product for smallholder dairy farmers in Pakistan. This joint venture has been setting the platform for the good quality silage for the dairy animals and control impulsive downfall in the dairy production trends in feed scarce periods in Pakistan. The project has provided 65 tons of bailed silage for 249 milking animals belonging to 69 livestock farmers from AJ&K, KP and Punjab. The average increase in milk production was 1.2 liter per day/animal, and it ranges from 0.8 to 2.5 liters per animal per day.

Baled silage and animals relishing it

3.1.4 Moveable mesh wall dairy animals housing for mountainous and disaster prone terrains

Various types of livestock housing serve as a coping strategy against the climatic anomalies which affect the production potential of the dairy animals. Historically, the mountainous terrain of Pakistan is witnessed by extreme climatic incidence including floods, abrupt changes in rainfall pattern as well as heavy snow fall.

Thus, AIP has inaugurated first moveable mesh wall model housing for the dairy animals in collaboration with livestock and dairy development department, KP during the farmers awareness program on various feeding strategies for indigenous Azi-Kheil buffalo breed on May 29, 2016 at village Bedara, district Swat. This model housing was handed over to the poor widow dairy farmer to improve the management practices and conditions for dairy animals. Moreover, more than 700 dairy herders also attended this program from various parts of the Khawaza khela area within Swat.

Inauguration of the mobile mesh wall housing in Swat, KPK

3.1.5 Impediments, Interventions and Impact Assessment for Dairy Farmers in Pakistan

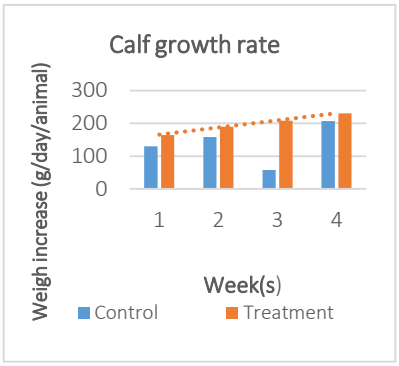
The establishment of farmer's participatory model farms (14) in Punjab helps in recovering 1.4 million PKR (US$ 133,333) worth from feed wastage annually. However, the water and balanced feeding intervention resulted into 6.2 million PKR (US$ 620,890) benefits alone in Punjab. The identified constraints and key issues have been effectively addressed through farmer participatory field demonstrations and targeted capacity building on specific issues, which could eventually lead to change in mind-set and significantly increase livestock productivity, and their livelihoods. The above findings were presented at the 1st International Conference on TASP held in Thailand from 26-29 July, 2016.

Model farms in Bahawalnagar

3.1.6 Introduction of calf starter to enhance calves growth rates

The farmer's participatory trial was conducted with total 39 calves (24 male and 15 female) in village Ganga Singh district Bahawalnagar. The result reveals that the calves' growth can be further increase by 198 grams per day/animal with only providing half a kg of calf starter after one month of age.

Over a period of 3 months, the calves will be 12 kg heavier than the recommended three month of age for feeding calf starters. In terms of opportunity cost, every livestock farmer in Pakistan is losing US$ 21 in those two months. According to the statistics, livestock farmers in Punjab only have been paying US$ 113,079 with 30% adoption rate of feeding calf starter for their calves as an opportunity cost.



Farmer weighing his calf relishing it

3.1.7 Rural entrepreneurs: Unemployed youth in rural dwellings links with Dairy value chain

AIP-ILRI has been encouraging rural entrepreneurs to setup the business models best suits the different agro-ecologies to uplift the rural economy bridging gaps of input supplies for betterment of livestock sectors. Mr. Sajjad has laid the foundation stone for AIP-ILRI in Punjab. He started the village based silage input supplier model and up to now sold 4 MT of bailed silage to 11 livestock farmers in his village within one month. He is hoping to expand his business and also planning to buy other farm inputs to diversify his business in coming days.

Input supplier in Bahawalnagar

3.1.8 Gender sensitive analysis of dairy sector contribution towards food security in Gilgit

The study focused on the widow livestock farmers to get an in-depth view of rural livestock economic system in Gilgit as a special case study. Information from 26 widow livestock farmers was gathered using a structured questionnaire covering the various aspects of livestock related activities and their shares. The result reveals that 88% farmers owned at least 1-2 milking animals which contributed US$ 60-150 monthly, apart from daily home consumption. Moreover, 58% farmers didn't have proper housing facilities for their animals to mitigate the harsh climatic conditions in the area. Majority of farmers (81%) were more cater towards marketing of milk and milk products, of this 57% sold butter and 19% sold desi ghee. Despite of these earnings, the major share was spent on purchasing of wheat bran (76%) and wheat straw (34%) due to unavailability of the lands for fodder cultivation. Based on the Dairy Value Chain Rapid Assessment report of AIP-Livestock, the biggest confronting challenge to the rural livestock economy is the primitive method of management and availability of

Interviewing a widow in Bahawalnagar

extension services related to improve management practices, fodder varieties, availability of farm inputs and poor physical infrastructure related to the marketing.

3.1.9 Willingness to pay for aflatoxin free raw milk

AIP-Livestock aimed to help milk producers by investigating consumers' preferences for different attributes of aflatoxin free milk. For this purpose, a discrete choice experiment was conducted with a random sample of 360 households drawn from two mega cities of Punjab (Faisalabad and Lahore) and capital city (Islamabad). Random parameter logit and latent class models were used to incorporate preference heterogeneity in the choice analysis. Empirical findings suggest that consumers have maximum willingness to pay for milk having minimum concentration of aflatoxin. Based on these findings, we suggest there is considerable scope for the rapid development of aflatoxin free milk, even though it will be marketed at prices that are significantly higher than current milk prices.

3.1.10 Pre-testing of livestock adoption census survey in District Bahawalnagar

AIP-ILRI has initiated the process for piloting adoption census surveys across the Pakistan. AIP-ILRI team has already pre-tested this survey for further refinements and mutated towards realistic manners. In August, Dr. Nils Teufel (ILRI Scientist) were visited Pakistan and devised the action plan for the implementation of this proposed survey in more than 50 project villages. This census survey would set the platform for getting the exact adoption figures for each technologies and initial internal assessment for farmer's responses to technology promotion activities of AIP-ILRI.

Re-testing of adoption survey questionnaire Bahawalnagar

3.2 Small Ruminants Value Chain

3.2.1 Small ruminants health camp at Baghbana, Khuzdar, Balochistan

The Baghbana area of district Khuzdar was particularly focused to demonstrate proper control strategy against internal parasites in sheep and goats. The fecal samples analysis of the sheep and goats from this target site showed 80% animals infected with seven types of internal parasites i.e., *Dictyocaulus, Moniezia benideni, Moniezia expensa, Fasciola hepatica, Strongyloides, Trichostrongylus* and *Trichuris ovis* with mean 2400 fecal egg counts.

A Small Ruminants Health Camp was held from May 06-08, 2016 in collaboration with PARC and Livestock Department, at Baghbana, Khuzdar, Balochistan. A total 10,603 animals (6353 sheep and 4250 goats) belongs to 78 farmers were drenched with anthelmintic (Nilzan Plus). The farmers were provided awareness on the handling of internal parasitic problems and also major diseases in sheep and goats.

Farmer health camp in Kuzdar, Balochistan

3.2.2 Lamb/kid fattening with supplemental feeding

The lambs/kids (Bibrik, Shimwar Afghani, Kamori, Beetal and Patari breeds) fattening protocol with different commercial supplemental rations were demonstrated at Loralai (Balochistan) and Umerkot (Sindh) for sale on Eid-ul-Adha marketing/scarification. During this period, the prices of animals are higher and farmer can earn up to 30-40% extra returns. Therefore, the farmers prefer to rear animals for 5-6 months prior to this event and started marketing 10-15 days before this event.

a) Fattening of Lambs/kids at Loralai

A total of 60 male-lambs and 30 male-kids were selected from three farmer's flocks at Darghai Saifullah, Loralai. The lambs/kids were equally divided into three groups i.e., A, B and C. All the lambs/kids were allowed in nearby areas for grazing daily for 6-8 hours. In the evening the lambs/kids in group A were fed commercial concentrate (source I), and those in group B were fed commercial concentrate (source II), and group C was the control (no concentrate feeding). The concentrate feed was offered @ 0.5 kg/head daily from June 13, 2016 to September 1, 2016. Before the start of the experiment, all the animals were drenched against internal parasites, ear tagged and initial live-weight recorded. Thereafter, live-weight data was recorded at 15 day intervals. The lambs/kids in group A showed the highest mean live-weight gain (15-17 kg), followed by group B (12-16 kg). Lambs/kids in the control group gained only 5-6 kg of live-weight over the 80 day period.

b) Fattening of kids at Umerkot Sindh

Three farmer flocks having 30 goats of mix breeds (Patari, Kamori and Beetal) in each flock were selected at Umerkot Sindh for the demonstration of the fattening operation. Thirty male-kids between 10-11 months old from three flocks were equally divided into three groups i.e., A, B and C. All the kids were allowed in the nearby area for grazing daily for 6-8 hours. In the evening the kids in group A were fed supplemental commercial ration I (Source I), kids in group B were fed the other ration II (Source II) and last group was not given any supplemental feed. The supplemental feeding was given @ half kg/head daily during July 15, 2016 to September 9, 2016. Before the start of the experiment all the animals were drenched against internal parasites, ear tagged and initial live-weight gain data were recorded. Afterwards, the live-weight gain data was collected on 15 day interval. The kids in group B showed higher live-weight gain (10.22 kg) followed by group A (7.5 kg). While kids in the control group (C) gained only 3.77 kg live weight over 60 day period.

3.2.3 Increasing goat productivity through improved breeding bucks in Bahawalpur

In Pakistan, most of the farmers have mix goat breeds without clear breeding objectives, as such the expected genetic improvements are rather arbitrary. AIP-Livestock provided two pure Beetal (Makhi-Cheeni) breeding bucks to the local community at Chak 93DB to improve productivity and incomes from goat production. Five farmers' goat flocks were involved in this breeding exercise.

The breeding strategy (like breeding season, supplemental feeding to breeding stock, record keeping of the breeding) and provision of two quality bucks was compared with the use of local mix beetal breed bucks with five farmers' (having 20-30 goats each). The breeding was initiated in November 2015 and kids were received in April 2016. The birth weights of kids dropped from the use of quality bucks were higher (2.2 kg) as compared to those from local bucks (1.5 kg). The animal production percentage was higher (84%) in properly managed flocks compared with local practices (78%).

3.2.4 Recognition of the role played by female livestock farmers in deserted rural ecologies of Pakistan

Khawateen Goat Show was organized on August 27, 2016 in collaboration with UAF and KWC, Bahawalpur for the appreciation and recognition of the role of women in livestock sector.

More than 700 female livestock small holders, included 182 female small holders from district Bahawalnagar attended this historic event and setting new trends in agro-based economy of Pakistan and take on board important stakeholders of Society. Trophies and cash prizes were awarded to those who reared the best male, female goats, and also the best goat kids.

3.2.5 Development of Model cum Training farms for Small Ruminants linked with the value chain

a) Model farms Umerkot, Sindh

AIP-Livestock collaborator ICARDA established three model cum training farms at Umerkot, Sindh. The first one was inaugurated by Technical Advisor of Chief Minister, Sindh on September 05, 2016. The event was attended by officials from the Planning Division of the GOP, PARC, Livestock Department in Umerkot, AZRI and 50 farmers. They were briefed on objective, concept and protocol of the model farm. The Chairman PARC briefed on joint effort of AIP and PARC for uplifting the farming community. Member of Animal Science provided a view of the livestock production in context of Sindh ecology. Stakeholders highly appreciated the model farming concept launched by the AIP in Sindh.

b) Model Farm at 54 DB, Bahawalpur

Two Small Ruminant Model Farm were completed and inaugurated at 54 DB, Bahawalpur on the 9th of August 2016. Sixty participants included farmers and the representatives from the Punjab Livestock Department, ICI and the Corporate Group participated.

Small ruminant model farm inauguration in Bahawalpur and Umerkot

Kids from the Makhi-Cheeni beetal buck

3.2.6 Application of ultrasonography in small and large ruminants

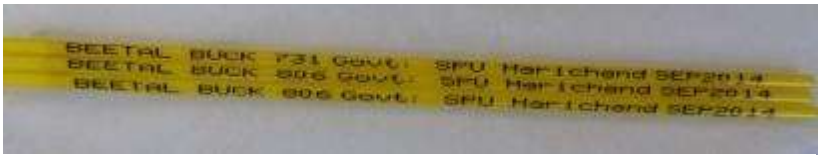
AIP-Livestock in collaboration with ICARDA and UVAS, Lahore conducted four days training from August 8-11, 2016 on "Field application of Ultrasonography in small and large ruminants" at UVAS. Twenty veterinarians from all the provinces and administrative states of Pakistan were trained for utilizing ultrasounds. The participants also received hands-on training on the identification of various stages of the reproductive cycle

Field application of Ultrasonography in Chakwal

In collaboration with ICARDA, AIP-Livestock conducted a special four days training on ultrasonography on from August 16-19, 2016 at NARC Islamabad. The training focused on the field application of ultrasonography for pregnancy diagnosis to improve fertility in small ruminants and to set the framework for the introduction of ultrasound-based pregnancy diagnosis in Chakwal and Bahawalpur. The field training was conducted with the flocks in the two model farms set up at the project site in Chakwal. Trainees obtained hands-on training and practice on portable ultrasound devices fitted with both sectorial probes for trans-abdominal pregnancy diagnosis and linear probes for trans-rectal use.

3.2.7 Artificial insemination in goats

In 2014, AIP-Livestock together with UAF took initiative to maintain the genetic purity of the small ruminants by introducing AI in goats including high productive goat breeds such as beetal, makhi cheeni, Nachi etc. In 2014, a group of 24 NARS scientists, academia and members of breeder associations from Punjab, Sindh, KP, Baluchistan and AJ&K were trained as master trainers. Since then, to date 1771 have been trained on AI in goats (1519 government and private practitioners and 252 final year veterinary students). As a continuing activity and AIP-livestock conducted a demand driven three days training in collaboration with the Reproduction and Breeding program (NARC), and L&DDD, KP at NARC Islamabad for 30 participants (field veterinarians, livestock assistants and private AI technicians from all provinces). Beetal goat semen produced at the SPU at Harichand was used at this training. Also, the participants were trained on the use of ultrasonography to detect pregnancy. The AI goat training manual the Nachi judging and selection manual produced by the project were used as training materials.



Frozen Betal semen straws in Harichand farm, KPK

3.3 Range, Fodder and Feed

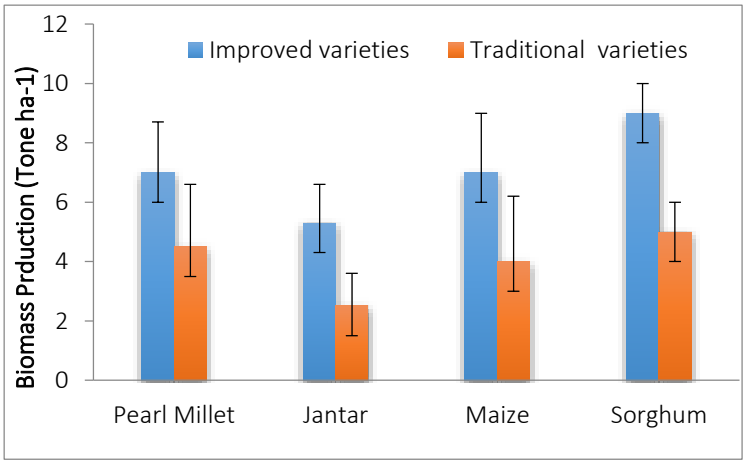
3.3.1 Performance of multi-cut sorghum in problematic soils in deserted ecologies

The livestock farmers under deserted ecologies were mainly relying on canal water irrigation and the rest was met with tube well irrigation systems. AIP-ILRI has been working in Tehsil Haroonabad where farmers were facing severe fodder shortages due to inundation of their cultivable lands under saline water last year (damage of saline water drainage in the area and more than 50 villages were affected). AIP-ILRI initiated an activity in May 2016 to cultivate multi-cut sorghum (late sowing) in these lands (six acres on water stressed conditions and four acres on saline conditions) with higher seed rate to get the substantial fodder production for their animals. The result shows that the height of the plants were 8-9 feet as compared to 6-7 feet traditional sorghum variety. The livestock farmers were able to get 17 tons per acre yield of sorghum (2 cut on an average) and maintain the availability of fodder in the severe soil problematic conditions as well. In terms of opportunity cost, those livestock farmers saved US$ 3040 (@ US$ 40/Kanal standing crop) in this year.

Multi-cut sorghum Bahawalnagar

3.3.2 Demonstration of the potential fodder varieties in Sindh

Improved varieties of Maize S-2002, Millet KS.05, Sudan Sorghum grass hybrid (SS2002), *Sesbania bispinosa* (Jantar: KS.TG.1 Long) were planted in May 2016 in 10 farmer fields under irrigated conditions in Umerkot Sindh. The main objective was to improve the fodder productivity and to make a comparison with the local traditional varieties to educate famer communities of the Kunri area of Sindh.



The biomass production of improved varieties were significantly higher than the local traditional varieties. All of the improved varieties produced nearly their maximum potential for Pakistan. The increase of 50% more biomass as compared to traditional variety in not only fulfilled their own feed requirements but also was sold to neighboring farmers.

3.3.3 Performance of Rhodes grass in Punjab and Sindh:

In collaboration with AIP-Livestock collaborator (ICARDA), Rhodes grass (Katambora) plantation was established in May 2016 as a feeding component part of value chain on an area of two ha at Chak# 54, Bahawalpur (Punjab) and 3.5 ha in village Kunri (Sindh). After one month, one meter quadrate was used to measure the biomass and found that the Rhode grass produced 6 tons per ha^{-1}. Animal performance from these sites will be evaluated in November 2016.

Rhodes grass in Bahawalpur

3.3.4 Village Based Seed Enterprise (VBSE) in Danyore valley, District Gilgit

Ryegrass is a widely grown cool season grass which has greater suitability and agronomic potential in northern mountainous parts of Pakistan. AIP-ILRI has been working for the improvement of dairy production through higher biomass production of improved fodder varieties especially in mountainous areas like Gilgit since 2015. Chand Bibi, a female dairy farmers successfully produced ryegrass seed to lay a foundation stone for village based seed enterprise in Danyore valley through AIP-ILRI improved fodder varieties seeds program. The field monitoring and result shows that she earned/saves US$ 784 amount biomass production last year with the meager US$ 16 investment from AIP-ILRI by providing only one kanal seed initially. This amount is other than three kg ryegrass seed (US$ 16 per kg) production from only three quarter of the land cultivated last year. AIP-ILRI seeds program in Gilgit last year yielded amounted US$ 4516 from high biomass production only from 2.5 acres of land which helps the dairy farmer to provide highly nutritious feed with increased milk production (0.5-2.5 lit./day/animal) for their animals.

Rye grass seed entrepreneur in GB

3.3.5 Effect of rotational grazing on rangeland and livestock productivity in arid/semi-arid

a) Monitoring biomass production in rangelands of Chakwal

In continuation of the last year rotational grazing trials at Chakwal, the biomass production is being monitored. Vegetation sampling was conducted in April 2016 at both research sites. The data revealed that in the protected area the total biomass was 375 and 280 kg ha^{-1} and in the unprotected area 190 and 176 kg ha^{-1} at Dhulli and Beghal sites, respectively. This year both site received 70% less rainfall as compare to 2015. The stocking rate in protected area was kept 2.7 and 2 animals/ha/month while it was 1.4 and 1.3 animals/ha/month in control plots at Dhulli and Beghal sites, respectively

b) Rotational grazing at Ahmadun, District Ziarat, Baluchistan

In 2nd consecutive year, the biomass sampling was done from the same blocks developed during 2015. Same procedures were used which opted in 2015 for plant sampling. The Biomass was measured in April

in each block and fresh biomass production was 746, 711, 597, and 749 kg ha-1 in block A, B, C, and D respectively while in the grazed area the biomass was 457 kg ha-1. The stocking rate in protected area was kept 5 animals/ha animals/ha/month while it was 3.3 animals/ha/month in control plot.

c) Rotational grazing at Dargai Saifullah, District Loralai, Baluchistan

Dargai Saifullah, district Loralai, is the new study area, located in north-east part of Baluchistan, receiving an annual rainfall between 200 to 250 mm where the local community protected approx. 500 ha for last one year. The grazing is managed with the approval of selected committee of the village. Before initiation of activity, there was no systemic rotational grazing. The protected area was equally divided in to 3 blocks and selected one plot in un-protected area as a control. The total fresh biomass production was 592, 647 and 539 kg ha-1 in block A, B, and C respectively while in control plot the biomass was 187 kg ha-1. The stocking rate in protected area was kept 4.5/animals/ha/month while it was 1.4 in control plot.

Discussion with Community in Lorali

The ewes that grazed on protected rangelands before and after the monsoon season showed higher average daily live-weight gain (27 and 66 gram, respectively) than on un-protected rangeland (24 and 48 gram, respectively) in 73 and 50 days, respectively. The data indicates that sheep could gain more weight on protected pastures with an increase of 2.74g/day before monsoon and 18 g/day after monsoon compared to the unprotected sites.

d) Rotational grazing at Hurrabad, Umerkot, District Sindh

AIP program initiated a study to monitor the effect of rotational grazing on the rangeland biomass and livestock productivity in Hurrabad, District Umerkot. At this site the range area was protected from grazing since early 2016, and divided into three blocks having 15 ha each, and a block of same size as control (un-protected area). The plant sampling was done in the end of April 2016 before monsoon rainfall. The fresh biomass production was 152, 170 and 181 kg ha^{-1} in block A, B, and C, respectively while in control plot the biomass was 28 kg ha^{-1}. The stocking rate in protected area was 2.5 animals/ha/month while it was 0.35 animals/ha/month in un-protected area. The ewes/does grazing on protected rangelands before and after monsoon showed higher than average daily live-weight gain (69 and 204 g, respectively) than livestock on un-protected rangeland (19 and 143 g, respectively) in 42 and 28 days, respectively. Livestock could gain more weight on protected pastures with an increase of 49.52g/day before monsoon and 61.43 g/day after monsoon as compared to the unprotected sites.

View of open vs controlled rangeland

3.3.6 Village Awareness Programs in district Jhang and Nankana Sahib

AIP- ILRI awareness program was undertaken on May 19, 2016 at farm level on "balanced feeding and open access to water" in 166-JB at Tehsil Jhang attended by a total of 151 participants including females. In addition, to awareness program water buckets and milk can were distributed among farmers for quality improvement. Moreover, awareness program about feed and fodder on August 17, 2016 has conducted in village Asal par, District Nankana Sahib. Rhodes grass seeds among 20 livestock farmers were distributed. Whereas, the important agronomic practices of Rhodes grass was also the part of the event to increase the production efficiency of Rhodes grass. A total of 32 farmers participated in the event.

Awareness & seed distribution in Nankana Sahib

3.3.7 High quality Protein Maize (HQPM) for Poultry

Amino acid profile of the two QPM (QPM 200 and QPM 300) introduced to Pakistan by CIMMYT was evaluated/compared with a conventional maize variety use by poultry feed manufacturers. The complete amino acid profile of these 3 maize types were analyzed at PCSIR (see appendix 01). The QPM's not only contained higher crude protein content, but also contains higher contents of the essential amino acids needed for poultry. Within the 2 QPM's, QPM 300 seems to have higher amounts of these essential amino acids. Based on this preliminary analyses, a broiler poultry trial is in progress at UAP to validate the performance of broilers fed conventional maize, QPM 200, QPM 300 and 50:50 ratio of QPMs.

4 Maize

4.1 Development/ introduction of climate resilient maize

The following climate resilient maize trials have been conducted and data were collected from the testing sites:

A total of 88 yellow kernel climate resilient maize hybrids sourced from CIMMYT's Colombia and Mexico offices have been evaluated across 13 sites. Trials consisting of 12 entries of white kernel hybrids sourced from Colombia were evaluated across three sites.

Heat stress tolerant hybrids consisting of 16 entries plus four local checks were evaluated across nine sites in Pakistan. The germplasm were accessed from the HTMA project, another CIMMYT led USAID's project being implemented in four South Asian countries: Pakistan, Bangladesh, Nepal and India. This effort targets to deploy best performing heat stress tolerant maize hybrids from the HTMA project in Pakistan by creating synergies among the two USAID's project (HTMA and AIP).

The above list of spring 2016 trials were grouped under 22 sets and were evaluated in different trial sites located mainly in Punjab and KPK provinces. The evaluation of these trials is helping AIP maize partners to identify well adapted climate resilient maize hybrids for future large scale commercial production.

Manual field preparation for AIP maize trials at Sariab-Quetta (Baluchistan)

4.1.1 Evaluation of low soil nitrogen stress tolerant maize

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 are being evaluated in Kharif 2016 season along with two local check varieties. The data from this second season evaluation will help to identify best low soil nitrogen stress tolerant varieties for commercial release. Three public research institutes (CCRI, MMRI and NARC) are hosting the trials and they are managed by not applying any type of nitrogen fertilizers.

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 IITA for evaluation in Kharif 2016. The inbred lines are white grain and adapted to mid altitude ecologies. The trials evaluation is being made for the second season at CCRI, MMRI and NARC and it is expected to identify best lines that will not only help to widen the genetic pool of partner's maize breeding program but also to develop drought stress tolerant hybrids or open pollinated varieties. Furthermore, such water efficient maize germplasms in Pakistan not only promotes climate resilient maize farming but also increases the competitiveness/profitability of the commodity by reducing water and energy use which in turn contributes in many ways to the climate and the national economy.

Field evaluation of climate resilient maize hybrids at Kanzo Quality Seeds and Ali Akbar Plc.

4.1.3 Registration of new climate resilient maize varieties in Pakistan

AIP maize partners are in the process of officially registering the allocated maize germplasm in the provincial or federal level variety registration system as per details given in below table. As a result, NARC is processing the case of three maize hybrids (two QPM and one normal) at the federal level. In addition, four OPVs in GB and five OPVs in Balochistan provinces are under the registration process in their respective provinces. Some of the private partners also started this registration process. The full status and outcome of this process will be shared in the next semiannual report. The registration process will help partners to list the new varieties in the federal or provincial variety registry which in turn creates public awareness.

List of candidate maize varieties under the registration process

No	Variety code/name under AIP	Maize type	Proposed by	Province
1	SA2146-75	Hybrid	NARC	ICT
2	SA1988-5	Hybrid	NARC	ICT
3	SA2150-4	Hybrid	NARC	ICT
4	TP1217	OPV	Dept. of Agriculture	Gilgit Baltistan
5	TP1220	,,	,,	,,
6	TP1222	,,	,,	,,
7	ZM521	,,	,,	,,
8	CZP132006	,,	Agr. Research Institute	Balochistan
9	TP1220	,,	,,	,,
10	ZM309	,,	,,	,,
11	ZM401	,,	,,	,,
12	ZM521	,,	,,	,,

4.2 Development/Introduction of biofortfied maize

4.2.1 Promotion and dissemination of quality protein maize in Pakistan

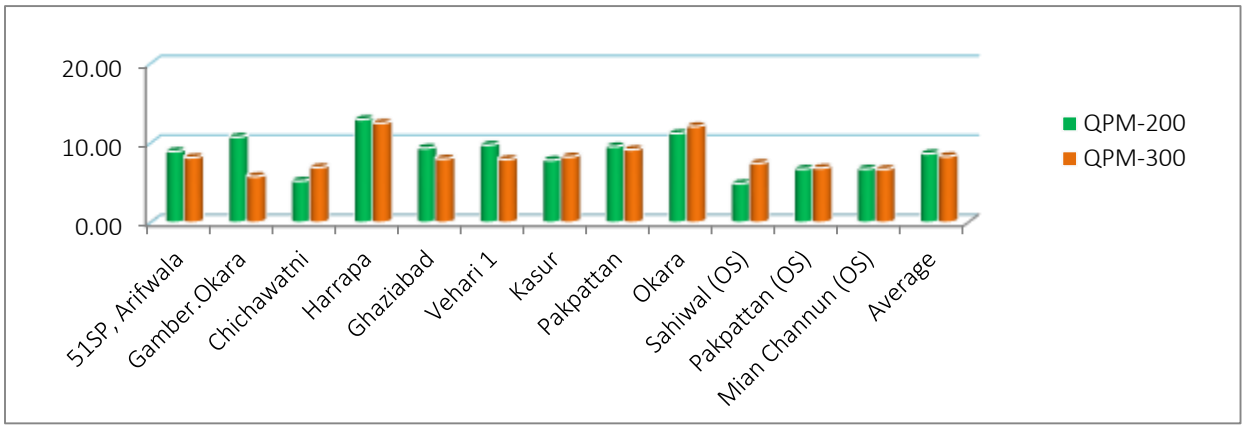
Among the major breakthroughs of the AIP maize program is the launch of two protein enriched maize, widely known as QPM, in Pakistan. These hybrids were officially launched in February 2016 and they are the first kinds of QPM hybrids in the country. Demonstration seeds were distributed to farmers and end users by NARC across KP, AJ&K and Punjab. The hybrids have higher level of protein quality than normal maize which helps to reduce protein malnutrition mostly among children either by direct consumption or through value added products. During the spring season, demo seeds of the two hybrids named by NARC as QPHM 200 and QPHM 300 were distributed to farmers for on-farm evaluation against known commercial checks.

The on-farm demonstration was conducted by NARC in collaboration with private companies where the later helped in identifying progressive farmers and ideal sites in their operating areas. This can be taken as a good example for public-private-partnership. Based on the first season grain yield evaluation presented in the below table the QPM hybrids were better or at par with the widely adapted commercial checks at most of the sites. The across sites data are being compiled by NARC which is currently the lead center for the seed production and dissemination of the QPM hybrids in Pakistan. However, data of grain yield from Punjab, the base of spring maize in Pakistan, are presented in (see below table showing grain yield performance from 12 locations). The demos were conducted/hosted by TCS Pvt. through selected progressive farmers who have links with the company in testing new products. Out of the twelve sites three (Sahiwal, Pakpattan and Mian Channun) were on-station (OS) where the company also handles other multiple trials and the rest were on-farm sites managed exclusively by farmers. Based on the grain yield results, the two QPM hybrids performed well at Harappa and Oakra by yielding between 11- 13 tons per hectare. The average performance of the two QPM hybrids are close to the widely known non QPM commercial checks most of them from multinational companies. The two QPM hybrids performed closely between themselves except that QPM 200 was better at Gamber-Okara and Vehari and QPM 300 performed better at on-station site in Sahiwal, however, the two hybrids have differences in maturity. Based on the results from the demo plots, it can be concluded that the enhanced nutritional quality coupled with the better/comparable grain yield will make the future of the QPM hybrids highly promising in Pakistan, provided quality seed production and engagement of private sector at various levels are ensured.

A QPM demo farmer Malik Muhammad Nawaz. Area: Zain Pur, Behra Sargodha

Demo site/ location	QPM-200 (t ha^{-1})	QPM-300 (t ha^{-1})
51SP, Arifwala	8.96	8.18
Gamber.Okara	10.76	5.81
Chichawatni	5.23	6.93
Harrapa	**12.98**	**12.52**
Ghaziabad	9.37	8.01
Vehari 1	9.76	7.96
Kasur	7.85	8.27
Pakpattan	9.57	9.18
Okara	**11.22**	**12.11**
Sahiwal (OS)	4.91	7.46
Pakpattan (OS)	6.74	6.86
Mian Channun (OS)	6.76	6.71
Average	**8.68**	**8.33**

Table 1Grain yield performance (t ha -1) of QPM hybrids evaluated under on-farm demonstration in the maize belt districts of Punjab, Spring 2016



Grain yield (t ha-1) comparison of QPHM200 and QPHM 300 at various locations in Punjab (Source: TCS PVT)

4.2.2 Evaluation of Pro vitamin A and Zn enriched maize in Pakistan

Provitamin A is fat soluble carotenogenic vitamin that is essentially important for health. According to the WHO, Pakistan has severe sub-clinical vitamin A deficiency (VAD). Similarly, Zinc deficiency in humans results from reduced dietary intake, inadequate absorption, increased loss, or increased use. The most common cause is reduced dietary intake; as much as 25% of the world's population is at risk. Increasing the amount of zinc in crops is an effective preventative measure.

To mitigate the formidable challenges of having nutritious food, AIP maize is working on the introduction and evaluation of biofortified maize varieties in Pakistan. Maize varieties enriched with Pro vitamin A and Zn are being evaluated in Pakistan for agronomic performance across different maize growing ecologies. The grain yield data from the Provitamin A and Zn enriched trials shows very promising performance for the hybrids in Pakistan. The agronomic performance of the biofortified maize hybrids is presented under (appendix 02 & 03). Three Provitamin A hybrids were requested by the UAF for the allocation of the parental lines for further seed production.

4.3 Development/or introduction of biotic stress tolerant maize

Maize stem borer (*Chilo partellus*) tolerant germplasms were accessed from the IITA to be tested in Pakistan. As a result, AIP-maize is currently screening 15 (including checks) stem borer tolerant open pollinated maize varieties by artificial infestation and natural condition (without the application of pesticides). The trials were planted at CCRI, MMRI and NARC. All the required data are being collected and the results will be analyzed. The trial will help to identify stem borer tolerant entry (ies) which can be further registered for commercial seed production. In addition, the best performing entries can be used as source germplasm to develop stem borer tolerant hybrids in a conventional method. Commercialization of these products also contributes for the reduction of greenhouse gas emissions as a result of less use of pesticides.

Artificial infestation of maize stem borer in the field at MMRI (L) and jar and natural diet for mass rearing of stem borer at NARC (R).

AIP funded the establishment of a national mass rearing facility for maize stem borer that will help to expedite the screening process of stem borer tolerant maize germplasms. The facility is the first in the country and it will serve as a center for screening stem borer tolerant maize germplasms. In addition the lab will help students and researchers from public and private sector who wanted to study further about the biology of the pest and developing integrated pest management practices.

4.4 Enhancing the Maize Seed Sector

4.4.1 Seed increase of the newly introduced maize varieties

Ten AIP maize partners (five private: 4Brothers, Jullundur Pvt (JPL), ICI, AAG and PSC; and five public institutions: NARC, MMRI, CCRI, ARI-Quetta and Department of Agriculture Gilgit Baltistan) have started the micro seed increase of the allocated maize inbred lines. This is part of the seed producibilty trial where partners can identify information about the seed production potential and synchronization pattern of the parental lines. Some of the introduced parental lines were unable to fully set seeds due to thermal heat associated with late planting in the spring season particularly at JPL and ICI stations. In other sites where planting was early and temperature effect was less, parental lines exhibited good seed setting. The seed increase also continued during the Kharif season and preliminary field performance shows satisfactory response of the inbred lines in seed setting. The information from this activity will help partners to plan where and when to multiply the seeds. In addition, seed increase of the OPVs was done at the public institutions they were less affected by high temperature. Based on this experiences, partners were advised to make seed increase

Seed increase of maize parental line at 4B group farm in Multan (L) and seed micro increase and variety verification plot- Gilgit Baltistan (R)

of the hybrid parental lines preferably in Kharif and in spring planting of inbreds should start in January and if late early February in the areas of central and southern Punjab to avoid heat waves (which usually occur in the months of May and June). The amount of harvested seed further scale-up plan will be compiled and shared in the next semiannual report. However, the seed increase activity is the linchpin of the AIP maize effort where it will lead to a successful local hybrid/OPV seed production in Pakistan.

4.5 Public Private Partnership Enhanced through Collaborations in Varietal Evaluation

The number of AIP partners reached twenty one (11 private and 10 public). As usual AIP partners shared performance information from the various trials conducted across the country. Another exemplary collaboration during the reporting period was the joint evaluation of the new QPM hybrids from NARC.

Four private AIP partners (ICI-Pakistan, JPL Co., TCS Pvt. and RMP Pvt.) hosted the demonstration plots for the promotion of the two QPM hybrids (QPHM 200 and QPHM300). The companies used their innovation platforms to distribute the seed of the new hybrids. A total of 24 demo plots were conducted under this collaboration. Performance data also shared to NARC (further details under section 4.2.1; table). The companies have list of progressive farmers and satellite stations where they gather stakeholders to demonstrate new products and services and get feedbacks from their stakeholders. This collaboration helped NARC to reach many farmers and far flung places in Punjab and enhance its networking with the private sector in exploring future market channels. In addition, NARC maize program's awareness and publicity will increase through this synergy as farmers and other stakeholders get chance to see the research products of NARC. In other way the private sector will benefit from this joint activity at least in the following ways:

- Keep bringing new technologies to members of their innovation platforms
- Able to compare their product(s) against the new ones
- The collaboration will create a way to get license of the products, if convinced by the performance of the new hybrids
- Promote their goodwillness and corporate responsibility to their clientele by promoting public products
- Strengthen their networking with public sector and the surrounding community in building trust and good reputation

Similarly, three public institutions (MMRI-Yousafwal, UAP), Department of Agriculture, AJK) joined hands with NARC to promote the new QPM hybrids in their Jurisdictions.

The diverse partnership in the variety evaluation also included the main maize value chain actors including but not limited to research institutions, seed companies, wet milling industry, farmers and farmer institutions. Bringing all the relevant public and private stakeholders at one platform will further cement collaborations in a win-win approach which is crucial for the continuity of the project outcomes.

QPM cobs and field evaluation by stakeholders at a farmer demo plot in Rawalakot, AJK (L) and at Tara Crop Sci. Plc out station site near Harappa (R)

a) Annual AIP Maize Working Group Meeting

During the annual maize working group meeting organized by the AIP from May 10 to 11 2016, 21 public and private seed companies including higher learning institutions of Pakistan discuss their progress and work plan. The meeting was held in Islamabad evaluated the progress of partners particularly in fast tracking the deployment of CIMMYT derived maize products that were allocated recently to partners.
Chairman of PARC, Dr. Nadeem Amjad, appreciated the progress of the maize component of AIP particularly in identifying suitable varieties, allocating parental lines and deploying these in Pakistan through public and private collaborations. He further said the share of valuable parental lines and breeder seeds is one of the invaluable contributions and success of AIP.
During the meeting Partners shared the progress of parental seed production in their own field and the road map to deliver quality seeds to the farmers. In addition, partners identified key challenges in the maize seed value chain of Pakistan and proposed recommendations during the group discussion session of the meeting.

b) Training on breeding program management and statistical data analysis

AIP-CIMMYT in collaboration with NARC conducted a training course on maize breeding program management and statistical data analysis from May 23 to 27 2016 in Islamabad, Pakistan. The training was attended by 40 participants nominated from agricultural universities, public and private institutions across the country. It was the first in its kind to address breeding program management and introduce current software to analyze various phenotypic and genotypic data. This hands-on training will help scientists to select varieties suitable for use by Pakistani farmers based on multi-environment datasets.

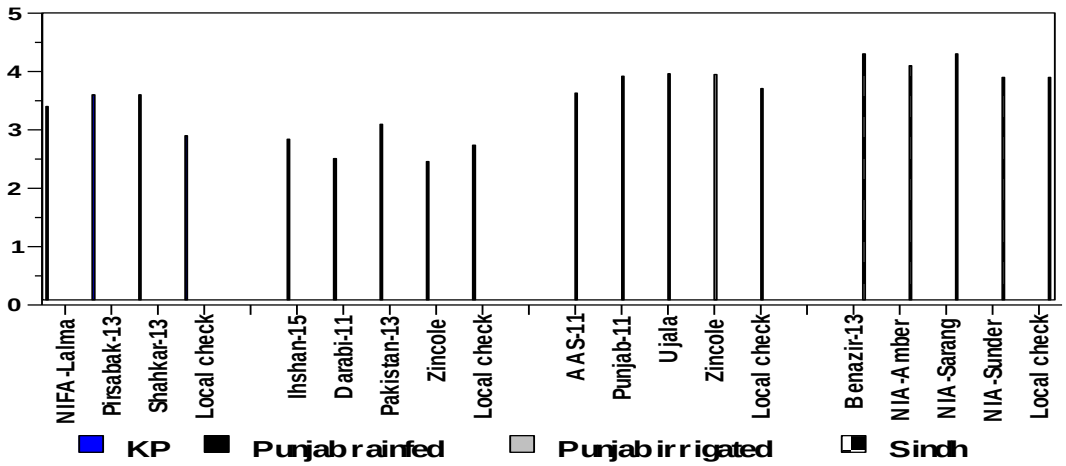

Ms. Rabia Akram from NARC receiving her certificate (L) and participants of training course(R)

5 Wheat

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 PVS

New 14 high yielding rusts resistant wheat varieties were validated for their performances involving 255 farmers across three provinces. In KP, Pirsabak-13, NIFA-Lalma and Shahkar-13 were all superior to local checks with a yield increase of 16 to 24%. In the rainfed areas of Punjab, Pakistan-13 was the only variety with significant yield advantage with 13% yield gain while in the irrigated area new varieties, e.g. Zincole and Ujala were at par with the local checks with 5-6% yield gain. In Sindh, Benazir-13 and NIA-Sarang were significantly superior to the rest of the varieties as shown in below table.



Grain yield of new improved varieties in PVS trials during 2015-16 wheat growing season

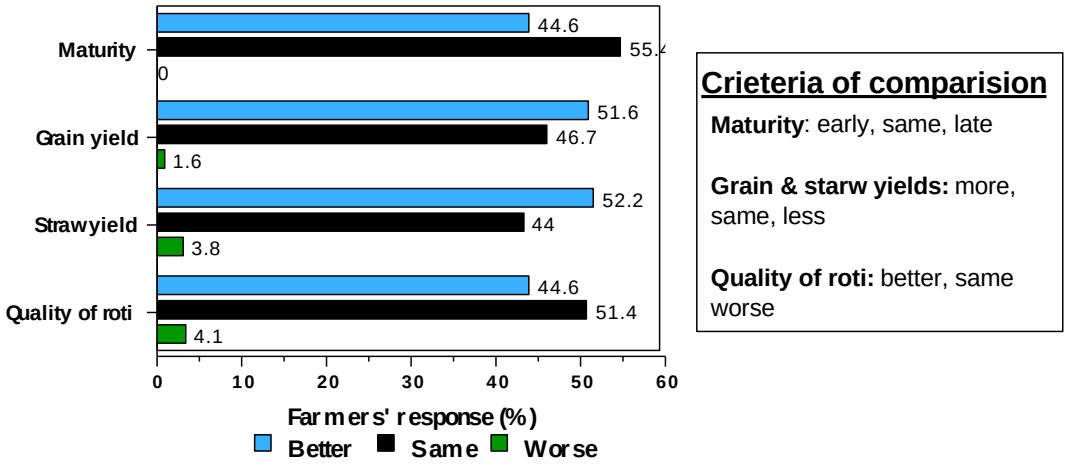
The findings from this research will be used to select best varieties to go into variety popularization and seed production stream during wheat season starting October 2016.

5.1.2 Fast tracking deployment of new high yielding, disease resistant wheat varieties for delivering genetic gains to farmers

Paired plot on farm Demonstrations using IRD were conducted during wheat growing season of 2015-16 involving 7,200 smallholders' farmers including women and covering 53 districts of Pakistan. This was aimed at replacing old and obsolete varieties by fast tracking deployment of newly released, high yielding, rust resistant wheat varieties. Post-harvest assessment of new varieties on a randomly drawn sample of 368 farmers out of 7,200 beneficiaries provided an indication of acceptance and competitiveness of new wheat varieties.

New varieties were rated similar to widely grown farmers' varieties in terms of maturity, grain, straw yield and for grain quality (shown in below graph). Other key findings that featured from a post-harvest assessment of wheat varieties involving randomly selected 368 farmers are as follows:

- 302 out of 368 farmers said they will grow new varieties next year.
- 297/368 saved seeds of new varieties on average 321 kg per household.
- 242/368 farmers were approached for new seed varieties by other farmers.
- 146/242 were willing to share seeds with the fellow farmers while others were yet to decide.
- 60/368 farmers indicated that new varieties were not better than the existing ones mainly due to low yield, poor grain quality, more disease.



Farmers' responses from a survey of post-harvest evaluation of wheat varieties included in IRD paired plot comparison during 2015-16 wheat growing season.

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

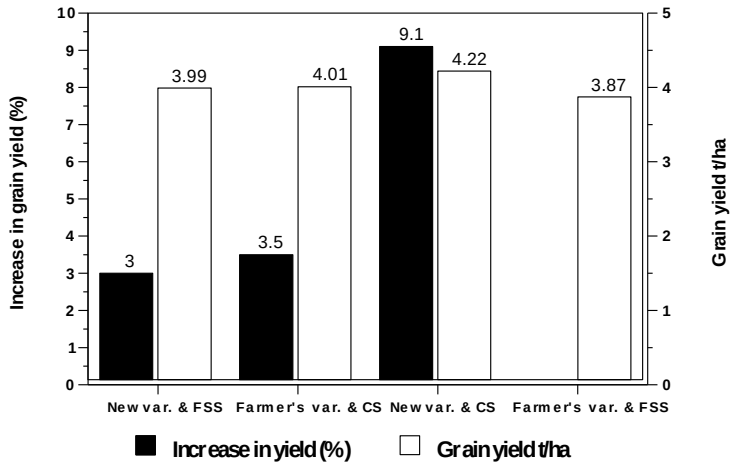
During the wheat growing season of 2015-16, 48 Diamond Trials (2x2 factorial on farm trials) were conducted for creating knowledge about replacing old and obsolete wheat varieties by new high yielding, rust resistant ones (details listed below table).

Summary of diamond trials conducted on wheat during 2015-16 wheat growing season

Partner Organization	No of trials	New variety	Old variety
Wheat Program NARC	6	Pakistan-13	Chakwal-50
CCRI	6	Pirsabak-13	Pirsabak-05
BARI	10	Dharabi-11	Inqualab-91
WRI Faisalabad	10	Galaxy-13	Seher-06
WRI, Sakrand	6	Benazir-13	TJ-83
Engro	10	Punjab-11	Sehar-06
Total	48		

Most widely grown but rust susceptible wheat varieties in each province were compared with best bet new wheat variety with the objective of demonstrating the importance of varietal replacement versus just the seed replacement. Preliminary results revealed the following:

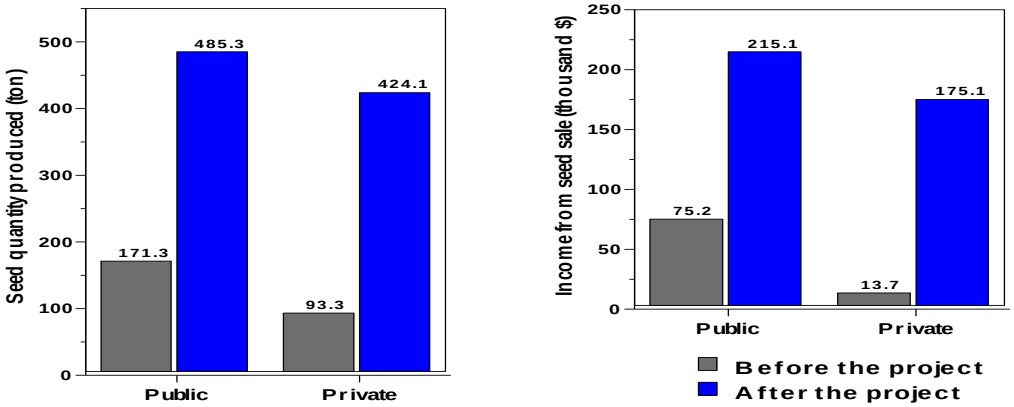
- 9.1% yield gain was reported from new wheat varieties with certified seeds over old varieties and farm saved seeds.
- Using certified seeds of old and obsolete varieties is less profitable than using the farm saved seeds of new high yielding and disease resistant improved varieties but in reality it would be worse off considering the extra cost of using certified seeds that will reduce the profitability (see below graph in terms of grain yield).



Increase in grain yield due to the interaction of type of wheat variety with the type of seed (solid dark bar) and actual grain yield (open bar). CS =certified seed, FSS=farm saved seed

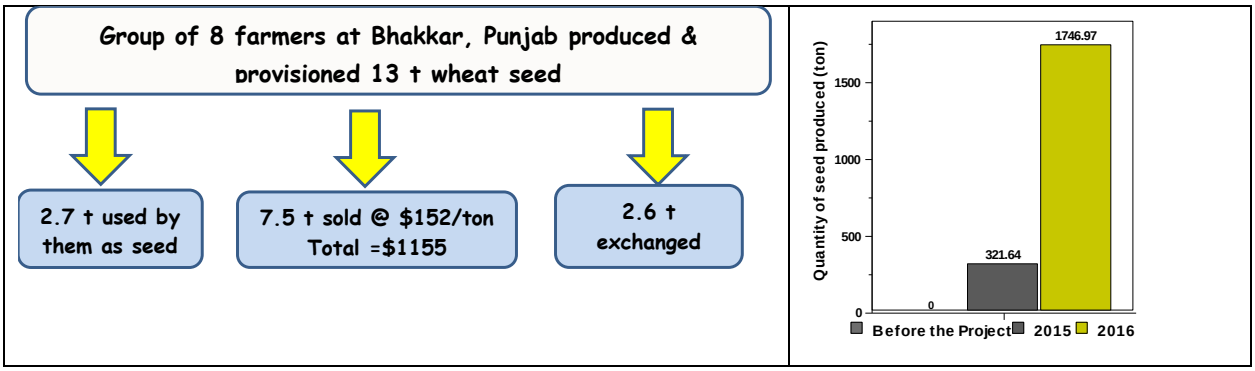
5.1.4 Production and provision of seeds of recently released wheat varieties through public-private partnership

- Project facilitated public and private seed companies for linking them with farmers' seed system to have better impacts.
- Private sector increased production by nearly 5 fold and income by >12 fold before and after the project, which is much higher than in the public sector as compared, detail is given in below chart .



Seed production, sale of new wheat varieties by the public & private sector partners of AIP before/after the project intervention

- There was a steady increase in the second year while it increased by more than five-fold in the third year of the project.
- A case study example (see below the case of group of eight farmers from Bhakkar indicated the mode of seed dissemination through informal groups in the villages
- More than half of the seeds (7.5 tons) were sold with a modest cash flow to each of the seed growers in the group. (see for detail appendix 04)



Seed production of new improved wheat varieties by village-based seed production initiatives (right) and a case study example of seed provisioning through seed producer groups in 2015 (left) following project intervention.

Baba Mureed of Pind Malkan with IRD saved 640 kg produce; graded locally & sold as seeds of AAS-11 to 7 farmers @Rs 16/kg with an additional income of $100

Munib Khan of Gujar Khan compares field of NARC-09 (left) grown from the seeds harvested from 2014-15 IRD with Seher06 (right.) He intends to sell most of the harvest as seeds after grading locally

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

5.2.1 Yield loss assessment of wheat due to rust using fungicides

Folicur, Nativo and TILT fungicides approved by US Federal law for crop protection are being evaluated in the 2015-2016 to establish the yield loss of wheat due to rust that can be reduced using any of these fungicides in the event of sudden outbreak of wheat rusts in Pakistan. Preliminary results indicate a highly significant yield differences for wheat grain yield after fungicide spray was administered over negative control (no fungicide).

Stripe rust trials were conducted at NARC Islamabad and CCRI Pirsabak, leaf rust trials at WRI Faisalabad and RARI Bhawalpur while stem rust trials were in WRI Sakrand and CDRI, Karachi

Time of the spray is very crucial, pre rust emergence spray of fungicides was found to be very effective on reducing the yield loss of wheat. For controlling yellow rust, TILT and Folicur showed edge over Nativo. Natiovo followed by TILT seemed to be effective against leaf rust. A limited paired plot comparisons on farmers' fields will be planned during coming wheat season. Two year results will be synthesized and shared widely (see appendix 05).

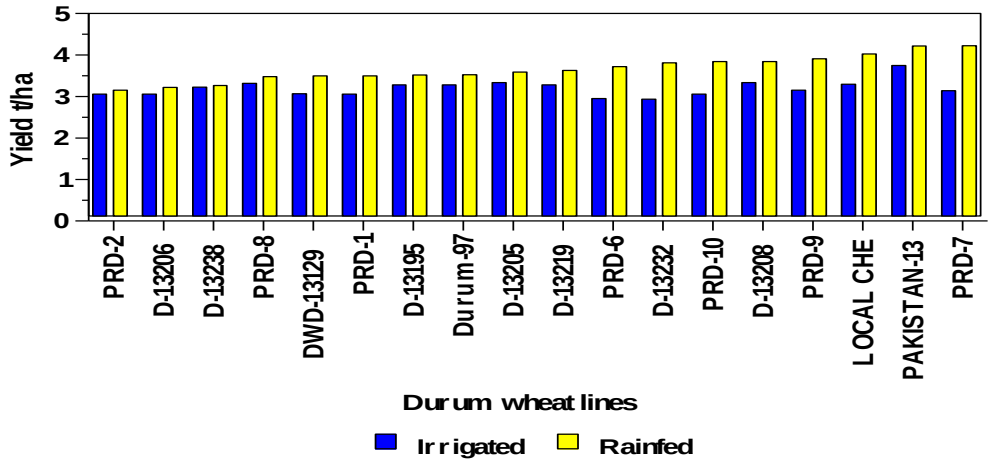
5.3 Development of durum wheat value chain

5.3.1 Durum Wheat National Uniform Yield Trial (DWNUYT)

DWNUYT was conducted in nine locations; four rainfed and five irrigated across Pakistan. Fifteen durum wheat lines were evaluated along with one durum wheat and two bread wheat checks.

Field observations indicated that durum wheat lines had less rust incidence compared to bread wheat and few of those (durum wheat) also appeared superior to the check varieties in the trial. However, analysis of yield data did not support it.

In rainfed sites a number of durum wheat lines are at par with durum wheat check-Durum-97 while PRD-7 was the only variety with significantly higher yield over this check (disregarding Pakistan-13 the best check) while none of the durum wheat lines showed their superiority even over durum wheat check in irrigated areas.



Yield performance of durum wheat lines in irrigated and rainfed environments over three check varieties evaluated in DWNUYT. Durum-97, local check and Pakistan-13 were the checks in the trial.

Yield performance of durum wheat lines in irrigated and rainfed environments over three check varieties evaluated in DWNUYT. Durum-97, local check and Pakistan-13 were the checks in the trial.

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

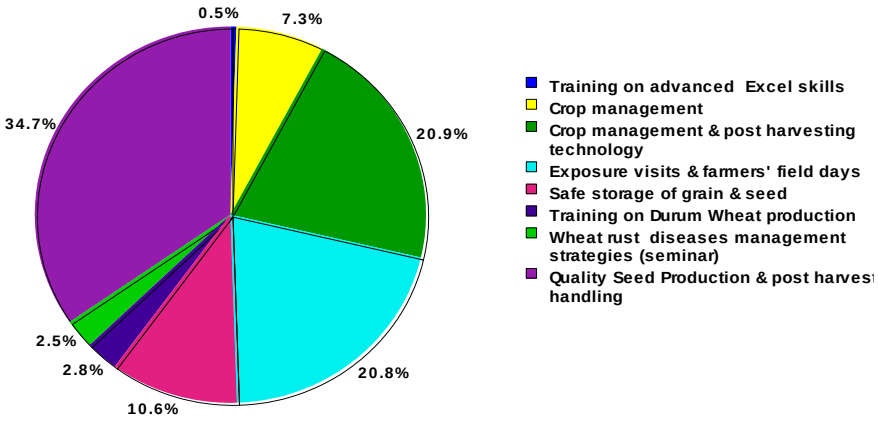
Processing and end use quality of selected 20 recently released bread wheat varieties is currently being analyzed. Test entries have been compared with five most popular wheat varieties to find out their gluten strengthens and extensibility along with other nutritional qualities. Two grain quality laboratories listed below have undertaken this task.

a) FQSRI, PARC, Karachi, Pakistan
b) Grain quality laboratory, WRI, Faisalabad, Pakistan

Results will be synthesized and shared in a national workshop with all the major stakeholders of wheat value chain before the end of 2016. This will help popularize appropriate varieties for specific use by involving various actors of wheat value chain to create new processing and other business opportunities from this research.

5.5 Training and Capacity building

A total of 4,181 participants representing RSP staff, seed company staff, seed growers, other farmers collaborating on various on farm research and demonstrations were trained during 2015-2016 covering improved wheat production, quality seed production and handling, exposure visits and farmers field days to enhance wheat productivity as segregated in below pie chart.



A summary of capacity building activities undertaken in AIP wheat during 2015-16 wheat season.

6 Agronomy

6.1 Dissemination of Conservation Agriculture (CA) Technologies

AIP-Agronomy component disseminated improved technologies to more than 90 farms through demonstrations, trained 70 agriculture professional and disseminated improved production techniques to 1732 farmers through 19 field days and events in the project area that provided an opportunity to observe the benefits of LASER land leveling, ZT and ridge planting at their fellow farmer fields.

6.2 Partnership for out scaling CA technologies

Total 23 national partners collaborated for implementation of AIP - Agronomy activities included dissemination of ZT and ridge planting of wheat, testing and multiplication of new CA planters and fertilizer management techniques in four provinces of Pakistan. Collaborating national partners included 16 from public sector (research institutes and agriculture extension) and seven from private sector (seed companies, machinery manufacturers and NGOs) in Punjab, Balochistan, Sindh and KP provinces.

6.2.1 Demonstration of CA technologies:

National partners collaborated with farmers for application of improved technologies on 90 farms in project area. Farmer experienced LASER land leveling on 69 sites in districts DI Khan and Nowshera of KP, ZT planting of mung and guar on 17 farms in Bhakkar and Chakwal districts of Punjab and ZT maize planting after wheat on 04 farms in district Nowshera of KP. These demonstrations were established in collaboration with AZRI Bhakkar, BARI Chakwal, CCRI Nowshera and MFSC - KP.

During wheat season of 2015 – 16, AIP-Agronomy collaborated with 17 national partners in application of improved technologies on 491 farmer such as; zero tillage wheat planting, ridge planting of wheat and LASER land leveling in in Punjab, Sindh, KP and Balochistan provinces of Pakistan.

a) Farmers experienced ZT wheat planting on 248 sites in district of Jaffarbad in Balochistan, Thatta, Shikarpur, Jacobabad in Sindh and DI Khan in KP. ZT wheat technology helped farmers in planting of wheat earlier without land preparation and obtained 0.5-0.6 t/ha better wheat yield in comparison with farmer conventional practice of broadcasting in prepared land. ZT drills were used in collaboration with service providers and national partners.

b) During the last wheat growing season, farmers also experienced ZT wheat planting after mung / guar crop in districts of Bhakkar, Chakwal and DI Khan. Results from on farm demonstrations in 2015-16 suggested that farmer were able to get 0.2 t/ha higher wheat yield and saving of RS. 7500/ha in cost of cultivation with ZT in comparison with farmer practice of broadcasting seed in prepared land.

NRSP farmers in their ZT wheat plot located in Bhakkar

c) During 2015-16 wheat season, ridge planting of wheat was done on 162 sites in districts of DI Khan, Nowshera, Mardan, Peshawar and Swabi in KP; Hyderabad, Matiari, Shaheed Benazir Abad Tando M Khan, Umerkot and Thatta in Sindh; Bahawalnagar, Bahawalpur, Bhakkar, Gujranwala, Gujrat, Khushab, Layyah, Lodhran, MB Din, Mianwali, Sheikhupura, Sialkot and Vehrai in Punjab. Farmer adopting ridge planting of wheat had 0.2 – 0.6 t /ha higher yield and 30 - 40 percent irrigation water in comparison with farmer practice of broadcasting.

Ridge planting of wheat in District Shaheed Benazir Abad, Sindh.

d) MFSC collaborated with farmer's management committees for dissemination of LASER land levelling in districts of DI Khan, Nowshera, Peshawar and Jaffarabad. LASER land leveling has helped farmers in saving 25 percent irrigation water and improving the yield by 12 percent.

6.2.2 Training of stakeholders on CA techniques

Farmers in the province of KP applying fertilizer following general recommendations from department of agriculture or as per their knowledge and affordability. Department of Agriculture Extension has initiated soil sampling from 25 districts of KP under the project (Sustainable agriculture development for food security through integrated approach in KP) to develop area specific fertilizer recommendation for various crops that would improve farm productivity and promote efficient use of fertilizer in the province. AIP – CIMMYT provided 26 GPS receivers and arranged training for 70 field officials of agriculture department on the use of GPS receivers on August 11, 2016. Trained staff will gather information about geographical location of soil sampling sites that would be use for digital soil fertility map in KP.

6.2.3 Dissemination of technologies through field days

In partnership with national partners organized 19 field days including two in Balochistan, three in the province of KP and 14 in Punjab province for dissemination of improved techniques such as; LASER land leveling, ZT Happy seeder planted wheat, ZT planting in wheat based systems , ridge planted wheat, maize planting through push row planter and bed planting of cotton. More than 1732 farmers attended these events in districts of Jaffarabad in Balochistan, Nowshera and Kohat in KP, Bahawalpur, Bhakkar, Sheikhupura, Lodhran, Sahiwal, Vehari in Punjab province Farmers have opportunity to interact with fellow farmers, observe field under improved practices that would help in adoption of these techniques and improve wheat and maize productivity (appendix 06).

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

Under this activity, Greenland Engineers and Petal Seeds produced 92 planters including 37 Multicrop (MC) ZT planter for DSR and 55 push row maize planters that were made available to farmers in Pakistan. Around 291 farmers used locally manufactures planters for planting of maize, cotton and rice in Punjab, KP, Sindh and Balochistan provinces. In addition, more than 50 smallholder maize farmers were trained on the use of push row maize planter that would help farmers to improve crop stand and maize yield in KP.

Farmer field day in Gandakha, district Jaffarabad Balochistan

Farmers on LASER land leveling field dav in Kohat

6.3.1 Local manufacturing of new CA planters and evaluation

a. AIP-CIMMYT imported a multicrop, ZT planter from India that has the ability to drill both seed and fertilizer simultaneously, and maintain an appropriate distance between plants without breaking the seeds. National partners evaluated locally modified multicrop zero-till planters at five sites for dry seeding of Basmati rice in Punjab during 2015. These sites produced 10 percent higher plant population, tillers and grain yield compared to those using older fluted roller drill machines for seeding. During the current 2016 rice season, Greenland Engineering has manufactured and sold over 37 multicrop planters to rice growers across Pakistan that helped farmers to adopt water and labor saving DSR technology.

Manufacturers of MC ZT planter (Irfan and Iqbal Mughal) Greenland Engineering, Daska

b. In 2015, CIMMYT imported Push row planter with the help of CIMMYT Nepal and evaluated in districts of Nowshera, Mardan and Peshawar in KP province on more than 50 farmer fields. Maize planting with push row planter reduced the cost of planting through reduction in labor required for planting and placing fertilizer. The planter has vertical seeding mechanism that facilitate precision planting by

maintaining uniform plant to plant distance and improve plant population. The planter help farmer to plant more area in less time increase planting area in less time, better plant population and improve maize grain yield. During 2016, CIMMYT collaborated with CCRI and Petal Seed for local production of this planter in Mardan. Farmers were satisfied with the performance of locally manufactured planter. CIMMYT joined hands with Petal Seed, a local seed company in the province of KP, for local manufacturing and distribution of push row planter on cost sharing basis. A total of 55 push row planters have been distributed among smallholder farmers in the KP province.

Farmers with Push row maize planter in Mardan

6.3.2 Demonstration of New CA planter at farmer fields

Demonstration of maize and cotton bed planting was carried out on 32 sites in districts of Nowshera and Mardan in KP, Vehari, Sahiwal, Bahawalpur and Faisalabad district in Punjab and Shaheed Benazir Abad in Sindh province.

Use of MC ZT planter for DSR was carried out by 55 farmers s in the districts of Jafarabad and Shikarpur in Sindh; Sheikhupura, Sialkot, Gujranwala, Nankana Sahib, Multan, DG Khan and Jhang districts in Punjab. Rice Partner Limited (RPL) used three MC ZT planter and demonstrated technology on more than 100 acres in the district of Sheikhupura. Their results also supported that better rice plant population was achieved with planter and reduction in basmati seed breakage.

Raham Dil, smallholder maize farmer with push row planter in Mardan.

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 KP. Raham Dil, a farmer from village Per Sadi district Mardan, not only used the planter on his farm but also offered planter to 40 fellow farmers in his village and surrounding area for use on their farms that resulted in maize planting on more than 200 acres.

Pilot testing of locally manufactured ZTHS: Sharif Engineering Faisalabad, Punjab developed first local version of ZTHS that was evaluated at Muhammad Rafi's farm in Nanakana Sahib district of Punjab province. Wheat planting was done in 1.5 hours/ acre, without burning of rice residue, using ZT happy seeder with 85hp and 60hp tractor. This environment friendly technique of wheat planting enables the farmers to reduce cultivation cost and get 11 percent or 0.4 t/ha higher wheat yield in comparison with farmer practice of burning residue and planting wheat after heavy tillage.

Farmer field data received from AR Farms Gujranwala & Sheikhupura, RRI – KSK, Engro Fertilizers and WRI - Faisalabad showed that farmers using ZTHS wheat planting technology in districts of Faisalabad, Gujranwala, Nankana Sahib, Sialkot and Sheikhupura reduced five tillage operations to one, reduced cost of cultivation in the tune of RS 12000 / ha, avoided burning of residue with increase in 0.2 t/ha wheat grain yield.

6.3.3 Training of Stakeholders on New Seeders

AIP-Agronomy in collaboration with CCRI, Petal Seeds and MFSC arranged two farmer meeting / trainings on use of push row planter for maize planting at CCRI, Nowshera and Petal Seed Farm Mardan on June 03 and July 21, respectively. Hand training on maize planting with push row planter on its use in field were received by fifty farmers. These trainings were also attended by agriculture professional from research and extension.

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

6.4.1 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 KSK, WRI-Faisalabad and CCRI Pirsabak Nowshera. These trials helped validate new techniques, improved understanding 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: Due to precise plant to plant distance and 90 percent emergence with hand planted cotton on raised beds / ridges, seed yield was 0.3 t/ha higher in comparison with drill and mechanized bed planted cotton. Wheat planted as relay crop in standing cotton on beds / ridges had 0.8 - 1.0 t /ha more wheat in comparison with wheat planted after harvesting of cotton.
2. Effect of Planting Techniques on the Productivity of Different Rain-Fed Cropping Systems at BARI Chakwal, Punjab: Summer crop mung bean and soybean grain yields were at par with ZT, farmer practice and wide beds planting techniques. Timely wheat planting after mung and green manure crop resulted in 2.7 and 2.6 t/ha wheat grain yield in comparison with 2.0 t/ha after soybean crop. Higher system productivity was observed in mung bean - wheat with ZT and conventional planting techniques. However, there was saving in cultivation cost with ZT planting in comparison with conventional tillage system.
3. Evaluation Of Different Residue Management and Planting Techniques Under Heavy Residue Environment Of Rice-Wheat Cropping System at RRI KSK, Sheikhupura, Punjab: After two rice – wheat cycles, DSR followed by ZTHS wheat in residue had highest system productivity of 7.3 t/ha in comparison with other planting systems that included 3.7 t/ha of rice and 3.7 t/ha wheat yield. Basmati Rice yields were higher with transplanted rice in comparison with DSR. Wheat yield were 0.5 t/ha higher in plots planted with ZTHS in residue in comparison 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 at CCRI Nowshera District of KP Province: After 2 cropping cycles, maize yield with bed planting was 4.4 t/ha in comparison with 3.2 t/ha on farmer practice. However, wheat yield was 3.4 t/ha with ZT in comparison with 3.0 t/ha with bed planting and farmer practice. Results showed that bed planting is better for maize planting and ZT for wheat planting.
5. Evaluation of Double No-Till of DSR and ZT Wheat in a Low Residue Environment of Rice-Wheat System at WRI Faisalabad, Punjab: After two cropping system cycles, paddy yield with direct seeding (DSR) was at par with transplanted rice in Faisalabad. However, wheat grain yield with ZT planting was 0.25 t/ha higher after transplanted and DSR rice in comparison with conventional planting. By adopting DSR followed by ZT wheat could help in saving of water, reduced labour and cultivation cost for planting and land preparation in comparison with prevalent farmer practice.

6. **Evaluation of mung – wheat cropping system in rianfed area of KP**: After first cropping system, mung bean - wheat had higher system productivity in comparison with fallow – wheat cropping system. Inclusion of mung bean in rainfed system resulted in additional production of 0.8-1.4 t/ha of mung bean with wheat yield of more than 3.0 t/ha with bed planting, zero tillage and conventional planting techniques in Nowshera district of KP province.

6.4.2 Strengthening of CA research partners through capacity building, information sharing.

A two day annual meeting was jointly organized by AIP-Agronomy and PARC, from August 02 to 03 2016. Dr. Nadeem Amjad, Chairman of PARC inaugurated meeting and appreciated AIP-Agonomy and national partners' efforts in development and dissemination of crop management techniques to the farming community in the country. In this meeting, 60 agriculture professional's belongings to 23 national partners (provincial and federal research institutes, agriculture extension, universities, private companies and international research centers) shared progress on AIP's agronomy activities, discussed implementation related issues and future activities. National partners were instrumental in dissemination of conservation agriculture techniques such as ZT wheat, ridge planting of wheat; new seeders like Zero till happy seeders, push row planter, multicrop ZT planters and nutrient management techniques to more than 7500 farmers through 1000 on farm demonstration, 22 trainings and 78 farmer days. AIP agronomy also facilitated training of 131 partners' staff and it helped to train more than 800 farmers and support staff in the project area. AIP - Agronomy collaborated with local machinery manufacturer, Petal Seeds, Greenland Engineers and Sharif Engineering Works and provided 55 Push row planter and 37 multicrop ZT planter and ZT Happy Seeders to farmers.

Participants of AIP Agronomy Annual Meeting -2016 with Chairman PARC in Islamabad

6.5 Nutrient Management

A total of 40 demonstrations on LCC (Leaf color chart) use for N application in rice were planted, 87 persons trained on LCC use in rice and 800 LCC were distributed among rice farmers in rice-wheat area of Pakistan. These helped in promotion of balanced and site specific fertilizer management among farming community and improve farm productivity.

6.5.1 Fertilizer Management Trials:

a) **Development of guidelines for Nitrogen management with LCC in widely grown rice varieties in rice – wheat area of the Punjab:** The trial planted at 04 sites (RRI – KSK, AR farms Sheikhupura and Gujranwala and WRI Faisalabad) that would help to validate LCC technology for popular rice varieties of the region such as: PS-2, Super Basmati, PK-386 and KS-515.

b) **Fertilizer management in Rainfed wheat:** In collaboration with BARI Chakwal and NRSP, farmer field demonstrations on fertilizer application in rainfed wheat were planted on 16 sites in districts of Chakwal, Attock and Nowshera. Results showed that application of recommended fertilizer (80 Kg N and 58 Kg P/ ha) as basal dose at planting improved 60% wheat grain yield in comparison with farmer practice. Application of DAP as basal and split application of urea at first shower improved 20% wheat grain yield in comparison with basal application of all fertilizer.

6.5.2 Evaluation and demonstration of SSNM in collaboration with national partners

a) **National partners namely RRI – KSK, Engro Fertilizers**, AR Farms Gujranwala and Sheikhupura, WRI – Faisalabad and PARC – Jaffarbad were instrumental in establishing demonstration of LCC Nitrogen application for rice crop on 40 sites in districts of Faisalabad, Gujranwala, Sheikhupura, Mandibahudin, Hafiz Abad, Nanakana Sahib, Sialkot, Narowal, Gujrat and Jaffarabad.

b) **Use of Green seeker for N management in wheat:** Green Seeker use for N management is SSNM technique for wheat that help farmers to apply urea according to crop response and improve wheat grain yield. Results from 35 farmer fields demonstrations in 2015-16 in districts of Bahawalpur, Bhakkar, Faisalabad, Lodhran, Nowshera, Sheikhupura and Swabi showed that there was saving of 0 – 47 Kg N /ha in comparison with farmer practice without any grain yield reduction (3.7 t/ha).

Use of Green Seeker for N management in wheat in Bahawalpur

c) **Nutrient Expert** is DSS for site specific nutrient management (SSNM) in wheat and maize. Validation trials of NE for irrigated wheat were planted on 80 farmer fields in the districts of Bahawalpur, Bhakkar, Faisalabad, Layyah, Sargodha, Lodhran and Sheikhupura in Punjab, Nowshera, Swabi and DI Khan districts in the province of KP and Mitari, Shaheed Benazir Abad, Hyderabad and Umerkot in Sindh province. Results showed that NE recommendation promoted balance use of fertilizer for wheat and results in saving of 6000 PKR / ha for farmers.

6.5.3 Dissemination of LCC use in rice crop in rice-wheat area

Leaf color chart, SSNM technique, help farmers to apply Nitrogenous fertilizer according to demand of rice crop. 2014-2015 results from on farm demonstration showed that there were no reduction in rice yield with the saving of 26 Kg urea per acre (65 Kg urea per hectare). A training on the use of LCC for N management in rice crop was organized at RRI, KSK on July 18, 2016. In this event, 20 master trainers from national partners namely RRI – KSK, Engro Fertilizers, AR Farms Gujranwala, Sheikhupura and WRI-Faisalabad were trained through technical presentation, discussion and on field demonstration. These master trainers provided training to 67 farmers and distributed 800 LCC among rice growers in the districts of Faisalabad, Gujranwala, Sheikhupura, Mandibahudin, Hafiz Abad, Nanakana Sahib, Sialkot, Narowal, Gujrat and Jaffarabad.

LCC use in rice crop training at RRI Kala Shah Kaku – Sheikhupura Punjab

7 Rice

7.1 Breeding and Crop Management

On the breeding component, promising elite lines (n = 16,982) sent in 2014 were grown in 2015 and 2016 cropping season, for observational trial and selection by Dr. Surapong, in partnership with breeders at RRI, KSK. These lines were part of promising lines sent to Pakistan in 2014 through coordination with IRRI-Pakistan CO Scientist Dr. Abdul Rehman. They are composed of irrigated elite lines, Super Basmati lines with BB R genes, flood tolerant/DSR lines, IR6-Sub1, Sabitri-Sub1, Sub1 MAGIC lines, and IRBB NIL sets. Test entries consisting of KSK-RRI breeding materials and IRRI elite materials were grown at RRI-KSK at Kala Sha Kaku and Emkay Farm, Farooqabad, Sheikhupura. Promising lines from these breeding populations were selected for advancement and further performance evaluation on-station and later, in researcher-managed trials at farmers' field.

In dry season 2016, irrigated breeding team of IRRI HQ tested 211 breeding lines composed of submergence and drought tolerance, bacterial blight (BB) and blast resistance genotypes along with 8 parental lines in observational yield trials (OYT) stage. After analyzing data, 90 lines were promoted for next season trial in PYT stage considering yield performance and field reaction on diseases and selected lines planned for testing for disease and abiotic stress in 2016WS. Also identified 78 BB resistance lines in IRRI154 background and will test them for yield performance in 2016WS. In 2016WS, all those selected lines were tested in PYT and OYT stage, respectively. The crops were harvested for measuring their yield performance and also screened them against of respected diseases and stresses. Data are now undergoing analyses.

At IRRI, a set of these lines sent to Pakistan were also evaluated for their resistance to bacterial blight (BB), drought, submergence and salinity tolerance. During this period, the resistance to BB has been evaluated on lines introgressed with different combinations of Xa genes. From this set of lines, seven promising lines were identified to possess broad spectrum resistance to the disease, which contains different combinations of Xa4, xa5, Xa7, Xa21 (appendix 07) These serve as good donors for resistance to BB in Pakistan, including Xa23, shared with partners at RRI-KSK, NIBGE and Emkay Seeds (Pvt.) Ltd.

In October 17-19, 2016, a partner from NIBGE, Dr. Muhammad Arif, participated at the 5th International Conference on Bacterial Blight of Rice. He presented the output of collaboration between IRRI and NIBGE on 'development of basmati rice for bacterial blight resistance using molecular breeding approach.' During this visit, a meeting with IRRI GRS Dr. Amelia Henry, Dr. Tobias Kretzschmar, Dr. Casiana Vera Cruz, Dr. Ricardo Oliva, and Dr. Jauhar Ali have been arranged for discussion of future collaborative plans through incoming PhD students.

To continue the improvement of post-harvest and quality control, a training was conducted by Engr. Joseph Rickman on May 5-13, 2016 on good management practices for post-harvest processes to improve grain quality standard for Basmati exports. On the training component, Ms. Abha Zaka, PhD student from NIBGE has been awarded a grant under the International Research Support Initiative Program (IRSIP) of the Higher Education Commission of Pakistan for a 6-month research scholarship at IRRI. She joined the Genetics and Biotechnology Division on October 12, 2016, and a discussion about her proposed research plan. On October 14-15, she participated in a training-workshop on 'Resistance, Genomics and Molecular Diagnostics of Plant Pathogens' with Dr. Ralf Koebnik (IRD, France), Dr. Mathilde Hutin (Cornell University), Dr. Jillian Lang (Colorado State University) and the IRRI GB Division Team as resource speakers/trainors.

She also attended the 5th International Conference on Bacterial Blight of Rice and presented a poster of her research on bacterial blight.

8 Vegetables

8.1 Protected Cultivation of Vegetables

There are two aspects of this sub-project activity; improving protected cultivation under plasti-culture in five provinces and developing natural off-season vegetable production in Punjab and Sindh. Thirteen partner's research institutes and agriculture extension departments are evaluating vegetable varieties on-station and on-farm in collaboration with farmers and the private sector. Work has focused on tomato, cucumber, sweet pepper, chili, bitter gourd and vegetable marrow. Farmers received training on the use of plastic tunnels, improved production and integrated pest management practices.

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

Public sector institutes (Agriculture Extension, GB, Agriculture Department, AJ&K; Agriculture Extension and ARI (North), Mingora; NT&HVCRI, Shinkiari-Mansehra; Directorate of Vegetable, NARC, Islamabad; BARI, Chakwal; VRI-AARI, Faisalabad; AZRI, BARI (South) DI Khan; NS&THCRI, Thatta and Directorate of Vegetable Seed Production, ARI, Quetta) have been given commercial hybrids and imported germplasm of priority vegetables for breeding, multiplication and being evaluated on and off station since 2013-14.

On station Validation Trials

a) Plasti-culture

A total of 26 trials with 134 varieties and hybrids under two different planting conditions at 27 locations were undertaken by provincial partner institutes; Mingora, Rawalpindi/Islamabad, Chakwal and DI Khan. Of the 10 tomato hybrids tested, Sahil, Anna and Deenar performed well at most partner institutes while two WorldVeg tomato lines, AVTO 9001 and AVTO 9601 performed as well as the local check in Mingora-KP. Over 2014-2016 the cucumber hybrids; Yousaf, Termessos, Waleed and Ramzan performed best out of 14 varieties tested in Faisalabad and DI Khan. The sweet pepper hybrids Coral and Orobelle yielded up to 30.0 t/ha of fresh produce when tested in Faisalabad and Islamabad. Out of 25 chili cultivars/hybrids screened in Faisalabad, the highest fresh green fruit yield of 34.8 t/ha was obtained from Fengaio # 2 followed by Super-Hot F1 (33.9 t/ha), and these may be alternatives to the commonly grown P-6 commercial hybrid.Six advanced WorldVeg Bitter gourd lines evaluated at four locations showed that AVBG1304 yielded highest in Islamabad (43.3 t/h) followed by AVBG1301 in Mingora (34.1 t/ha) and AVBG1334 in Quetta (26.2 t/ha). The highest yielding of five vegetable marrow hybrids tested in DI Khan this year was Sanam (15.7 t/ha) followed by Liza (12.5 t/ha) while Charisma yielded well in 2014-15.

b) Normal season

Tomato: In a continuation of last year's yield trials 10 hybrids were tested by the AARI, Faisalabad at three locations (Multan, Sheikhupura & Faisalabad) across Punjab. The hybrids NBH-2, NBH-25 and NBH-3 from the NIAB -Faisalabad were the top three performers (32.0 to 37.0 t/ha), well out-yielding the commercial check hybrid T-1359 (23.0 t/ha). Most pre-release formalities for these high performing public sector hybrids have been completed.

Four other determinate tomato hybrids were tested in multi-location trials in Faisalabad, Islamabad, Swat, Mansehra and Quetta against the same standard hybrid check T-1359. The Hybrids NBH-6, NBH-13 and NBH-4 yielded between 20.0-71.0t/ha and performed better than the check. They appeared to perform better in Quetta, Islamabad and Manserha than in Mingora and Faisalabad.

A replicated yield trial at NIAB in Faisalabad of 10 tomato lines received from the WorldVeg Gene Bank showed that the lines AVTO-[1005, 1080, 1009, 1219, 1323, and 1008] yielded from 52.0 to 129.0 t/ha compared to 48.0 t/ha of standard variety Naqeeb.

Initially, three public sector determinate tomato hybrids with the help of NIAB, Faisalabad are being released for farming community after the approval of Punjab Seed Council. Another four are being tested at multi-locations for a sustainable supply from public sector compared to commercial hybrids.

Onion: 10 WorldVeg 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 tested by the NARC Vegetable Program, Islamabad. A nursery was raised in October, 2015 and used to grow crop for seed production in autumn 2016. This seed will be used for the spring crop of 2017. Through this breeding system we will be able to provide compatible open pollinated varieties of onion for the benefits of farmers.

On Farm Adaptability Trials: A total of 36 trials were conducted 53 vegetable varieties or hybrids of tomato, cucumber, sweet pepper, chili, bitter gourd and vegetable marrow in different locations with collaboration of provincial partners (Agriculture Extension, GB, Agriculture Department, AJ&K; Agriculture Extension and ARI (North), Mingora; National Tea and High Value Crops Research Institute, Shinkiari-Mansehra; Directorate of Vegetable, NARC, Islamabad; BARI, Chakwal; VRI-AARI, Faisalabad; AZRI, Bahawalpur; ARI (South) DI Khan; NSTHCRI, Thatta and Directorate of Vegetable Seed Production, ARI Quetta under protected structures and natural off-season conditions. Demonstration plots and trials were conducted with 179 farmers for increased yield and income.

a) Plasti-culture

- Tomato: In continuation of previous years' trials, 11 tomato hybrids (Anna, APCL, Sahil, Cosmic, 4040, Mission-102, Sallar, Sandal, Lima, Deenar, Nadir) were evaluated under protected cultivation at 13 locations (Gilgit, Muzaffarabad, Mingora, Haripur, Rawalpindi/Islamabad, Sheikhupura, Gojra-Faisalabad, Noorpur Thal, Bahawalpur, Quetta and Bostan). Despite wide local differences in performance, two years of data indicate that the best overall performers were the hybrids Sahil, Anna, Deenar and Sandal (97.8 to 37.2 t/ha) followed by APCL and Sallar (81.6 to 45.8 t/ha) across locations.

Sahil raised with drip irrigation under plasti-culture at Kallar Syedan (Punjab)

- **Cucumber:** Eight commercial hybrids (Yousaf, Saad, Waleed, Yala, Babylon, Kandil, Beit Alpha and Termessos) were tested for yield and other horticultural traits at six locations across KP and Punjab. The highest yield of 222.0 t/ha was obtained from Termessos at Gojra-Faisalabad followed by Yousaf (91.2t/ha) in DI Khan and Yala (91.0 t/ha) in Gojra-Faisalabad. Data revealed that Termessos, Yousaf, Saad and Waleed may be adopted as the best performers across locations and years.

Cucumber with stakes and net under plasti-culture at Mingora (Khyber Pakhtunkhwa)

- **Sweet Pepper:** The hybrids Orobelle and Extra-2 were best performers across locations and years. This year the late maturing hybrid Extra-2 yielded 81.0 t/ha in Gojra-Faisalabad followed by Orobelle (74.0 t/ha) but it yielded much lower in Shiekhupura (63.3 t/ha). While Extra-2 yields better than Orobelle, it is also late maturing and receives a lower price.
- **Chili:** Three varieties/hybrids (P-410, Golden heart and Pusa Jawala) were evaluated at Gojra-Faisalabad and Muzaffarabad. The variety P-410 yielded best (7.5 t/ha) followed by Golden heart (7.1 t/ha) at Faisalabad
- **Bitter gourd:** Two hybrids; Palee and TS-222 were evaluated against the local variety Kala Karela in Bhikhi-Shiekhupura, Gojra-Faisalabad and Mansehra. Palee yielded best (22.9 t/ha) in Gojra-Faisalabad followed by Kala Kerala (10.2 t/ha) in Mansehra. Palee and local Kala Kerala are widely used and preferred by farmers.
- **Vegetable Marrow**: Six hybrids (Sanam, liza, Jalal, Starex, Charisma and Clarebela F1) were evaluated in Mansehra and DI Khan. Sanam yielded best (22.8 t/ha) followed by Charisma (12.6 t/ha) in DI Khan and across locations.

b) Natural off Season

- In previous years farmers produced wheat, barley and gram in these areas of district Khushab, but are now raising high value vegetable crops to get a better return.
- **Tomato:** 10 hybrids/varieties (T-1359, Savera, Lerica, HT-100, KHT-104, Kimia, Riograndi and Melsi) were compared with local checks Simti and Tarnab in Khushab district. Over two years trials Savera and T-1359 performed far better than the local checks in the Soon Valley and Katha Saghral.
- **Cucumber:** Three hybrids; Beit Alpha, Babylon and Market More were evaluated in the Soon Valley and Mansehra. Beit Alpha yielded best (26.7 t/ha) in the Soon Valley followed by Market More (24.6 t/ha) in Mansehra.
- **Sweet Pepper:** Four hybrids; Early Morlin, Astra, Ganga and Royal Wonder were compared in the Soon Valley and Mansehra. Higher yields were recorded in the Soon Valley due to a prolonged cropping season and more pickings. Astra yielded 49.9 t/ha followed by Ganga with yield of 45.7 t/ha in the Soon Valley whereas Early Morlin yielded 17.9 t/ha in Mansehra. The best yielding hybrid was Ganga across locations and years.
- **Chili:** Four hybrids / varieties (Sky-9 F1, Captain F1, Magma and Pusa Jawala) were evaluated in Mansehra and Muzaffarabad. Sky-9 F1 yielded best (8.1 t/ha) in Mansehra followed by Magma (7.3 t/ha).

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

Yellow sticky traps used to control pests including fruit & white fly by Malik Sharif at Chevanda-Faisalabad

Insects and diseases can significantly reduce yields under protected cultivation (plasti-culture). Training was provided to help farmers to control growing temperatures and humidity under protected cultivation in December and January. They were also trained that insect management is most crucial from mid-March to mid-May and from mid-July to mid-October, and the value of using improved IPM practices including insect nets, kairomone and yellow sticky traps. Training was provided to 96 farmers on the use of compost, sterilized media, multi-pot trays, field production and IPM technologies in Quetta-Balochistan, Faisalabad-Punjab and Rawalpindi Islamabad. Data collected by the AIP field team from Mingora, Rawalpindi/Islamabad, Sheikhupura, Noorpur Thal, Bahawalpur, DI Khan and Quetta showed that there was a 10-15 percent reduction in pesticide use. Following training's guidelines, farmers were more careful in use of pesticide with less spraying. The use of yellow sticky traps was claimed by farmer Malik Sharif which reduce both pesticide costs and the labor needed for spraying.

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

AIP project introduce spinach and coriander in summer as off season vegetables and were successfully grown under green nets over the last two years. This activity has been repeated at six locations across KP (Mingora, Mansehra) and Punjab (Rawalpindi/Islamabad, Khushab, Sheikhupura & Faisalabad). The initial coriander varieties trial; Irani and Kandhari were replaced with high yielding "Ramses", while the spinach variety "Desi palak" was encouraging in most locations. Project beneficiaries obtained an average spinach yield of 43.9 t/ha and earned an additional income of US$ 14,647. The average yield of coriander was 14.6 t/ha with an extra income of US$ 15, 979.

8.1.4 Identify and promote improved protected cultivation systems

Drip irrigation systems were installed at 23 locations across KP, Punjab and Balochistan to demonstrate the effect of drip and furrow irrigation on water and fertilizer efficiency and crop growth in 45 tunnels covered with insect net. Cucumber crops saved 25 to 45% of water and 29 to 40% of fertilizer with an increased yield of 27 to 43% at five locations. Tomato saved 36 to 41% of water and 33 to 39% of fertilizer with an additional yield of 28 to 40% at four locations. The biggest saving of water (90 %) and fertilizer (86 %) were achieved with a 26% increase in yield in the sandy soil of Noor Pur Thal. Bitter gourd yield increased from 20 to 33% by utilizing 39 to 45% less water and 34 to 42% less fertilizer at two locations. Vegetable marrow yielded 21% more as compared to crop irrigated through furrow system, saving 32% in water and 37% in fertilizer at Mingora-KP. The drip irrigation system not only saved water and fertilizer but also helped to reduce the cost of production and minimize the use of weedicides and fungicides under plasti-culture. Drip irrigation was also of value in open fields. In a trial in Quetta-Balochistan, a 500 m^2 onion crop grown in an

Spinach & Coriander planted under green net in summer season at Noor Pur Thal

open field with drip irrigation yielded 18% more and saved 22% of water and 43% of fertilizer as compared to a crop irrigated through furrow irrigation.

8.2 Improved Mungbean Production

The six provincial and national institutes participated in various project activities at different geographical locations and a summary of major activities is given below.

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

The intervention were carried out in four different cropping systems;

a) Mungbean production in the traditional area

A happy farmer on his bumper mungbean field in Bhakkar (Punjab)

Demonstration plots of both high yielding varieties NM-11 and AZRI-6 were planted in six clusters in the Bhakkar and Layyah districts involving 63 farmer beneficiaries. The use of improved production practices including line sowing, use of *Rhizobium* + PSB (*Phosphorus Solubilizing Bacteria*), post-emergence chemical weed control and IPM to control insect pests led to a significant increase in yield and farmer income. In 2016, a mean yield of 1237 kg/ha in the six clusters (1129-1368kg/ha range) was achieved as compared to 1143 kg/ha during 2015 (970 to 1375 kg/ha range). A net profit of US$ 672 to 902 was obtained as compared to US$ 519 to 909 achieved during 2015. The impacts on increasing the overall area and production in the targeted districts have been significant (shown in below table).

Area, production and average yields in Bhakkar and Layyah disticts from 2013-2016.

District	Area (ha)				Production (t)				Average Yield (kg/ha)			
	2013	2014	2015	2016	2013	2014	2015	2016	2013	2014	2015	2016
Bhakkar	56,657	51,033	60,704	76,892	43,031	43,031	48,017	62,700	760	806	791	815
Layyah	16,791	20,437	20,440	23,553	15,765	15,765	22,382	29,050	939	1104	1095	1235

Source: Crop Reporting Service, Govt. of Punjab, Pakistan, 2016.

b) Mungbean production in rice-wheat cropping system

This sub-activity was carried out by AARI, Faisalabad in Punjab and QAARI, Larkana in Sindh province. During 2016, the mean yield ranged from 450 to 550 kg/ha as compared to 594 to 1297 kg/ha during 2015. The net revenue gain during 2016 ranged from US$ 84 to 156/ha as compared toUS$ 188 to 695/ha during 2015. During 2016, heavy rains, poor drainage and *Cercospora Leaf Spot* (CLS) disease affected the mungbean crop. It is a very serious matter that a huge area of new mungbean cultivation was put at risk through this disease as NM-11 was considered to be tolerant to it.

c) Mungbean production through intercropping with sugarcane and citrus

Two institutes, NSTHRI, Thatta in Sindh and AARI, Faisalabad in Punjab were involved in mungbean intercropping with sugarcane and the third institute, CRI, Sargodha in Punjab was involved in intercropping with citrus. During 2016, the mean yield was in the range of 190 to 510 kg/ha as compared to last year's yield range of 190 to 667 kg/ha, with a net profit/ha of US$ 185 to 416 as compared to US$ 185 to 529/ha in 2015. Unusually heavy rains affected the crop in Sargodha, Punjab where it was intercropped with citrus. Sindh growers heavily irrigated their fields which caused water logging and crop submergence affecting yields. As in the previous year, the major yield differences between the two provinces were mainly due to differences in the soil types and management.

d) Mungbean production through double cropping in Pothwar region

This sub-activity is being carried out by the Pulses Program, NARC, Islamabad. Their activities encompass five districts of Pothwar region and only medium (350 mm rainfall) to high rainfall areas are being targeted for mungbean cultivation under complete rainfed conditions. In the Chakwal district alone, mungbean is planted on around 500 ha in a small pocket. At the time of reporting, the crop was in the field and almost 20 ha of 0.4 ha demonstration plots have been planted. Harvesting is in progress in some locations, and fields will be vacated by the end of September or first week of October, ready for moisture conservation for wheat planting under rainfed condition.

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

AZRI Bhakkar produced 24, 28 and 31 tons of high quality seed during 2014, 2015 and 2016, respectively of three major high yielding varieties (AZRI-06, NM-11, NM-16). At the same time, NARC produced and distributed 1.2 tons of seed during 2014 and 10 tons during 2015. Mumtaz Seed Company produced 500 tons during 2014 and 150 tons during 2015. The data for 2016 from NARC and Mumtaz Seed Company were not available. So far, 744 tons of quality seed has been produced in less than three years and the total may reach 1000 tons after getting data from these two sources. A minimum of 700 tons of seed was provided to farmers for planting during 2016; sufficient for planting 28000 ha. If recovered this area could yield 28000 tons of seed, and potentially half or more of it may enter the seed market during 2017. This is highly encouraging and close to meeting the life of project target of producing 10000 tons of quality seed. This year, 31 tons of quality seed of two main high yielding varieties, AZRI-06 and NM-11, produced by AZRI, Bhakkar had a market value of US$ 29,808.

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

a) Training beneficiaries to minimize postharvest storage losses

This sub-activity was carried out after harvesting and threshing of the crop and 378 direct / indirect farmers benefitted in the project areas.

b) Breeding for bruchid resistance in Pakistan

Bruchids can be controlled by chemicals, but a resistant cultivar is preferable due to reduced risk to health, environment and reduction in the cost of insecticides. In 2013-14, 18 mungbean genotypes including 14 lines from WorldVeg and four improved varieties from Pakistan were tested to identify bruchid resistant genotypes. These genotypes were evaluated under controlled conditions in collaboration with the IPMP, NARC, and Islamabad. The genotype V 1001802 B-G showed minimum percentage grain damage (0.7%) followed by AVMU 8901 with 1.3% damage. These genotypes were resistant to *C. maculatus*. The resistant genotypes with a small seed size and dull testa were crossed with four cultivars with high yield, bold-seeded, shiny testa and susceptible to *C. maculatus*. No new crosses were attempted. However, two generations of F4 and F5 were obtained during 2016 by growing the F4 in spring and F5 in the normal summer planting. Presently, 8 crosses in F3 and 7 crosses each in F4 and F5 generations have been produced.

8.2.4 Identify opportunities for adoption of IPM practices in mungbean cultivation

AZRI, Bhakkar organized two field days and provided hands-on training for IPM of mungbean to 378 participants to make them aware on the use of IPM practices and the potential for yield increases of over 20%. Practices involved pest scouting, monitoring of parasites and parasitoids. Farmers were involved in the identification of insect pests and controlling the sucking pest complex of thrips, white flies and jassids using imidacloprid 15 ml/15 L of water, applying detergent with water and spraying Chlorfenapyr (Squadrin) @ 500 ml/ha. Armyworms were controlled with Match (Lufenuron) 25 ml, field crickets with Lorsban (Chloropyrophos) 4 ml/L of water and mixing in 5 kg wheat flour for application. Lambdacyhalothrin (Silk) @ 620 ml/ha was sprayed for the control of Helicoverpa and pod borer. Post-emergence weedicides were also used and farmers were provided with a complete training program and handouts were distributed.

8.2.5 Assess the opportunities for mechanical harvesting of mungbean

A lack of combine harvesting technology in Pakistan is the only hurdle in completely mechanizing mungbean production. After fine tuning of the technology at the institute level, a large wheat combine harvester was used in 2015 with tremendous success on a chemically desiccated farmer's field in Daggar Rohtas village in Bhakkar. In 2016, the mechanical harvesting of mungbeans was demonstrated in Thal and Pothwar regions. A total of 4 ha of mungbean were harvested with a combine harvester on farms in Bhakkar, Layyah and 10 ha in Chakwal. The data obtained from the service providers showed that at least 7000 ha in Bhakkar, 250 ha in Layyah and 202 ha in Chakwal have been similarly combine harvested.

Mungbean combine harvesting in progress on a desiccated crop at Bangwala-Chakwal (Pothwar) rainfed region

8.3 Vegetable Value Chains

Capacity building training programs continued and intensified in both the seed value chain and fresh value chain components. Seed industry backstopping, postharvest and value adding technology generation also continued with the support of ten public and private partners.

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

a) Conduct evaluation trials for improved varieties of at least 3 major vegetables

- Tomato: Eleven lines from the last season trials (April-September 2015); AVTO9708, AVTO1455, AVTO1429, AVTO1424 , AVTO1418, AVTO1409, AVTO1405, AVTO1289 and AVTO1288 were raised in a nursery at ARI(N), Mingora-Swat and transplanted in April 2016. The highest yield were obtained from AVTO1455 (30.4 t/ha) and AVTO9708 (25.9 t/ha). Two AVRDC advanced lines (AVTO1456 and AVTO1420) did not germinate while five did not survive at NARC, Islamabad when planted in March 2016. The two that survived in Islamabad had low yields: AVTO-1456 (17.1 t/ha) and AVTO1429 (14.4 t/ha) compared to those obtained in Mingora-Swat due to a severe infestation of early blight.
- Chili: Eight AVRDC advance lines (AVPP-0506, AVPP-0701, AVPP-0705, AVPP-0903, AVPP-9704, AVPP-9804, AVPP-1346 and PBC-518) were planted in March in AZRI Umerkot and yield data collection will be completed in December, 2016.

Onion: The last season's trial of eight varieties was repeated at ARI (N), Mingora- Swat, with the addition of one hybrid (Sunset F1) with the objectives to assess its yield potential and shelf life. Transplanting was completed in January, 2016. The variety Hunter River gave maximum yield of 49.1 t/ha, followed by variety 15007 with a total yield of 48.67 t/ha. Sunset F1 showed the lowest bolting percentage of 6.7% while Chiltan-89 had the highest with 28.0%. These varieties have been stored for shelf life assessment.

b) Build capacity and provide technical backstopping on improved seed production, processing, packaging, storage and marketing

A training of trainers (TOT) on onion seed production technology was conducted in Chitral, KP in collaboration with Magnus Khal International (Pvt) Limited. An onion seed thresher was demonstrated and handed over to the Shuga Seed Growers Association in a ceremony held in Shuga, Bunir, Swat with 56 participants

Farmers with onion seed thresher and field tools provided to the Growers Association of Shuga Seed Village, Bunir-KP

c) Facilitate seed production of improved varieties

At least four major vegetables on 40 hato meet seed requirement for 2,000 ha production for seed, fresh market and/or processing

Seed crops of onion, chili, tomato, okra and peas were planted on 30.9 ha against a target of 20.0 ha for the year 2015-16. The number of partner institutes in seed production has been increased to cover almost every corner of the country suitable for seed production, and a total 21.2 tonnes have been obtained as given in table below.

Institute /Seed Company	Crops					Total (Kg)
	Onion	Tomato	Chili	Okra	Peas	
Mountain Ag. Research Center, Jaglote, GB	208	-	-	-	-	208
ARI Quetta, Balochistan	1735	-	-	-	-	1735

AZRI Umerkot, Sindh	400	-	-	-	-	400
ARI, Mingora, KP	563	-	-	-	-	563
VRI-AARI, Faisalabad, Punjab	-	20	-	2580	2475	5075
NARC, Islamabad, Federal Area	475	-	-	118	-	594
Beacon Seeds, Kunri, Sindh	350	-	-	-	-	350
ARCO Seeds, Gujranwala, Punjab	-	-	-	6000	6250	12250
Total	3731	20		8699	8725	21174

Volume of seeds (kg) produced during October 2015 to September 2016

d) Link farmer-seed producers with key private seed companies, seed markets, technology providers and business development services for increased profitability and sustainability

Nine coordination meetings have been organized with seed producers and dealers in GB, KP and Punjab. Farmer groups of GB have been successfully linked with the MARC, Jaglote while farmers of KP were linked with the Agriculture Extension Departments in Swat and Bajaur Agency (FATA). The Shuga Growers Association was linked with Zamindar Seeds Mingora and the Farm Service Centers of the Ag Extension Department, Mingora. Farmers in Faisalabad, Chiniot and Nankana Sahib were linked with Siddique & Sons, Faisalabad, and farmers in Sahiwal have been linked with ARCO Seeds. In addition, Beacon Seeds in Kunri-Sindh and Kashmala Seeds in Quetta, Balochistan, are helping seed growers in the project area.

e) Establishment of seed villages in Punjab, Sindh, Balochistan and KP provinces

Members of the "Shuga Growers Association" in Bunir-Swat, KP were given an onion seed thresher and field tool kits in a huge gathering of farmers and representatives from agriculture research /extension and private companies. Onion umbels were threshed as a practical demonstration with excellent results (95-98 %) along with time and money saving. Its capacity is threshing 100 kg of seed per hour and it can be further improved once farmers get used to it. Farmers will save labor charges of approximately from US$ 1.0 to 1.3 per kg contributing to reduced production cost. After the declaration of a Seed Village, surveys were carried out to establish other vegetable seed villages across the country, and in this regard, Kuchlaak village in Balochistan was as the next seed village to be developed.

8.3.2 Evaluate value chains for major vegetable crops to assess and promote improved post-harvest and value adding technologies

End-users technology promotion activities related to Postharvest and value adding technology studies were carried out in coordination with partner institutes.

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

A set of 11 AVRDC advanced tomato lines were planted in ARI, Mingora and yield data collected. Eight advanced chili lines at AZRI, Umerkot await final field evaluation and seed multiplication. Experimental data collection is in progress and results will be presented in the next semiannual report. The objectives of these experiments are to evaluate the varieties for improved shelf life and processing attributes.

- **Packaging study on tomato, Quetta, Balochistan:** The objectives of the packaging study were to compare the effectiveness of Potassium metabisulphite (a chemical being used as a preservative to prevent microbial contamination of fruits and to improve their shelf life) in combination with storage in net bags, gunny bags, wooden crates and cartons with no packing. A set of five kg of

untreated tomatoes were used for each treatment; packed in plastic crates, wooden crates, net bags and gunny bags. Storage was done at ambient temperature (12-22 oC). Another set of five kg of tomato was first dipped in 0.1% Potassium metabisulphite solution for 20 minutes and then packed into same packing material used for untreated tomatoes to compare the effectiveness of chemical preservative for prolonging the shelf life of fresh tomatoes. The samples were studied for sensory evaluations at every 3 days interval for a period of 9 days (see below table).

Treatments	Color		Flavor		Texture		Difference in weight g.		Overall acceptability	
	Treated	Un-treated	Treated	Un-treated	Treated	Un-treated	Treated	Un-treated	Treated	Un-treated
Control	4.93	5.33	6.24	5.91	5.58	5.16	175	152.5	6.00	5.83
Plastic crate	7.49	7.49	6.37	7.66	7.83	7.49	77.5	75	8.16	7.83
Wooden crate	7.41	7.24	7.83	7.33	7.49	7.41	113.5	97.5	7.66	7.41
Net Bag	7.24	6.99	7.41	7.16	7.41	7.33	120	92.5	7.41	7.08
Gunny Bag	6.91	6.58	7.08	6.91	6.83	6.58	155	126	6.91	6.58

Mean data of treated and untreated tomatoes; packed in different packing materials and stored at ambient temperature in PH&FT, ARI, Quetta, and Balochistan

In both treated and untreated fruits, packing in plastic crates showed the maximum quality characteristics but maximum mean scores were observed in the treated samples. Treatment with 0.1% Potassium metabisulphite prior to packaging can extend the shelf life of tomatoes.

- Storage study of onion at Quetta, Balochistan: In the Directorate of Vegetables ARI, Quetta, Balochistan, seven varieties (Trich Mir, Chiltan-89, Tarnab Red, Nasar Puri, Swat 1, Phulkara and NARC-2) were evaluated using the June 2015 onion production. The crop is presently standing in the field. Harvesting will be completed in mid-September.
- Chili drying and storage study for aflatoxin reduction, Sindh: The experiment on chili aflatoxin was conducted last year and reported in the preceding semi-annual report (October 2015-March 2016). This has been repeated and the crop is still standing in the field. The data will be recorded from October to December 2016 and reported in the next semi-annual report.

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

Postharvest technologies developed at Postharvest Research Center (PHRC) AARI, Faisalabad.

- PHRC did work on postharvest and value added technologies for tomato and onion as detailed below:
- A new type of tomato handling system has been introduced using folding & interlocking field crates for easy and safe transportation as a returnable packing material. The shelf life of the green tomato hybrid "Anna" was extended by up to 40 days at 10 ^{o}C using CA storage. Tomato pastes and juices were prepared for kitchen use. Using a brine solution the shelf life of tomato pulp was extended up to 150 days and tomato cut pieces up to 60 days. Small scale tomato pulp production techniques have also been tested successfully.

- Onion powder was prepared as a bi-product using fresh onion through processing and value addition for kitchen use in the slack season. Onion pickle was also prepared using fresh bulbs. The shelf life of fried onion was extended up to 90 days with the use of acetic acid (vinegar).

Effect of storage with different media on physiological losses of onion bulbs in Kunri, Sindh

At the FQ&SRI in the SARC Karachi, four experiments were conducted to study physiological losses of bulbs of the onion variety Phulkara in storage on a farm in Kunri: (1) storage on racks, (2) storage on the ground, (3) storage on 5 cm thick but loose silt and (4) storage in a cement store on the ground. The losses were recorded at 30, 60 and 90 day interval of the storage period. The lowest (5.9%) total loss was recorded while onions were stored on a rack with a single layer with foliage, followed by storage on a rack in a double layer with foliage. The maximum total weight loss was recorded in onions when stored on a rack in a double layer without leaves, which are cut 2-3 cm above the bulb neck.

c) Build R&D capacity of partners on postharvest research

Capacity of eight resource persons of partner's institutes; ARI, Mingora & DI Khan, PHRC-AARI, Faisalabad and FQ&SRI-SARC, Karachi was enhanced on postharvest management and value adding technologies through exchange of training material and visits This will help in postharvest and value adding R& D, and to generate new technologies and transfer to the stakeholders.

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

Research and development activities (assessing proper maturity stage, picking method, sorting, storage, using right packing material and preparing value added bi-products) were conducted at

PH&FT-ARI, Quetta, Balochistan; PHRC-AARI, Faisalabad, Punjab, and FQ & SRI-SARC Karachi, Sindh to adapt and optimize selected postharvest technologies for inclusion in the technology promotion phase.

e) Trainings on postharvest management for at least 200 future trainers and 2,000 farmers and other value chain actors in the four provinces conducted

Women with their own products and resource person at DI Khan (Khyber Pakhtukhwa)

A total of 105 participants including 34 women were trained through one day hands on training on July 29, 2016 to develop a pool of master trainers through four trainings in postharvest and value addition technologies. Members of Shuga Seed Village, Bunir, KP, were also trained to cut and dry the undesirable

onion bulbs (double, small and sprouted) that were normally discarded. There was a lot of interest in making valuable use of these. The dried onion can be used and sold locally that will consequently increase their income (detail given in appendix 08 and 09)

9 Perennial Horticulture

All 22 commissioned projects were making good progress toward both technical and outreach objectives. However, the funding cuts slowed project progress in July-September, 2016. Even with the cuts, 67 trainings/workshops/field days with a total of 1302 beneficiaries including 69 females were successfully managed (appendix 10). A total of 203 farmers farming 2781 acres adopted innovative agricultural practices. Key achievements are given below:

- A total of 34 demonstration plots with five fruit commodities includes grape (4), citrus (15), mango (4), guava (7) and pistachio (4) were successfully managed through 61 training sessions and on-farm demonstrations in 12 districts namely Islamabad, Quetta, Mastung, Nawabshah, Naushero Feroze, Larkana, Sargodha, Multan, Attock, Chakwal, Faisalabad and Rawalpindi. In the farmer's field schools 105 guava and 160 citrus registered growers and 28 demonstration plot were visited fortnightly to provide both technical and material support on nursery, orchard and post-harvest management.
- A 40-year old pistachio orchard at ARI Quetta was successfully rehabilitated to turn the neglected non-fruiting trees into normal fruiting trees through AIP recommended Good Agricultural Practices (GAP). The average yield per tree has been increased to 7-8 kg, triple the 2-3 kg yield the previous year. The large, high quality, clean split pistachio nuts clearly demonstrated that Quetta has true potential as a pistachio production area.
- Two pistachio varieties Kerman and Peter introduced under AIP during March 2016 have successfully adapted to Pakistan's climatic conditions at ARI Quetta's rehabilitation block; 18 Kerman female and two Peters male buds have sprouted and survived out of the 300 trees total budded.
- Cultural practices were also developed for the pistachio nursery project including media preparation, growing nursery in polythene bags, irrigation and nutrition management of young seedlings, temperature control etc.
- 750 Mango plants were distributed to growers in Faisalabad, Rahim Yar Khan, Okara, Toba Tek Singh, Muzaffargarh, Vehari and Multan.
- The 15 sites established during August 2015 in Multan, Vehari, Toba Tek Singh, Okara, Faisalabad and Muzaffargarh were visited during May, 2016 to evaluate the growth and performance of the newly distributed mango plants. Survival was approximately 60 percent.
- 1100 Rough Lemon Citrus rootstocks were grafted with ten improved scions; Salustiana, CRI-7, Tarroco, CRI-8, Arnold Blood, Mars Early, Kishu Mandarin, Harward Blood, McMohn Valencia and Kinnow seedless. The plants will be distributed in March, 2017.
- The standard postharvest procedures for "Citrus Packing Houses" were finalized and the critical control points were identified by CRI Sargodha researchers in consultation with allied pack houses; Citrus Asia Enterprises, Subhan Kinno Factory, Sajawal Enterprises, Al Arshad Kinnow Factory, Al

Qamar Kinnow Factory and Abdullah Enterprises. No further steps were taken due to funds shortage.

- The postharvest facility established under AIP at CRI Sargodha was further equipped with latest lab equipment including one digital penetrometer, one manual penetrometer, two Brix-Acid meters, two handheld optical refractometers with a range of 0-80 Brix, one digital caliper, and two temperature probes.
- Four more recipes have been developed by the postharvest demonstrative site at CRI i.e. a mixed fruit jam, an orange pulpy drink, a sugar free orange marmalade and a citrus peel enriched candy. However, due to financial constraints the brochure could not be published.
- The first course on "Harvest and Postharvest Management of Summer Fruits and Vegetables" for 104 students was successfully completed during June at ATI-Sakrand. Upon suggestion from 84 % of the students, the curriculum for the second post-harvest course to be started in October 2016 has been translated into Urdu
- Need based trainings on olive and vineyard management have been conducted throughout the season
- A baseline survey of 82 growers, 32 pistachio and 50 guava, has been completed during May, 2016.

9.1 Human Resource Development

9.1.1 Graduate studies

The AIP held a Scholars Conference at UC Davis 11-14 July 2016. The overall purpose of the event was to assess the performance of the students and resolve the problems if they are facing in timely completion of their degree programs. Fourteen AIP Scholars (nine MS & five PhD; six men & eight women students) participated in two days of discussion and presented their research work. The scholars are enrolled at seven different Land Grant Universities across the USA – UC Davis, Washington State U, Texas A&M U, Purdue U, U of Missouri, Mississippi State U and U Massachusetts. Dr. Muhammad Imtiaz, CIMMYT, Dr. James Hill, UC Davis, Dr. Helene Dillard, Dean, CAES, UCD and Dr. Ermias Kebreab, UCD Associate Vice Provost, Global Affairs also presented their views. In panel discussions students shared their experiences as graduate students in the USA and concerns about their future. Some of the important points from the discussion are given below.

- AIP cannot pay for extra time to the scholars.
- If students require extension beyond their completion date, they should discuss with their supervisor and inform AIP committee as soon as possible. Special arrangements will have to be made with USAID in this regard and final decision subject to USAID approval.
- The MSc students who have opportunity to get admission for PhD are required to follow legal obligations.
- The travel expenses can be adjusted from student's budget with consultation of supervisor and AIP committee should be informed.
- Students should use care in selecting their research and examination committees. Moreover, practice and care should be taken for qualifying exam.
- All the students are doing their course and lab work at USA so the committee member from Pakistan is not required unless considered necessary by the student and USA professor.

The participants also visited UC Davis, Sacramento and San Francisco. This was a good experience for all the students and it was a very successful conference

9.1.2 Vocational Training

Under the Vocational Training component of AIP, two workshops with a total of 44 participants (40 males and 4 females) were organized. Brief summary of the workshops is as follows:

a) Mini workshop on file size Optimization: A short training was organized on May 05, 2016 at NARC Islamabad for AIP primary partners include CIMMYT, ILRI, and AVRDC (total participants 13; Male 11, Female 2. Major topics discussed were; affects downloading speed, reasons for large file sizes and what can be done. This training will help the primary partners to prepare their extension messages easy to be retrieved online by the users.

b) Quality Seeds; Issues and Options: On May 9-11, 2016, a workshop on seed quality issues was organized at Faisalabad. A total 32 stakeholders from public and private sector related to seed business attended this workshop. An exposure visit to Pioneer Seeds (International level seed Company) and Sohni Dharti (A national level seed company) was organized for the participants. The trainers of the workshop Dr. Joseph Rickman and Dr. Mark Andrew Bell emphasized on the production of quality seeds as good quality seed can increase the yield by 5 to 20 percent.

c) Follow-up: The follow ups on three vocational trainings (Grant Writing, Action Planning and effective meeting workshops) was done during July-August. The report of all follow-ups will be shared in the next reporting period.

9.2 E-Pak Ag

The following nine successful events were managed under E-Pak Ag (Component leader Dr. Mark Andrew Bell).

9.3 E-Pak Ag events

Event	Number of Beneficiaries		
	Male	Female	Total
Conference on Agriculture Productivity Improvement through Nudging at AAUR, Rawalpindi	74	168	242
Workshop on ICT and extension workshop at MNS University of Agriculture, Multan	37	8	45
Launching ceremony of ICT working paper at NARC Islamabad	66	5	71
Training on Rural Poultry Farming at Mansoora, Faisalabad	0	17	17
Training on Dairy Farming at Joiya, Okara	0	20	20
Training on Kitchen Gardening and Goat Farming at Chakwal	0	25	25
Training on Dairy Technology at Koont, Chakwal	0	25	25
Training on Dairy Herd Health Program at Joiya, Okara	0	20	20
Training on Dairy Herd Health Program at Mansoora, Faisalabad	0	20	20
Total Beneficiaries	**177**	**308**	**485**

- Other significant achievements of E-Pak Ag are as follows:
- The launch of ICT working paper was chaired by the Federal Secretary, MNFSR. Many other distinguished guests participated in the event. The ICT working paper and ICT field kits were distributed among the participants of this ceremony.

- The project PI of E-Pak Ag Dr. Babar Shahbaz visited UC Davis California, USA under another USAID's funded project and participated in a training workshop on short video making organized by the Digital Green USA.
- E-Pak Ag Website received 2,450 sessions involving 2,123 users and almost 5,000 page views.
- In addition to the web site visits, there have been 2,395 views of PowerPoint training materials uploaded to Slide share (http://epakag.ucdavis.edu/).
- Three students from UAF have completed their research projects on ICT and agriculture.

10 Socioeconomics (SEP)

Follow up surveys are currently being conducted by AIP-SEP across Pakistan to document the impact of AIP wheat and maize based systems interventions. The main objective of the follow up surveys is to document the impact of the AIP wheat, maize and conservation agriculture (CA) technologies across Pakistan. Currently eight surveys for different interventions are in progress and are listed as follows;

- Follow up surveys regarding 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
- Assessing the impact of pre released seed multiplication of wheat varieties to shorten seed availability of new varieties on farmer's field
- Impact of laser land leveling technology adoption on household income and food security in Pakistan
- Impact of ZT technology adoption across various districts of Pakistan

10.1 Follow Up Survey on Impact of Selected CA Technologies

Follow up survey was conducted in August and October, 2016 to determine the impact of conservation agriculture technologies like ZT happy seeder, ZT, raised bed planting, laser land leveling, direct sowing of rice and nutrient management in Punjab and KP provinces.

Data was collected from three districts of Punjab i.e. Sahiwal, Vehari, Faisalabad and four districts of KP i.e. Peshawar, Nowshera, Sawabi and D. I. Khan. Currently the data entry is in progress.

10.2 Follow up Survey on impact of access to improved maize seed among rural Households

The follow up survey was conducted during August and October, 2016 to determine the impact of access to improved maize seed among rural household in Sahiwal district of Punjab and four districts of KP i.e. Charsadda Peshawar, Nowshera and Sawabi. The data was collected from both beneficiary and non-beneficiary farmers. The beneficiary farmers got seed of maize varieties i.e. YH-1898 and Babar in Punjab and KPK provinces. Currently the data entry is in progress.

During the survey the data was also collected from the QPM beneficiaries to document the impact of agronomic performance and adoption implications of QPM hybrids among small holder farmers in AJ&K

and KP. In KP the survey has been successfully completed while in AJ&K survey is delayed for some time due to security situation and will be completed once the situation is normal.

10.3 Impact of Zero-Tillage technology adoption in the rice-wheat area of Pakistan

Comprehensive questionnaires were designed to document the adoption and impact of ZT technology and ZT happy seeder. The survey was carried out in the Faisalabad, Sheikhupura and Gujranwala districts of rice wheat area during August-October, 2016. The ZT manufacturers in Deska were also interviewed regarding the supply of the ZT technology. Currently the data entry is in progress.

10.4 Follow up Survey to identify preferences, uptake, outcome of AIP wheat interventions

Questionnaire was designed to document the impact of AIP wheat interventions across Pakistan and currently the survey is in progress in KP and Balochistan provinces while it will be initiated in beginning of November 2016 in Punjab and Sindh provinces.

10.5 Capacity Building

In continuation of the efforts to build capacity of social scientists across Pakistan regarding use of SPSS and STATA soft wares, a training entitled "Orientation to SPSS" was organized on 24-25th May, 2016 in collaboration of BARDC, Quetta. About 30 scientists were trained on the use of SPSS. The training on SPSS will help the scientists in their future research work.

11 Monitoring and Evaluation

The AIP project has outperformed and hit the targets for FY 2016. A total of 35,000 beneficiaries were target including 4,000 women. To meet the targets a robust and rigorous monitoring was under taken in different project areas and reports prepared to ensure that activities are on track with the monitoring plan. Gaps and challenges were identified and strategies were developed and strengthen to overcome those gaps. The project has an exciting success stories from the field which were captured and shared with the USAID, CIMMYT Management and implementing partners.

USAID working group meeting was attended where the DQA was discussed. In this regard, MSI conducted AIP-CIMMYT DQA for 10 MSF outcome indicators. This was a comprehensive process and lasted for 3 days. Based on DQA experience, AIP Monitoring Unite carried out DQA of implementing partners with a purpose to ensure data quality in the project. Findings were shared with partners and partners M&E plan and other pertinent documents were updated under the guidance of AIP Monitoring Unite. Progress on output indicators during the reporting period is given in the appendix-11.

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. Additionally, the government system also not allowing them to run competitive projects without fulfill the assignment account requirements; this assignment account requirements are to make first expense and then claim reimbursement where none of the project investigator could make advance spending. CIMMYT is working with PARC to find ways for implementing CGS in the provinces and find the way forward to spend the fund received. PARC forwarded a draft plan for investment in Borlaug institute (shared with USAID), however, during coming months a tri-parties meeting among USAID, CIMMYT, PARC (ministry) is expected to resolve this issue and decide on the way forward.

13 Personal Management

Two RA's completed assignment in late July and three senior technical members and five RA's completed assignment with the team on 30th September, 2016.During the reporting period one RA recruited by AIP Maize and posted to CIMMYT-Yousafwal office.

Perennial Horticulture and E-Pak Ag, have collectively created 12 jobs, including one female. They were hired to handle the technical aspects of commissioned projects under the supervision of the project PIs.

Four positions were advertised through the CIMMYT web-portal and interviews were held in November 2015. Mr. Ehtisham Khokar, RA Maize. Ms. Mariam Muzammal, Database Analyst Mr. Kashif Communication Specialist, Ms. Mehvish Memon, Accountant took charge in January 2016. A dairy Associate resigned in January 2016. One of the maize research associate resigned from AIP-CIMMYT during the reporting period. Research associate AIP-CIMMYT Yousafwala office has relocated to Islamabad. The replacement of research associate for Yousafwala office is in process. Ms. Asma Shahzadi took charge as an M&E officer in AIP-UC Davis office Pakistan.

14 External Factors

- Due to pending issue of INGO registration, getting visa for resource persons coming from outside of Pakistan remains as a hurdle to conduct planned trainings by AIP. Peace and security situation in the project area in Pakistan remain conducive. Heavy rain and hail storms at Multan during the months of February and March caused severe damage to the newly multiplied mango accessions; leading to a delay in plant distribution
- Delay in funding to CIMMYT from USAID affected the performance of collaborating institutes/primary partners / farming communities.

- Heavy rains in the middle of crop growth in the rice-wheat cropping system and intercropping with citrus badly affected the yield of mungbean.

15 Risks

- AIP-SEP was conducting surveys in different areas of Pakistan and AJK. Due to security problems, the data collection process have been postponed in AJK and will start again once the situation improved in AJK.
- The sudden budget cut posed a great challenge in achieving the targets of the annual work plans. As only half of the first year budget was transferred to UC Davis perennial horticulture project accounts, there are chances to encounter the honorarium issues from the project PIs.
- Farming communities are reluctant to adopt improved technologies especially in natural off-season growing areas of Thoa Mehram Khan, Katha Saghral and Soon Valley because of small land holdings and a low level of resources.
- Monsoon rains may affect the late planted mungbean crop in rice-wheat cropping system.
- Heavy soils with poor drainage in the rice-wheat areas as well as in intercropping with sugarcane fields in Sindh causes low yield in mungbean.
- Heavy thunder and hail storms affected tunnel structures to some extent in Kallar syedan and DI Khan and deformation of green nets in June in Noorpur Thal-Khushab.

16 Contribution to USAID Gender Objectives

AIP encourages the participation of women in all possible ways. In this regard UC Davis conducted trainings for domestic women and school girls in Sargodha, Chakwal, Faisalabad, Okara and technical, material support were provided to five women training institutes in Sargodha. Total 381 females were trained on farming of poultry, small and large ruminants, kitchen gardening and value addition of horticultural crops. A special focus was placed to introduce rural school girls to the use of ICT to address the agricultural issues faced by them.

A total of 37 women participated in trainings organized by agronomy on dissemination of improved techniques. Participation of women as direct beneficiary and for various training and capacity building activities rose to 25% compared to 12% during 2014-15.

- 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. The various AIP maize activities also created job opportunities for women. A particular example is at JPL where women are constantly engaged in the follow up of AIP and other maize trails at the seed farm in Arifwala. In addition women were invited during the QPM visit held in AJK.
- A total of 43 women farmers/field workers have been trained in vegetable production, practices, IPM and postharvest technologies.
- Increased (7-10%) women's' participation in prevention of postharvest losses through the preparation of pickle, ketchup, sauce and sun drying of onion and tomato.

- Women are specifically involved in seed processing and storage processes for mechanically harvested mungbean. Female members of the farming family will be encouraged to participate in the forthcoming trainings in postharvest technology.

17 Environmental Compliances

Most of the CIMMYT's maize germplasm are climate smart varieties which can best perform under stress environments and will benefit farmers in water scarce environments. In addition, CIMMYT materials which are under evaluation in Pakistan are developed through conventional breeding techniques, hence, they don't need additional inputs or extra environmental/biosafety care as compared to germplasm developed through non-conventional ways. 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. These varieties will not only save farmers money, but could potentially significantly reduce greenhouse gas emissions. Similarly, varieties included under the stem borer tolerant trials will have significant environmental impact by avoiding or reducing chemical pesticides.

AIP agronomy is disseminating improved techniques like ZT, 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.

AIP-Wheat popularized newly released, rust resistant and high yielding wheat varieties, farmer's responses from post-harvest assessment of new wheat varieties provided basis for the replacement of old and obsolete varieties by new ones ultimately minimize the use of pesticides. Few varieties have drought tolerance and require less water. There will no adverse environmental impact of growing these wheat varieties in Pakistan.

Approximately 10-15 % less pesticides have been used by farmers for vegetable due to awareness through training provided by AIP and the greater adoption of insect nets, kairomone traps and yellow sticky bands.

18 Communication

In the reporting period, AIPs' Communications proactively highlighted the AIP's interventions which include arranging successful events, writing persuasive stories, producing engaging documentary, and maintaining digital 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 the mediums utilized to communicate the AIP activities are listed below:

- AIP-newsletter
- Flickr
- Publications
- Video
- CIMMYT's Blog and e-newsletter
- Events

For example AIP-Perennial Horticulture published monthly citrus calendar and the vineyard project produced one training video. The achievements of this project were also highlighted on the official

facebook page of USAID. The UC Davis's country staff participated in the Dawn Food & Agri Expo on April 05 2016 at Lahore, Mango project team presented in a mango seminar on April 19, 2016 at the MRI, Multan. The formal launch of ICT working paper by AIP-E-Pak was published in the newspaper included The Nation, Press reader, Business, Baluchistan Times and same news was posted in CIMMYT web news. The paper was also telecasted in USAID's Weekly Radio Show at FM 101 on May 12, 2016. The Conference on Agricultural Productivity through Nudging was highlighted in The Express, Tribune, Daily Times, Pakistan Observer and PMAS AAUR's News.

AIP agronomy has publicized its following activities:

a) New multi-crop zero-till planter boosts yields and farming efficiency in Pakistan: http://www.cimmyt.org/new-multi-crop-zero-till-planter-boosts-yields-and-farming-efficiency-in-pakistan/
b) Push Row Planter distributed among smallholder maize farmers in Khyber Pakhtunkhwa province of Pakistan: http://www.cimmyt.org/push-row-planters-manufactured-and-distributed-locally-among-smallholder-maize-farmers-in-pakistan/
c) PARC and CIMMYT Conduct Two Day Agronomy Annual Meeting-2016 under USAID Funded Agricultural Innovation Program (AIP) for Pakistan: http://www.parc.gov.pk/index.php/en/component/content/article/122-news-flash/1337-parc-and-cimmyt-conduct-two-day-agronomy-annual-meeting-2016-under-usaid-funded-agricultural-innovation-program-aip-for-pakistan
d) PARC chief for transferring crop management technologies to farmers: http://www.brecorder.com/pakistan/industries-a-sectors/agriculture-a-allied/183:pakistan/72877:parc-chief-for-transferring-crop-management-technologies-to-farmers/?date=2016-08-08

The following mediums were utilized to communicate the AIP maize activities:

- CIMMYT *News* (*http://www.cimmyt.org/scientists-trained-on-breeding-program-management-statistical-data-analysis/*)
- CIMMYT News (http://www.cimmyt.org/pakistan-maize-stakeholders-discuss-progress/)
- CIMMYT annual report 2015 (http://www.cimmyt.org/cimmyt-annual-report-2015-building-resilience-to-risk-now-available-online/)
- Wheat-Naheed Fatima seeds of change: a short video
- https://www.facebook.com/USAIDPakistan/videos/1155707671116779/
- https://www.facebook.com/USAIDPakistan/videos/1126885930665620/
- AIP-Vegetable communicated the activities as below
- One detailed Radio Program was aired by Radio Pakistan on 3nd August, 2016 on prevention of postharvest loses of onion and tomato at DI Khan.
- A national television news channel (Geo News) highlighted off-season vegetable production activities in DI Khan on 7th April 2016.
- A national television news channel (Khyber News) highlighted Onion seed production of AIP/Vegetable, in Shuga, Bunir on 16 August, 2016.
- Six AIP-Vegetable Program Capacity building activities have been published in various local and national newspapers.

- Six news articles on AIP promotional activities were published in AVRDC's International Newsletter (FRESH).
  - Training of trainers for off-season production, April 08, 2016
  - Dawn Food & Agriculture Expo, Lahore, Pakistan, May 13, 2016
  - Vegetables thrive with drip irrigation in Pakistan, August 29, 2016,
  - Technologies to improve mungbean production, August 29, 2016,
  - Women learn postharvest processing methods, August 29, 2016,
  - Tunnels to produce tomato and cucumber, August 29, 2016,

19 LESSONS LEARNED

The following are the lesson learned during the reporting period:

- Green net is a better option for raising nurseries than the open field. The performance of 50 micron plastic sheet was better when used with insect net and tunnels must be covered with insect net in March/April to avoid wide spread of insect infestation. Staking with net is a better option due to balanced support as compared to just tying with rope.
- Drip irrigation system under plasticulture works best to reduce humidity and the number of pesticide sprays. Improved mungbean production technology is needed to avoid water stagnation in the field and early sowing after wheat harvest to avoid the onset of monsoon rains. A major mungbean disease "Cercospora Leaf Spot" resistant variety is needed while optimal mechanical harvesting of mungbean, training in seed drying, cleaning and storage is also needed to avoid any loss of seed quality and quantity.
- Maize planting with push row planter has gained acceptance among smallholders farmers in KP province. For its adoption, partnership established with Petal Seeds and initially 55 planters distributed to farmers and service providers on cost sharing basis. We are planning to provide ZTHS and MC planters in the project area to farmers through cost sharing basis.
- Grain yield of majority of new wheat varieties is not distinctly superior to most popularly grown wheat varieties. This is an important feedback to national and international wheat breeding research communities. Integrating organized, semi-organized and informal seed systems is the best way of strengthening wheat seed system in Pakistan.
- Pre rust emergence spray of fungicides was effective in reducing yield loss from rust.
- Genetic diversity for grain yield in durum wheat lines included in the DWNUYT is limited and there is a need to look for new germplasm with more wider genetic base.
- The funding cycle and the project initiation cycles must be timed appropriately in order to achieve the expected goals, keeping in mind the agricultural seasons of the specific crops.
- Importance of identifying ideal seasons and locations for maize parental seed production
- The need to establish/strengthen maize variety registration systems in Balochistan and GB provinces
- The follow-up of the previously accomplished trainings by E-Pak Ag indicates high demand and a desire 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 during training courses to add innovation and versatility in the shared ideas.

- The working paper launch identified suggested needs and major opportunities to advance the use of ICT in better reaching farmers. Research and consultations under E-pak Ag revealed that that mobile phone offers great opportunity for information delivery. With the advent of smart phone, short informative videos can be effectively used on mobile phone. However, there is a need to aware farmers regarding usefulness of mobile phone in the context of agricultural information. Furthermore, ICT is best when used as a complement to other forms of communication (e.g., field days, face to face, etc.). An important factor is that the ICT Corporate sector such as Telenor is an important stakeholder with vital reach to the rural farming households. Forged alliances with them proved to be mutually beneficial and helped in achieving objectives of ICT and Gender.

20 Appendices:

Appendix 01: AIP Livestock

Amino acid profile of conventional maize compared with High Protein Maize (QPM 200 and QPM 300)			
Name	Conventional Maize	QPM 200	QPM 300
Chemical composition			
Dry matter, % of fresh matter	90.43	90.58	90.47
Crude protein, % of dry matter	7.8	8.9	9.4
Amino acid profile (% dry matter)			
Threonine	0.28	1.84	6.85
Serine	0.35	0.15	0.54
Glutamic acid	1.42	2.31	4.99
Proline	0.69	1.62	1.59
Glycine	0.31	0.25	0.31
Alanine	0.56	0.85	1.1
Valine	0.36	0.24	0.42
Methionine	0.16	0.26	0.30
Isoleucine	0.27	0.35	0.40
Leucine	0.89	1.14	1.80
Tyrosine	0.23	0.28	0.56
Phenylalanine	0.37	0.42	0.36
Histidine	0.26	0.26	0.61
Lysine	0.22	0.26	1.00
Tryptophan	0.05	0.08	0.38
Arginine	0.35	0.87	2.15

Appendix 02: AIP-Maize

Performance of the top 10 Provitamin A hybrids compared with local check during spring 2016 at MMRI- Yousafwala (total no. of entries 36)

Entry	Entry	Grain Yield		Anth	Days to	ASI	Plant	Ear	Ear	Lodging		Ears/	Husk	Ear	Ear
no	name	FW	Rank	Date	Silk		Height	Height	Position	Root	Stem	Plant	Cover	Rot	Aspect
		t/ha	Rank	d	d	d	cm	cm	0-1	%	%	#	%	%	1-5
35	Local Check 1	15.4	1	68	70	2	220	125	0.6	2	5	1.1	4	1	2.0
2	HP1097-2	**13.3**	2	64	67	2	220	127	0.6	2	0	1.2	3	0	2.7
20	HP1100-22	**13.2**	3	64	66	2	245	131	0.5	0	7	1.0	17	2	2.3
25	HP1100-28	12.9	4	68	70	3	244	123	0.5	3	0	1.1	4	1	2.3
22	HP1100-25	12.8	5	66	68	2	232	127	0.5	2	0	1.1	6	0	2.9
9	HP1097-10	12.6	6	65	67	2	232	119	0.5	2	0	1.1	9	1	3.4
31	HP1100-37	12.5	7	68	70	2	263	158	0.6	0	3	1.0	2	1	3.6
13	HP1097-16	12.4	8	65	67	2	217	114	0.5	0	2	1.0	0	0	2.6
33	HP1100-46	12.2	9	65	67	3	241	119	0.5	2	2	1.0	7	1	2.6
8	HP1097-8	12.1	10	66	69	2	228	117	0.5	2	2	1.0	10	0	3.3
Mean		11.67	19	65.6	68.0	2.5	233.0	124.8	0.53	1.8	1.1	1.06	7.2	0.9	3.1
LSD (0.05)		1.55	11	1.7	1.7	1.6	18.7	11.9	0.08	4.1	3.1	0.13	10.9	2.4	1.1
MSe		0.56		0.7	0.7	0.6	80.9	32.9	0.00	4.1	2.3	0.00	28.7	1.4	0.3
CV		6.40		1.3	1.2	30.5	3.9	4.6	7.63	114.7	141.0	6.01	74.2	128.8	17.8
p		0.000		0.000	0.000	0.288	0.000	0.000	0.011	0.000	0.005	0.002	0.000	0.195	0.004
p		***		***	***	ns	***	***	*	***	**	**	***	ns	**
Min		9.19	1	63.2	65.7	1.3	190.4	93.2	0.40	0.0	0.0	0.83	0.0	0.1	2.0
Max		15.43	36	68.4	70.6	4.2	262.8	158.0	0.60	29.5	6.5	1.22	28.0	3.6	4.9

Appendix 03- AIP-Maize:

Performance of Zinc enriched maize hybrids compared with local checks during spring 2016 at MMRI- Yousafwala

Entry no	Entry name	Grain yield		Anth	Days to	ASI	Plant	Ear	Ear	Lodging		Ears/	Husk	Ear	Ear	Plant
	ID	FW	Rank	Date	Silk		Height	Height	Position	Root	Stem	Plant	Cover	Rot	Aspect	Aspect
		t/ha	Rank	d	d	d	cm	cm	0-1	%	%	#	%	%	1-5	1-5
1	SA2179-6	6.8	9	68	72	4	225	130	0.6	0	1	1.0	0	0.0	3.5	3.0
2	SA2179-7	6.9	7	67	69	3	236	136	0.6	0	1	0.9	0	0.0	2.5	3.4
3	SA2179-8	7.6	6	67	69	3	229	131	0.6	0	0	1.0	0	0.0	2.5	3.3
4	SA2179-9	6.7	10	68	71	4	228	135	0.6	0	0	1.2	0	0.0	3.8	2.8
5	SA2179-10	8.0	5	68	70	3	234	136	0.6	2	0	1.0	1	0.1	4.0	2.5
6	SA2179-11	8.7	3	67	69	3	233	121	0.5	0	16	1.1	0	0.8	3.0	3.5
7	SA2179-12	6.9	8	68	71	3	222	129	0.6	8	1	1.0	0	0.0	2.8	3.6
8	SA2179-13	8.2	4	67	69	3	227	124	0.6	0	0	1.0	4	2.7	3.2	3.4
9	Local check 1	10.5	1	66	68	3	217	120	0.6	5	0	1.1	24	18.7	2.0	2.4
10	Local check 2	10.1	2	62	65	4	238	99	0.4	0	3	1.0	37	50	4.8	3.2
Mean		8.04	6	66.8	69.3	3.2	229.0	126.0	0.57	1.5	2.2	1.04	6.7	6.5	3.2	3.1
LSD (0.05)		1.37	3	1.0	0.9	1.0	9.7	6.9	0.05	8.1	15.6	0.10	12.4	21.8	1.2	0.9
MSe		0.49		0.3	0.3	0.2	26.4	13.8	0.00	19.3	69.6	0.00	44.8	130.6	0.4	0.2
CV		8.68		0.8	0.7	15.2	2.2	2.9	4.40	292.8	380.7	5.39	100.4	174.8	20.2	14.4

p		0.000		0.000	0.000	0.039	0.003	0.000	0.000	0.381	0.448	0.000	0.000	0.001	0.002	0.062
p		***		***	***	*	**	***	***	ns	ns	***	***	**	**	+
Min		6.68	1	62.0	65.0	2.6	217.4	99.3	0.40	0.0	0.0	0.94	0.0	0.0	2.0	2.4
Max		10.47	10	68.3	71.7	3.9	238.1	135.7	0.60	7.7	16.1	1.23	37.3	50.3	4.8	3.6

Appendix 04 AIP Wheat:

Joshi, K.D., Rehman, A.U., Ullah, G., Zahara, M., Akhtar, J., Baloch, A., Khokhar, J., Nazir, M. F., Elahi, E., Suleman, M., Khan, M., Dar, A. I., Khan, A., Hussain, A. and Imtiaz, M. (2016). Rethinking the wheat seed system in Pakistan: fast tracking delivery of new genetic gains to farmers

Appendix 05 AIP Wheat:

Summary of yield loss assessment of wheat due to rust using fungicides during 2015-16 wheat growing season.

Rust§	Wheat variety used	Reaction to rust	Fungicides used	Fungicide spray schedule
Stripe	Morocco	Universal susceptible check	TILT, Folicur 430SC, Nativo 75WG	• No Fungicide spray (negative control) • Pre rust emergence • Second spray • Third spray
	Pirsabak-04	Highly susceptible	TILT, Folicur 430SC, Nativo 75WG	• No Fungicide spray (negative control) • Pre rust emergence • Second spray • Third spray
	Pirsabak-13	Resistant	TILT, Folicur 430SC, Nativo 75WG	• No Fungicide spray (negative control)
Leaf	Morocco	Universal susceptible check	TILT, Folicur 430SC,	• No Fungicide spray (negative control) • Pre rust emergence • Second spray • Third spray
	Sehar06	Highly susceptible	Nativo 75WG	• No Fungicide spray (negative control) • Pre rust emergence • Second spray • Third spray
	AAS-11	Resistant	TILT, Folicur 430SC,	• No Fungicide spray (negative control)
Stem	Morocco	Universal susceptible check	Nativo 75WG	• No Fungicide spray (negative control) • Pre rust emergence • Second spray • Third spray
	Sarsabz	Highly susceptible	TILT, Folicur 430SC,	• No Fungicide spray (negative control) • Pre rust emergence • Second spray • Third spray

	NARC-11	Resistant	Nativo 75WG	• No Fungicide spray (negative control)

Appendix 06 AIP Agronomy:

Details regarding farmer field days conducted during April - September 2016.

S.No	Hosting partner	Event title	Location	Date	No of participants
1	ARI Jaffarabad	Field Day on Zero till wheat planting	ARI Jaffarabad	14.04.2016	73
2	ARI Jaffarabad	Field Day on LASER Land Levelling	ARI Jaffarabad	22.05.2016	62
3	Extension (MFSC) KP	Field Day on Bed Planting & Zero Tillage	Pirsabak, Nowshera	21.04.2016	96
4	Extension (MFSC) KP	Field Day on LASER Land Levelling	Kheshki, Nowshera	27.04.2016	121
5	CCRI Pirsabak, Nowshera	Field day on local Made push row planter	Pirsabak, Nowshera	03.06.2016	37
6	BARI, Chakwal	Field day on ZT and fertilizer	BARI, Chakwal	01.04.2016	117
7	WRI, Faisalabad	Field day on ZTHS	Mango taru, Nankana sahib	04.04.2016	122
8	RRI, KSK	Field day on ZTHS	Dera Dahar, Mureedkay	05.04.2016	90
9	Engro fertlizers	ZTHS wheat	Rustam pur : Engro fertlizers	11.04.2016	38
10	Engro fertilizers	ZTHS wheat	kotli Krotana: Engro fertlizers	13.04.2016	32
11	Engro fertilizers	ZTHS wheat	Dahran: Engro fertlizers	14.04.2016	33
12	NRSP	ZT and ridge planting of wheat	NRSP: Bhakkar	14.04.2016	100
13	AR Farm Vahari	Wheat on ridges and beds	Maqsood Ahmed, Sahiwal	14.04.2016	123
14	AR Farm Vahari	Wheat on ridges and beds	M Yaqoob Ghauri, Malsi, vehari	0.7.04.2016	152
15	AR Farm Vahari	Wheat on ridges and beds	AR Farm Vahari	13.04.2016	212
16	AZRI, Bhakkar	Field day on zero tillage and ridge planting of wheat	CHAK No. 50/TDA, Bhakkar	15.04.2016	63
17	Lodhran	Farmer Day on Bed Planting of Wheat	Lodhran	03.04.2016	75
18	ARS, Bahawalpur	Field day on bed planting of cotton	Bahawalpur	12.09.2016	115
19	AZRI, Bhakkar	Field day on ZT mung bean in mung - wheat cropping system	Bhakkar	18.07.2016	71

Appendix 07 AIP-Rice:

Selected elite lines with broad spectrum resistance to 14 diagnostic strains belonging to 10 races of *Xanthomonas oryzae* pv. *oryzae*.

Entry*	Lesion length (cm)													
	PXO 61	PXO 86	PXO 79	PXO 340	PXO 71	PXO 112	PXO 99	PXO 145	PXO 280	PXO 339	PXO 349	PXO 347	PXO 363	PXO 341
IR99089-B-B-B-140	0.70	2.82	6.35	2.56	0.94	1.56	4.25	2.11	1.18	1.71	4.32	2.96	1.58	0.65
IR99089-B-B-B-141	0.72	4.07	3.45	1.52	1.84	0.59	3.26	2.46	0.67	5.41	2.93	6.20	2.30	1.44
IR99089-B-B-B-204	2.93	1.37	0.92	0.53	2.37	0.67	1.91	0.66	5.78	1.89	3.14	1.08	1.28	0.55
IR99089-B-B-B-55	1.52	1.63	1.77	1.83	3.06	1.97	2.97	1.37	0.44	2.39	5.10	4.77	1.91	0.89
IR99089-B-B-B-69	1.58	1.96	2.04	2.74	2.08	2.06	2.81	2.26	1.31	1.41	1.93	3.18	6.02	1.26
IR99089-B-B-B-8	1.05	1.79	0.99	1.45	0.63	1.46	1.50	1.71	0.52	4.76	1.63	1.22	1.11	1.39
IR99089-B-B-B-96	0.90	1.84	5.35	2.95	1.77	1.02	4.77	0.63	1.29	2.09	2.42	2.91	2.32	4.41
IR24 (S check)	16.12	14.18	16.51	28.23	12.43	14.38	15.27	14.06	13.59	14.88	14.44	15.73	13.90	15.85
IRBB4 (*Xa4*)	6.27	10.02	5.88	6.78	7.23	3.74	8.44	3.23	3.76	3.66	8.09	8.08	8.79	7.51
IRBB5 (*Xa5*)	3.40	7.27	4.51	5.10	5.92	7.38	5.82	3.14	6.76	7.02	4.92	4.49	6.58	6.67
IRBB7 (*Xa7*)	2.37	9.02	2.43	4.27	4.43	6.92	5.95	2.48	4.01	10.67	2.15	4.82	9.43	10.45
IRBB10 (*Xa10*)	9.27	10.24	12.68	3.68	7.72	10.81	13.91	11.70	15.83	15.17	8.38	14.03	11.44	12.97
IRBB14 (*Xa14*)	18.62	12.34	10.44	8.33	16.50	14.11	16.53	16.06	2.05	7.39	16.31	13.58	12.41	8.38
IRBB21 (*Xa21*)	9.97	8.63	2.73	5.91	9.28	12.13	8.96	4.80	5.95	14.57	12.95	12.52	8.81	10.57

*Pedigree of the elite lines: IRBB64/IR03A477//IRRI154; IRBB64 contains IRBB64 contains *R* genes *Xa4, xa5, Xa7, Xa21* for bacterial blight resistance. These lines were sent to Pakistan through coordination with IRRI-Pakistan, Dr. Abdul Rehman, in 2014. Lines were grown at RRI-KSK in 2015 and 2016 for selected advanced lines. These lines were part of lines sent to Pakistan, composed of irrigated elite lines, Super Basmati lines + BB *R* genes, flood tolerant/DSR lines, IR6-Sub1, Sabitri-Sub1, Sub1 MAGIC lines, and IRBB NIL sets.

**Resistant (R): <5 cm; moderately resistant (MR): 5 to 10 cm; moderately susceptible (MS): 10 to 15 cm; susceptible (S): >15 cm. All test lines and controls were inoculated at 40 to 45 days after sowing.

Appendix 08 AIP Vegetables:

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).
- Anonymous, 2016. One Pager on Mungbean Harvesting with Combine Harvester. USAID/AIP, World Vegetable Center-Pakistan (in Urdu).
- An article on "Simple techniques for preventing tomato crop from frost injury in Pakistan" has been published in "Feedback From the Field" 30 June 2016.
- Khan H, Khan TN, Ramzan A, Jillani G and Ali M, 2016. Genotypic response of garlic to various fertilizer levels and agro-climatic conditions of Islamabad. J. Agri. Res 43 (1): 63.73.
- Nasir M, Zubair Anwar M, Shah MH, Ali A, ZahidUllah Khan M. 2016. Baseline Report: Improved Mungbean Cultivation in World Vegetable Center Project Areas of Pakistan. World Vegetable Center Publication No. 16-804, World Vegetable Center, Taiwan. 37 p.
- Anonymous. 2016. Towards Development of Technology Driven Enterprises for Quality Vegetable Production. USAID/AIP, World Vegetable Center-Pakistan. 1 Poster. (in English).

Appendix 9 AIP-Vegetables:

Capacity Building- Vegetable Component (April to September 2016)							
A)	Trainings						
S #	Title	Date	Venue	Collaboration	No. of Participants		
					Male	Female	Total
1	On Farm Training On Tunnel Management Of Tomato & Cucumber	21-Jul	Khanozai-Pishin Balochistan	ARI Quetta.	47	0	47
2	Post-Harvest Mgt and Value Adding for Tomato & Onion	2-Aug	Himmat, DI Khan	ARI (S) DIKhan	0	34	34
3	Off Season Vegetable Production under Plasticulture	1-Sep	Malik Sharif Farm, Chevanda	AARI, Faisalabad	23	0	23
4	Production technologies for protected cultivation of vegetables	6-7 Sep	PGRI, NARC, Islamabad	Vegetable NARC, Islamabad	20	6	26
B)	Workshop / Seminar/Exhibitions/Meetings						
S #	Title	Date	Venue	Collaboration	No. of Participants		
					Male	Female	Total
1	Dawn Food & Agri Expo and conference 2016	5-6 Apr	International Expo center Lahore	AIP	3	0	3
2	Review of Activities of Vegetable Component	7- Apr	ARI (S) DIKhan	ARI (S) DIKhan & Geo News	14	2	16
3	Family Fun Fare and Exhibition	7-Apr	Dhani Shahdara, AJK	Dept. Of Ag., Muzaffarabad Azad Kashmir	0	1	1
4	Launching E-Pak Ag	5-May	NARC Islamabad	UC Davis	3	0	3
5	Mini workshop	5-May	NARC Islamabad	UC Davis	1	0	1
6	Conference/workshop	6-May	PMAS Arid Agric. Uni.	UC Davis & PMAS Arid Ag Uni, Rawalpindi	1	0	1

7	Field implements distribution ceremony	16-Aug	Shuga Bunir	ARI, Swat	40	0	40
C)	Farmers Gathering/Field Day/Exposure Visits						
S #	Title	Date	Venue	Collaboration	No. of Participants		
					Male	Female	Total
1	Field day and IPM training for mungbean cultivation in traditional area of Thal region.	3-Aug	Layyah	AZRI, Bhakkar	116	0	116
2	Field day and IPM training for mungbean cultivation in traditional area of Thal region.	4-Aug	Bhakkar	AZRI, Bhakkar	112	0	112
3	Field day on Improved Mungbean Production and its mechanization in Thal region.	19-Aug	Bhakkar	AZRI, Bhakkar	80	0	80
4	Field Day on Mungbean Cultivation as a Double Crop in the Wheat-Fallow Cropping System of Pothwar region & mechanical harvesting	5-Sep	Chakwal	Pulses Program, NARC, Islamabad	79	0	79
5	Field day on Improved Mungbean Production and its mechanization in Thal region.	7-Sep	Layyah	AZRI, Bhakkar	50	0	50

Appendix 10 AIP UC Davis:

a) Events and meetings held during April 1, 2016-September 30, 2016

Meeting Name	Person Responsible	Venue (City/Province)	Partners	Brief Outcome
22 Perennial Horticultural projects collectively managed 67 trainings on Nursery Production, Orchard Production, Post-Harvest Production and Value Added Products Production	Dr. Louise Ferguson	Sargodha, Attock, Rawalpindi, Chakwal, Islamabad, Larkana, Naushero Feroze, Quetta, Mastung, Peshawar, Mardan, Faisalabad & Nawabshah	CRI Sargodha, UAF, PMAS AAUR, ATI Sakrand, ARI Peshawar, ARI Quetta, Growers, Nursery men, Agri-students and Domestic females	Total 1302 participants were trained (1235 males and 69 females)
7 workshops, 1 Launching Ceremony and 1conference were managed under E-Pak Ag	Dr. Mark Andrew Bell	Faisalabad, Okara, Chakwal, Islamabad, Multan & Rawalpindi	PMAS AAUR, UAF, Students, Teachers, Public and private stakeholders	Total 485 participants were trained (177 males and 308 females)

2 workshops, one each on Seed quality and File size optimization were managed under vocational training	Dr. Mark Andrew Bell	Faisalabad, Islamabad	UAF, AIP Primary partners, relevant private and public stakeholders	Total 44 participants were trained (40 males, 4 females)
AIP Scholars Conference	Dr. Thomas L. Rost	UC Davis, California, USA	AIP Scholars, UCD staff and AIP Partners	Performance of 14 AIP scholars was monitored

b) International travel (April 1, 2016-September 30, 2016)

Sr No.	Name	Date	Place/destination	Purpose	Brief Outcome
1	Dr. Mark Bell	May 05-11, 2016	Islamabad, Pakistan	To manage seed workshop, mini workshop on file size optimization, formal launch of ICT working paper and to participate in nudging conference.	A total of 357 people were reached through these events.
2	Dr. J. F. Rickman	May 07-12, 2016	Islamabad, Pakistan	To train participants of AIP's seed workshop.	31 people were trained on "Quality seeds; issues and Options"
3	Sarfraz Rizwan	July 09-23, 2016	UC Davis, California, USA	To attend AIP Scholars Conference at UC Davis, California	Progress of all 14 AIP scholars was reviewed

c) List of sub-grants for Ongoing Projects (amount, recipient, purpose)

S. No.	Organization	No. of Projects	Amount Allocated	Through	Expected Outcome
1	Arid Agriculture University, Rawalpindi	4	$47,120.00	March 07, 2017	Adoption of good vineyard management practices by growers Increased use of ICT by school girls, Improved post-harvest practices of stone fruits
2	Agriculture Research Institute, Peshawar	2	$75,00.00	March 07, 2017	Adoption of good orchard and post-harvest management of olives by concerned growers
3	Agriculture Research Institute , Quetta	4	$14,500.00	March 07, 2017	Adoption of good nursery, orchard and post-harvest management of pistachio by concerned growers
4	Agriculture Training Institute, Sakrand	2	$10,651.00	March 07, 2017	Adoption of good orchard and post-harvest management of guava by growers Improvement in post-harvest handling of guava and mango
5	Citrus Research Institute, Sargodha	7	$41406.15	September, 2016	Adoption of good nursery, orchard and post-harvest management of citrus by concerned growers
6	University of Agriculture, Faisalabad	5	$22,100.00	March 07, 2017	Commercialization of new mango accessions in the field, distribution and canopy management of ber, improved post-harvest technologies, and increased use of ICT by extension workers

Appendix 11 AIP M&E:

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	1463
Number of improved production and agriculture management technologies/practices transferred/made available to farmers	1214
Number of demonstration plots/farms/trials established for farmers' awareness on improved agriculture technology and management practices	8611
Number of farmers received information on improved agricultural management practices through demonstrations/field days/trials	15775
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.	637
Number of farmers linked with input/service providers for improved production services/inputs	1107
Number of farmers using E-Pak Ag webpage for acquiring information on agriculture related information	2138
Number of new breeding lines/cultivars/rootstock of cereal and horticulture crops at development stage	21
Number of partnerships developed with input suppliers/companies for development of production inputs/services (PPR vaccine, Semen, new varieties)	46
Number of value chain assessments carried out to identify value chain constraints and opportunities (best bet interventions)	14
Number of training events arranged for interventions under different value chains	151
Number of farmers linked with public/private business development service providers (Input supply facilities, industries) through established partnerships	3698
Number of farmer selling products (cereals, vegetables, fruits, milk and small ruminants) value added , production cost decreased a as a result of Project interventions	542
Number of workshops carried out to disseminate new and improved agricultural products	15
Number of new/improved products identified and disseminated through value chain interventions	15
Number of training events arranged on concepts of value chain and value chain assessment/analysis	01
Number of entities (including national scientists, academics, value chain actors etc.) received training on concepts of value chain	2
Number of tools designed and utilized for carrying out value chain assessment	13
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	107