NIFA

Annual Report 2012

ISO 9001 : 2008 Certified

Nuclear Institute for Food & Agriculture
Peshawar, Pakistan

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Pakistan Atomic Energy Commission

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HIGHLIGHTS

This report covers the R & D activities of NIFA for the year 2012. During this period, the aims of research and development efforts were i) Enhancement of crop productivity through a) development of new varieties, b) integrated plant nutrient and soil management practices c) improved crop protection measures/approaches, and ii) Preservation and value addition of food commodities. Salient research and development activities carried out during the report period are described below:

Plant Breeding & Genetics

Pre-breeding, varietal popularization and demonstration of R & D activities were successfully undertaken during the period under report. Based on high grain yield and disease resistance in national trials, NIFA line NRL0517 was submitted to provincial seed council for release as new wheat variety named NIFA 2012. New candidate wheat lines WG-08030 and WG-08033 were assessed in the NUWYT (N & S) for 1st year mandatory evaluation in the country and showed higher yield (3991 $kg.ha^{-1}$) as compared to commercial check (3951 $kg.ha^{-1}$) coupled with acceptable RRI to Yellow and Leaf rusts. NRL0707, a new recombinant line was evaluated in NUWYT-Rainfed and performed well across different locations in the country and qualified for inclusion in the 2nd year national trials. Certified seed (14 tons) of NIFA released varieties i.e. Fakhre-e-Sarhad, Bathoor, Tatara and Barsat-10 was produced and distributed among agricultural departments, private seed companies and farmers in Khyber Pakhtunkhwa. Under IAEA research project, wheat variety Barsat exhibited good response under low N fertilizer and low moisture condition by producing maximum grain yield at NIFA and CCRI Pirsabak, Nowshera. Promising sugarcane genotypes were evaluated for frost tolerance, high cane and sugar yield. The line CPSG-169 was multiplied for further testing in the national trials. The variety CP-77/400 was subjected to 0.05, 0.1, 0.15 and 0.20 kGy gamma rays to induce frost tolerance, early maturity with high cane and sugar yield potential. Induced mutations and in vitro culture techniques were used to develop locally adapted improved genotypes of Stevia. Best callus induction was recorded on MS medium supplemented with 2.0 $mg.l^{-1}$ BA + 20 $mg.l^{-1}$ of 2, 4-D (84.6%). Best shooting response (96%) was recorded on MS medium containing 2.0 $mg.l^{-1}$ BAP after 20 days of culture. Maximum number (106) of shoots/explant were recorded when MS- medium were supplemented with BAP (1.5 $mg.l^{-1}$) in combination with GA3 (0.5 $mg.l^{-1}$). Maximum (85.7%) rooting was observed on half MS-medium containing IBA and NAA (0.5 $mg.l^{-1}$). The plantlets were successfully acclimatized. A new rapeseed (*Brassica napus* L.) variety NIFA Gold (04 K 12/13-10-1) developed through hybridization was submitted for approval as new commercial variety to Khyber Pakhtunkhwa Seed Council. High seed yield (>3300 $kg.ha^{-1}$), high oil contents (> 44%) and early maturity are major features of the candidate variety (NIFA Gold). A total of 32 advanced rapeseed and mustared mutant lines and recombinants were evaluated in different yield trials at NIFA. Six rapeseed and two mustared lines significantly out yielded the respective checks. Six demonstration plots of Durr-e-NIFA were planted at farmar field in District Swabi for popularization. Out of 48 advanced chickpea lines developed and evaluated at NIFA, 18 lines showed statistically significant ($p \leq 0.05$) higher seed yield (844-1294 $kg.ha^{-1}$) than check variety NIFA 2005 (average yield of 857 $kg.ha^{-1}$). Six cross combinations among seven chickpea genotypes were attempted to obtain suitable combination of genes for higher seed yield and its components. Eleven cross combinations among 8 mungbean genotypes were attempted for incorporation of bruchids tolerant gene from reported exotic bruchids tolerant lines into locally adapted mungbean varieties. A total of 2000 single plant selections were made on the basis of no or less flowers shedding under high temperature (above 40°C) and higher number of pods per plant from M_2 populations of mungbean genotype “NFM-5-91-21”. Surveillance for wheat diseases included yellow rust, leaf rust, powdery mildew and Barley Yellow Dwarf Virus (BYDV), carried out in fifteen districts of Khyber Pakhtunkhaw (KPK). Novel sources for yellow and leaf rust resistance were searched in 600 wheat genotypes at six hotspot locations across KPK. Biological trap nurseries indicated the presence of five yellow rust pathotypes while Yr10 and Yr15 were found completely free from infection in KPK. Field trials at NIFA revealed slow rusting trait in several wheat varieties.

Entomology

The Entomology division is engaged in integrated control of various pests of field and fruit crops such as fruit flies, termites, peach flat-headed borer, and chickpea pod borer, and in R&D activities on the integrated management of honey bee and honey production. Under the Integrated pest management (IPM) system, different IPM components are employed (chemical, biological, cultural phytosanitary and irradiation) to reduce losses caused by insect pests of agricultural importance. Citrus and mangoes are the two leading fruits of Pakistan in terms of area, production, and export. The distinct taste, size, and other quality characteristics of our indigenous varieties are appealing to the consumers world wide. The

division is also involved in R&D activities on development of generic irradiation doses for pests of quarantine importance and in post harvest life extension of fresh commodities. Under the integrated vector management control (IVM) program, the division has active collaboration with national and international organizations in devising short and long term control strategies for medically important disease carrying insects including mosquitoes and house flies.

Food Science

ALP funded project on "Assessment of Toxic Metal in Agricultural Products and their Relation with Nutritional Status in Khyber Pakhtunkhwa" was successfully completed. Recommendations were made to reduce the level of health risks from heavy metals. Findings of IAEA CRP on immunocompromised patients showed that consumption of NIFA formulated cancer diets for longer period would reduce hardship/recovery time of patients. Almost all the summer vegetables were found contaminated with pesticide residues and majority of them exceeded the maximum residue limits. Results indicated that packing type and storage of feeds were significantly influenced to various extents by radiation treatment. Further, the treatment increased Fe, Na and K solubility. Fortification of commonly consumed edible oils with non-conventional oil indicated a significant improvement in antioxidant content and therefore, offered many health benefits. The developed nutri-biscuits showed a significant increase in protein and fiber levels, which are useful in the treatment of obesity, atherosclerosis, heart diseases, cancer and diabetes. Effort has been made to develop low-cost weaning foods that could be easily adopted by the poor communities of Pakistan. A study for extraction of maximum apple antioxidants using different solvents was conducted. As a result of another study, it was observed that higher concentration of antioxidants in younger guava leaves might be due to changes of phenolic compounds and extractability with maturity. An extruder cutter with variable speed was developed and tested during extrusion cooking of rapeseed. Canned peach and diced tomatoes retained their texture and color during 12 months of storage. NIFA and DoST jointly organized workshops in Swat and adjoining areas for mushroom popularization. The feedback received from 240 participants was an overwhelming encouragement. Gaertn, a medicinal plant, was studied for its composition, phytochemical profile and free radical scavenging activity using radiation technology. It was concluded that radiation treatment of 12 kGy showed increase in the levels of phenolics and flavonoids. The 1st International Symposium on "Commercial application of irradiation technology for food safety, security and global trade" was organized at Bangkok, Thailand by NIFA in collaboration with IAEA (February 20-24, 2012). Radiation services were provided to PAEC and other research organizations. A high dose research irradiator having an activity of 24600 Ci, was installed at NIFA in August, 2012. A total number of 41000 rapid test kits (RTK) developed at NIFA were provided to the national USI/IDD program.

Soil Science

Maximization of crop productivity can only be achieved through efficient utilization of available natural resources (soil, water and nutrients) on sustainable basis. The soil science division is engaged to devise strategies for proper management and conservation of these natural resources to enhance crop productivity and to protect the environment. Apart from endeavors to improve soil health, scientists of this division are helping plant breeders in developing nutrient efficient varieties and also provide them information about nutritional requirements of candidate varieties. During the period report different research activities remained in progress and one of the projects funded by ALP was completed. It was concluded from the study that yield of deciduous orchards was almost doubled by the integration of organic and inorganic nutrients sources. The integrated use of NPK and FYM also improved the physical and chemical properties of soil. The growing of off-season vegetables in high and walk-in-tunnels was demonstrated to the farmers through a farmar's workshop. Results showed that application of 80 kg each of N & P and 90 kg K at 30 days interval starting from nursery transplanting till before last picking along with 5 kg Zn.ha^{-1} can yield 121 tons.ha^{-1}of tomatoes. Another study revealed that municipal solid waste and sugar industry waste @ 3 t C ha^{-1} can be effectively utilized for vegetables (potato and tomato) and cereal (wheat and maize) production. The results showed that half of the NPK requirement of potato and tomato were fulfilled by these organic sources to produce 19.2 and 24.7 tons of these vegetables, respectively. The study on wheat showed that NRL-0517 and NRL-0832 were Zn and B efficient genotypes as these genotypes produced significantly higher biomass at micronutrient levels as compared with other genotypes. In another field experiment conducted for two consecutive years, NIFA wheat line (CT-04192) produced higher grain yield even at low level of NPK (70-60-30) as compared with other tested genotypes. The integrated use of fulvic acid with NPK and Zn showed 50% increase in yield of tomato over control. Maximum tomato yield of 66.3 t.ha^{-1} was observed in the treatment receiving half of

NPK, 150 mg.kg^{-1} fulvic acid and 2.5 kg.ha^{-1} Zn. Three tons of compost were prepared from the agro-waste for fertilization as organic fertilizer for horticultural crops. The exothermic process of composting was exploited to devise a bio-geyser for heating. It has been registered for a patent.

Publications

Thirty eight (38) research papers were published in national and international journals (Pages 37-39) with a total impact factor 13.123.

Funded Projects

Nineteen (19) research projects funded by national as well international agencies (PSF, ALP, and IAEA) are going on at NIFA (Page-40-41).

Training Courses/Workshops

Twenty eight (28) national/international training courses/workshops were organized by NIFA scientists including those given on page 46.

Acknowledgments

The team work of fellow scientists and staff members has been commendable throughout the report period and certainly deserves appreciation and acknowledgment. On behalf of NIFA employees and myself, I sincerely thank the authorities at PAEC Head Quarter for their continued support in helping the Institute achieve its objectives. Special sense of gratitude is expressed for Director General (Agric. & Biotech.) Dr. Yousaf Zafar, T.I for his continuous support, inspiration and motivation in compilation of this report.

Director NIFA

PLANT BREEDING & GENETICS DIVISION

Wheat Improvement

Pakistan is the 8th largest producer of wheat in the world. Wheat is grown on 40 percent of the total cultivated area by nearly 80 percent of the farmers. It contributes 13.1% to the country's agriculture value added and 2.8% to the gross domestic product. It is also a staple food commodity covering about 58 % of the food crop area in Khyber Pakhtunkhwa (KPK). The province is highly deficient in wheat production, and 92% of its districts fall under "extremely deficient" category. Yield of wheat varies from place to place depending on variety and fertility of the soil. In KPK wheat is produced under two management regimes; the irrigated and the rainfed. NIFA wheat breeders are actively involved to develop cultivars best suited to different climatic conditions prevailing in the province.

Wheat Improvement for Irrigated Areas

Varietal maintenance & seed production

NIFA irrigated varieties i.e. Fakhr-e-Sarhad and NIFA Bathoor-2008 performed well on the farmer's field in the province. A total of 8.3 tons of BNS and Pre-basic seed were produced at NIFA. It was distributed among agricultural departments and seed companies in the province.

Evaluation of candidate wheat lines in National Uniform Wheat Yield Trials (NUWYT)

Based on excellent performance in yield trials, WG-08030 and WG-08033 were included in the NUWYT (N & S) for the 1st year. Under late planting across 35 locations in Pakistan WG-08030 has shown higher yield (3991 kg.ha^{-1}) as compared to commercial check (3951 kg.ha^{-1}). WG-08033 has also shown higher yields across 35 locations under both normal and late planting. In addition both the genotypes have shown acceptable RRI to Yellow and Leaf rusts.

Performance of elite wheat genotypes in Multilocational Yield Trials

Eighteen genotypes along with two checks i.e. Bathoor-08 and Pirsabak-2004 were evaluated in MPT at NIFA and 08 other locations in KPK. Highest grain yield was recorded for CT-09005 (5403 kg.ha^{-1}) across all locations followed by CT-09056 (5231 kg.ha^{-1}). In northern irrigated zone (Mansehra & Gilgit) none of the genotypes could exceed the high yielding check (Bathoor-08; 6389 kg.ha^{-1}). However, CT-09115 (6278 kg.ha^{-1}), out yielded the low yielding check (Pirsabak-04; 6083 kg.ha^{-1}). In Southern irrigated zone (Seri Naurang and D.I. Khan) WL-0912-1 (4731 kg.ha^{-1}) followed by CT-09056 (4525 kg.ha^{-1}) and WG-08036 (4481 kg.ha^{-1}) exceeded the check"Pirsabak-04" (3437kg.ha^{-1}).

Performance of promising genotypes in Advanced Selection Yield Trials (ASYT's)

A total of 32 genotypes were evaluated in two advanced selection yield trials under both normal and late planting conditions at NIFA. In ASYT-1 genotype CT-09065 (5489 kg.ha^{-1}) exceeded the check (Bathoor-08; 5467 kg.ha^{-1}), none of the other genotypes could exceed the check cultivars (Bathoor-08 & Pirsabak-04). Under late planting conditions, 10 genotypes out yielded the high yielding check (Bathoor-08; 3489 kg.ha^{-1}). The highest yield was recorded for WL-0918-3 (4733 kg.ha^{-1}) followed by CT-09007 (4667 kg.ha^{-1}) and WL-0918-1(4511 kg.ha^{-1}). In ASYT-II seven genotypes out yielded both the check cultivars (Bathoor-08; 5111 kg.ha^{-1}; Pirsabak-04; 5422 kg.ha^{-1}). The highest yield was produced by CT-09137 (6333 kg.ha^{-1}) followed by SRN-09087 (5989 kg.ha^{-1}) and CT-09141(5600 kg.ha^{-1}). Under late planting conditions 03 genotypes out yielded both the checks (Bathoor-08; 4383 kg.ha^{-1}; Pirsabak-04; 3600 kg.ha^{-1}). The top grain yield was produced by SRN-09063 (4700 kg.ha^{-1}) followed by CT-09137 (4511 kg.ha^{-1}) and SRN-09111 (4489 kg.ha^{-1}).

Performance of newly developed and exotic wheat genotypes in Preliminary Yield Trials (PYT's)

Ninety six genotypes were evaluated in PYT-1 to PYT- 6 with two check varieties (Bathoor-08 and Pirsabak-2004) under both normal and late planting conditions at NIFA experimental farm. Based on yield performance and disease reaction, 41 genotypes were selected for further evaluation. Out of the selected genotypes, 19 produced higher grain yield than the high yielding check, Bathoor-08 while 28 of the selected genotypes out yielded the low yielding check Pirsabak 2004. The highest yield was produced by CT-10026 (5756 kg.ha^{-1}) followed by CT-10218 (5689 kg.ha^{-1}) and CT-10015 (5533 kg.ha^{-1}).

Creation and exploitation of genetic variability

A crossing block consisting of 132 genotypes was planted on two different dates 32 cross combinations among desirable wheat genotypes were attempted. F_1 seeds were harvested from 28 successful cross combinations. F_2 seeds resulting from 18 cross-combinations were harvested. Based on improved ideotypes and better phenotypic expression, 287 desirable recombinants from F_3, F_4, F_5 and F_6 populations were selected in the field. Similarly, forty four desirable M_2 putative mutants resulted from seed irradiation of each of B-92, Bathoor and F. Sarhad irradiated with 10, 20 and 30 kRad doses.

Field evaluation of exotic wheat germplasm

International Bread Wheat Screening Nursery (44th IBWSN) consisting of 296 genotypes received from CIMMYT, Mexico was evaluated with local check Bathoor-08. Based on yield performance and disease reaction (Yr and Lr) a total of 41 genotypes were selected out of 296. Of the selected genotypes, 15 out yielded the check variety Bathoor-08.

Another nursery SBWON (Spring Bread Wheat Screening Nursery), consisting of 80 genotypes was evaluated for yield performance and disease (Yr) reaction with local check Bathoor-08. Out of 80 genotypes, 40 were selected for further evaluation and confirmation of their desired traits. Among the selected genotypes, 13 out yielded the check variety.

Wheat Improvement for Rainfed Areas

Seed production of "Tatara" and "NIFA Barsat-10"

Apart from wheat breeding activities a total of 6.3 tons quality seed of Tatara and Barsat-10 duly certified by FSC&RD was produced at NIFA experimental farm. The seed has been distributed among the agricultural departments, seed companies and growers.

NIFA new candidate line "NRL0707" in NUWYT-R

NRL0707 was subjected for its 1st year mandatory evaluation in National Uniform Wheat Yield Trials (NUWYT- Rainfed) at different sites in the country. The candidate variety expressed high level of resistance with RRI value of 9 to the prevailing yellow rusts. This line also showed resistance against local stem rust race RRTTF with TR value of zero. NRL0707 showed 0.19 coefficient of infection for karnal bunt and was categorized as resistant.

Botanical characterization of candidate lines

Two candidate lines (NRL0517 and NRL 0707) that showed high yield performance and wider adaptation were grown for plant characterization. As a pre-requisite for varietal release, detailed botanical characteristics were recorded for each individual line at different growth stages.

Multi-locational Micro-plot Tests

For assessment of grain yield stability, 10 promising genotypes along with 02 commercial varieties i.e., Tatara and Barsat-10 were tested at 08 different locations in the province. NRL 0931 produced high mean grain yield at all the locations and ranked 1st followed by Barsat and NRL0942. These were found promising and selected on the basis of grain yield stability and disease resistance.

Advanced Barani Trials (ABT)

Fourteen (14) promising genotypes were evaluated for grain yield, yield components and disease resistance along with Tatara and Barsat in advanced barani trials (ABT) at the institute. Based on grain yield and disease resistance 03 promising genotypes were selected. NRL 1027 ranked 1st by producing top grain yield followed by NRL1013 and NRL1003.

Preliminary Barani Trials (PBT)

Fifty five (55) newly selected genotypes were tested for grain yield, disease resistance and other agronomic traits in 05 preliminary yield trials (PBTs) under moisture stress conditions at the institute. Tatara was included as standard check in each trial. Eight genotypes i.e., NRL1101, NRL1117, NRL1120, NRL1121, NRL1122, NRL1123, NRL1130 and NRL1139 exceeded check variety Tatara in grain yield and were found resistant to YR. Based on possessing desirable traits of drought tolerance, high grain yield and Yr resistance these selections were picked for further testing.

Dryland spring bread wheat yield trial (12th)

The trial consisted of 24 entries; 20 lines, 03 dryland checks (Jawahir-20, Reehab-2 and Babaga-3) and 01 national check (Tatara) was planted in Alpha-lattice design with 03

replications. Two genotypes were selected on the basis of grain yield and disease resistance.

Wheat observation nurserries

Spring Bread Wheat Observation Nursery (12th SBWON)

The low rainfall section of 12th SBWON that comprised of 110 exotic genotypes was tested under rainfed conditions at the institute. A total of 10 best selections were made on the basis of grain yield performance and disease resistance.

Semi-Arid Wheat Screening Nursery (29th SAWSN)

A total of 145 fresh exotic genotypes were screened for grain yield, disease resistance and other agronomic traits in non-replicated trial under rainfed condition. Twenty best genotypes were identified and selected on the basis of higher grain yield than the commercial check variety Tatara. These entries also expressed resistance against the prevailing rust races.

Heat Tolerant Wheat Screening Nursery (6th HTWSN)

Due to recent climatic changes, heat stress occurs during grain filling stages that reduces grain production in wheat. To develop wheat germplasm for heat stress, 167 genotypes along with Barsat as check were screened in 6th HTWSN at the institute and 11 genotypes were selected for further studies.

Development and selection of new germplasm

To broaden the genetic base of the genotypes and keeping in view of our breeding objectives, simple, top and back crosses were attempted among the selected wheat varieties and synthetic wheat lines. F_1 population of different combination was raised. In F_2 population desirable plant selections were made.

Response of wheat genotypes to disease reaction

Yellow rust is the main disease in Khyber Pakhtunkhwa that reduces grain yield. Twenty four genotypes were screened for stripe / leaf rusts at hot spots in the country in NWDSN. Four genotypes i.e., NRL 1003, NRL 1017, NRL 1027 and NRL 0707 showed high level of resistance against yellow rust.

Selection and assessment of wheat germplasm for higher yield and improved water and nitrogen use efficiencies (IAEA Research Project)

Nitrogen fertilizer cost and environmental constraints exerted pressure on breeders and soil scientists to select Nitrogen Use Efficient (NUE) wheat varieties. Assessment of 03 wheat genotypes i.e., Barsat, NRL0707 and PM-376-HY for grain yield response to different N fertilizer levels was carried out at 02 experimental sites under rainfed conditions. Genotypic differences existed among the tested genotypes for grain yield and its components at different N fertilizer levels at both the experimental locations. Barsat gave good response to N fertilizer and produced maximum grain yield of 3.6 $t.ha^{-1}$ with 45 N $kg.ha^{-1}$ whereas PM-376-HY produced 3.5 2.9 $t.ha^{-1}$ with 0 N $kg.ha^{-1}$ at NIFA experimental farm. At CCRI experimental farm varieties showed great dependence on N fertilizer rate and Barsat gave maximum grain yield (3.1 $t.ha^{-1}$) followed by PM-376-HY (2.9 $t.ha^{-1}$) at 90 N $kg.ha^{-1}$.

NIFA wheat varieties popularization/ demonstration under Village Based Seed Enterprises (VBSEs)

The purpose of the VBSEs is to increase crop production and ensure food security at the local level. Demonstration plots of NIFA improved wheat varieties (i.e., Fakhr-e-Sarhad, Bathoor, Tatara and Barsat) were planted with selected farmers in Swabi, Mardan, Buner, Nowshera and Kohat districts.

Biotechnology

Sugarcane Improvement

Creation of genetic variability

Sugarcane variety CP-77/400 and Mardan-2005 were selected for creation of genetic variability for frost tolerance, early maturity with high cane and sugar yield potential. One hundred setts containing 2-3 $buds.sett^{-1}$were exposed to 0.05, 0.1, 0.15 and 0.20 KGy gamma radiation using Co^{60} gamma source. The irradiated material was sown in the field along with control in three replications dose/variety wise with three rows at 1 meter spacing.

Evaluation of M_2 generation

Healthy M_1 plants were harvested dose/variety wise and sown in bulk to generate M_2 populations. One hundred and eighty putative mutant plants

from 0.20 KGy gamma rays dose of CP-77/400 were selected on the basis of phenotypic plant characters. These mutant lines were analyzed for brix, CCS% and recovery. The highest recovery of 12.4 % was recorded in 0.15 and 0 .20 KGy treatments. Similarly the highest Brix (22.67%) and commercial cane sugar (CCS% 12.67) were recorded in 0.15 and 0.20 KGy treatments.

Evaluation of sugarcane National Uniform Yield Trial (NUYT) at NIFA

During the reporting year sugarcane NUYT trial seed in the form of setts were received from AARI, Faisalabad and national co-coordinator sugar crops, NARC, Islamabad. The agronomic and quality data of the trial were be recorded and communicated to the concerned quarters.

Screening of sugarcane genotypes for frost tolerance, high cane and sugar yield

Promising sugarcane genotypes were evaluated in three sets for frost tolerance, high cane and sugar yield using standard plot size of 6 x 4 m^2 with three replications in RCBD. Sugarcane line CP-77/400 was used as a check in all the trials. The data collected on various parameters is summarized below:

Agronomic evaluation

Stalk/plant: The highest stalk/plant (7.0) was recorded in line HOSG-795 followed by line QSG-1741 and CPSG-437 where 6.5 stalk/plant were recorded. The lowest stalk/plant of 3.3 was recorded in Line CPSG-2476.

Cane thickness: The data on cane thickness indicated variation among all the germplasm. The maximum cane thickness (26.5mm) was recorded in line CPSG-85 followed by line HOSG-1607 with cane thickness of 25.8 mm. The lowest cane thickness of 11.2 mm was recorded in line HOSG-200.

Number of nodes/plant: The highest number of nodes (22.7) was recorded in Line- CPSG-2476 followed by line CPSG-3456 and HOSG-795 with 22.0 nodes/plant.

Cane yield: Significant variations in yield were observed among the germplasm under study. The highest yield of 88 $t.ha^{-1}$ was recorded in line CPSG-25 followed by line CPSG-169 and CPSG-247 with 85.8 $t.ha^{-1}$. The lowest yield of 22.5 $t.ha^{-1}$ was recorded in line CPSG-494.

Plant height: The data on plant height of all the 53 genotypes showed significant variation. The highest plant height (290.0 cm) was recorded in Line HOSG-1021 followed by line HOSG-1275 and CPSG-2402 with height of 288 and 285.3 cm. The lowest plant height of 114.3 cm was recorded in line CPSG-586.

Quality evaluation

Sugar Recovery (%): Data regarding sugar recovery of all the germplasm showed significant variation. Highest recovery of 12.66 % was recorded in line HOSG-1607 followed by line CPSG-586 with recovery of 12.57 %. The lowest recovery of 8.00 % was recorded in line CPSG-375

Commercial Cane Sugar (CCS %): The highest commercial cane sugar (12.29%) was recorded in line CPSG-169 followed by Line CSSG-676 with 11.76% CCS.

Purity (%): The highest purity of 89.93 % was recorded in line CPSG-586 followed by line CPSG-263 with purity of 88.56%. The lowest purity of 70.66% was recorded in line CPSG-263.

Brix (%): The highest brix of 24.27% was recorded in line HOSG-118 followed by line HOSG -624 and CPSG -159 with 24.07 % brix.

Pol (%): The highest Pol of 19.74% was recorded in line HOSG-1607 followed by line HOSG -624 and CPSG-1004 with 19.66 and 19.57 % Pol.

Conclusion: Fifty three promising sugarcane genotypes were evaluated for frost tolerance, high cane and sugar yield. On the basis of the agronomic and chemical evaluation fourteen lines were selected out of fifty three for further evaluation in the field trial. As a result of high yield and brix content, line CPSG-169 was multiplied for further testing in the national trials.

Stevia improvement

Callus Induction from leaf explants:

Callus induction was achieved indirectly from Stevia leaf explant on MS medium supplemented with different concentrations of auxins. Leaf explants of S. rebaudiana responded to all 2, 4-D concentrations. Best callus induction (83.26%) was recorded on MS medium supplemented with 2.0 $mg.l^{-1}$ 2, 4-D after 14 days leaf culture. Significantly similar amount of callus (83.25%) was also induced by 4.0 $mg.l^{-1}$ 2, 4-D while no callus was observed on MS0 medium without any PGRs. The callus color, texture and growth were

also recorded on various concentrations of 2, 4-D alone after 35 days of culture. Various concentrations of 2, 4-D alone produced yellowish green, granular and spongy callus.

Shoot organogenesis from callus culture

Data on shoot organogenesis was recorded after 30 days sub-culture of callus and the best % shooting response (96%) was observed on 2.0 mg.l^{-1} BAP after 20 days of culture. BAP (1.5 mg.l^{-1}) in combination with GA3 (0.5 mg.l^{-1}) induced 90% shooting in S. rebaudiana after 18 days of culture. However, 85% shoot organogenesis was recorded for 1.0 mg.l^{-1} BAP. All the BAP concentrations used were effective in % shoot induction. Moreover, BAP containing medium when supplemented with 2, 4-D inhibited % shooting significantly. Maximum number of (106) shoots/explant were recorded when MS-medium were supplemented with BAP (1.5 mg.l^{-1}) in combination with GA3 (0.5 mg.l^{-1}). It was also observed that, BAP in combination with IBA significantly inhibited number of shoots per explant in S. rebaudiana. When shoots were transferred to elongation medium, the longest shoot (23.5 cm) was observed on MS-medium incorporated with 1.5 mg.l^{-1} BAP in combination with 0.5 mg.l^{-1} GA3.

Root organogenesis

When the elongated shoots were kept for more than 4 weeks on medium containing BAP, shoots started rooting. More than 85% rooting was observed on half MS-medium containing IBA and NAA (0.5 mg.l^{-1}) after 8 days of culture. Whereas when full MS-medium was incorporated with similar combination of Auxins, more than 73% rooting was recorded after 14 days of shoots culture. However, BAP(2.0 mg.l^{-1}) also produced similar %age of rooting in regenerated plantlets. Maximum of 19 roots per plantlet were observed when half MS-medium was incorporated with 0.5 mg.l^{-1} IBA in combination with 0.5 mg.l^{-1} NAA. Similarly maximum mean root length (14.3 cm) was recorded when half MS-medium was incorporated with similar composition of PGRs.

Stevia propagation through shoot tip explants

Shoot tips (1-2 cm) were collected from lathe house grown plants of Stevia. After surface sterilization, these shoot tips were cultured on MS-medium containing different concentrations of BAP. Data regarding % survival, number of plants per culture, mean shoot length and number of leaves per plantlet were recorded after 23 days of culture. Shoot tips showed 100% survival on medium containing 0.5, 1.5 and 2.0 mg.l^{-1} BAP after 10-18 days while lower % survival of 85.83% was recorded for 1.0 mg.l^{-1} BAP after 16 days of shoot culture. Similarly, maximum of 2.83 number of shoots/culture was recorded for similar BAP concentration. BAP in lower concentration (0.5 mg.l^{-1}) produced the longest shoot of 3.6 cm. Maximum number of leaves was observed on medium containing 2.0 mg.l^{-1} BAP. Furthermore, different concentrations and combination of auxins were used for root induction. In overall rooting experiment best rooting (66%), number of roots per plantlet (15) and mean root length (3) was exhibited by combination of IBA, NAA and IAA (0.5 mg.l^{-1}) when shoot tips were cultured on medium containing 1.5 mg.l^{-1} BAP within 29 days. However, each PGR (IBA, NAA and IAA) alone showed less root organogenesis as compared to combination.

Creation of genetic variability for higher yield and steviosides content through in vitro mutagenesis

Forty baby food jars containing fresh callus were exposed to Co^{60} gamma source for mutation induction. The irradiated calli along with control were placed in growth chamber. Constant Plant Growth Regulators (1.0 mg.l^{-1} BAP+ 0.3 mg.l^{-1} (NAA+IBA+GA3) were added to MS-medium for all calli growth. Maximum of 95.83% callus induction was recorded in control treatment after 8 days of culture with green color, granular and compact texture. More than 80% callus formation was observed in 5 Gy, 10 Gy and 15Gy treatments after 10-13 days of callus culture. However, 79.16% callus formation was recorded for 20 Gy treatments after 14 days of culture. Callus color and texture were constant for all radiated and control calli.

Oilseed Brassica

Devlopment of NIFA Gold (04 K 12/13-10-1) a new rapeseed candidate variety

A new rapeseed (*Brassica napus L*.) variety developed through hybridization was submitted to Khyber Pakhtunkhwa Provincial Seed Council for approval. The candidate variety is high yielding and has out yielded Hyola 401 (commercial control) by 23, 24, 27 and 29% at four different sites in the National Uniform Rapeseed Yield Trial in 2010-11. It exhibited overall 04% higher seed yield than the check variety on mean basis over all locations. It maintained its sustainability by outclassing checks at five sites out of eight by 12.79, 1.8, 23.65, 40.84 and 11.53 % on mean basis in the NURYT 2011-12. It has qualified spot

examination conducted by Technical Committee of Provincial Seed Council (2012) at NIFA Experimental Farm. High seed yield (>3300 kg.ha^{-1}), high oil contents (> 44%) and early maturity are major features of this candidate NIFA variety (NIFA Gold).

Quality seed production of oilseed brassica varieties

Maintenance of the genetic purity of approved/commercial varieties is mandatory to produce certified seed. In this regard, 75 pod rows and 120 progeny blocks were raised to produce Breeder Nucleus Seed (BNS) of each of the three varieties viz., Durr-e- NIFA (B. napus), Abasin-95 (B. napus) and NIFA-Raya (B. juncea). True to type pod rows and progeny blocks were selected and certified by the Federal Seed Certification & Registration Officer (FSCRO), Peshawar. A total of 152, 50 and 40 kg Pre-basic Seed (PBS) while 33, 35 and 30 kg BN Seed, respectively of Durr-e-NIFA, Abasin-95 and NIFA Raya were produced and certified by FSC&RD at NIFA, Peshawar.

Improvement of rapeseed (*Brassica napus*) and mustard (*Brassica juncea*) through induced mutations and classical breeding techniques

Performance of recombinants and mutants of rapeseed and mustard in Multi-locational Adaptation Yield Trial, 2011-12

Adaptation yield trial, comprising of seven rapeseed mutants and recombinants and three mustard mutants along with commercial checks viz., Hyola 401 and BARD-I, respectively, was conducted at ten locations viz, Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad, Barani Agriculture Research Institute (BARI), Chakwal, and Nuclear Institute for Food & Agriculture (NIFA), Peshawar, University of Agriculture, Faisalabad (UAF), Serai Naurang, Bannu, Nuclear Institute for Agriculture (NIA), Tando Jam, Agricultural Research Station, Buffa, Mansehra, University of Rawalakot and Agricultural Research Station, Kohat during Rabi 2011-12. The results were received from NIAB, Faisalabad, BARI, Chakwal, UAF, Faisalabad. Genotype and genotype-environment interaction bi-plot analysis was used to compare yield performance of 12 genotypes across three locations. Mustard mutants MM-III/06-3, MM-III/06-12 and MM-III/06-13 and two rapeseed recombinants viz., 04 K 8/13-18-2 and 04 K 9/13-9-2 produced higher seed yield than their respective checks over two years and showed reasonable stability by falling near the average mean yield and the highest seed yield circle when analyzed for the Average Tester Coordination for entry evaluation. These lines have been submitted to Oilseed Coordinator, NARC, Islamabad, for assessing their yield potential and adaptability over different agro-climatic conditions in Pakistan, during Rabi, 2012-13.

Agronomic evaluation of mutants/ recombinants in Advanced Yield Trials (AYTs), at NIFA, 2011-12.

Top fifteen mutants/recombinants of rapeseed were advanced from Preliminary Yield Tests (PYT) to Advanced Yield Trial and evaluated separately in two Advanced Yield Trials (AYT) along with a rapeseed check, Punjab Sarsoon at NIFA experimental farm, during 2011-12. The results revealed that line PYT-4(5) took least days to flowering (87 days) in AYT-I compared to check (98 days). Pertaining to plant height, rapeseed mutants RM-1/09-2, RM-1/09-4 and RM-1/09-22 attained less height (194, 190 and 186 cm, respectively) compared to check (195cm) in AYT-II. With respect to seed yield, only one rapeseed mutant RM-1/09-2 out of fifteen could out yield check by non-significant margin achieving 3472 kg.ha^{-1} compared to 3417 kg.ha^{-1} in AYT-II.

Performance of stable mutants for yield and other agronomic characteristics in Preliminary Yield Trial (PYT), 2011-12 at NIFA.

Stable and high yielding twelve rapeseed mutant and five mustard mutants/recombinants lines were evaluated in the preliminary yield trial in three sets comprising of six entries in PYT-I, PYT-II and five in PYT-III along their respective checks.

The results revealed that two mustard mutants and two recombinants flowered earlier (98 – 106 days) than the check (111 days) in PYT-III, while none of rapeseed and mustard mutants and recombinants was shorter than the control. With respect to seed yield, in PYT-I, rapeseed mutants RM-II/09-8 and RM-III/10-29 significantly out yielded control (2500 kg.ha^{-1}) by achieving 3833 kg.ha^{-1} & 3806 kg.ha^{-1} respectively, while in PYT-II, RM-II/10-59, RM-III/10-19 and RM-I/10-21 out classed the check (1833 kg.ha^{-1}) by producing 2944, 2833 and 2667 kg.ha^{-1}, respectively. The mustard lines evaluated in PYT-III, 010-10/9-8 and MM-6/10-32 produced significantly higher seed yield 2472 and 2028 kg.ha^{-1}, respectively compared to check (1194 kg.ha^{-1}).

Assessment of rapeseed and mutants/recombinants for yield and other

agronomic characteristics in Non-replicated Yield Trial (NPRT)

Mustard

Twenty five stable and high yielding mustard mutant lines of $M_{3:4}$ generations were evaluated for yield and other economic traits in a non-replicated trial planted in augmented design along with a commercial checks (BARD-I) replicated over the blocks. The results indicated that 11 mustard mutants achieved higher seed yield (2778 – 4028 kg.ha^{-1}) over the check mean (2709 kg.ha^{-1}) with the yield advantage of 2.4 – 32.74%.

Rapeseed

A non-replicated trial consisting of sixteen rapeseed mutants/recombinants along with Hyola 401 (commercial check) revealed interesting results. Six rapeseed entries outclassed the commercial check (3195 kg.ha^{-1}) by producing 3333 – 5417 kg.ha^{-1} with the yield advantage of 4.1 – 41.01 %. All mutants/recombinants recorded higher 1000 seed weight and high oil content (>44%).

Development of segregating populations

M_0/M_1 & F_1M_1 generation

Healthy and uniform seeds of two rapeseed varieties viz., Punjab Sarsoon and Hyola 401 were exposed to two doses of gamma radiation (1 and 1.2 kGy) with the view to incorporate earliness and reduced plant height. The treated seeds were directly planted in the field in isolation, dose/variety wise. Normal cultural practices were carried out. Plots were bulk harvested dose/variety wise at maturity and seed were manually threshed and bagged separately. First filial generation of selected four crosses attempted in 2009-10 were exposed to higher doses of radiation in order to broaden the genetic variability to get the desirable hybrid mutant with improved yield and other economic traits and bulk harvested dose and variety wise.

M_2 generation

The M_2 generation of two rapeseed (*B. napus*) and one mustard (*B. juncea*) exotic/local cultivars with two gamma radiation doses was developed. On the basis of visual observations, 08 mutant plants in mustard while 56 single mutant plants from rapeseed mutagenized population were selected using shuttle breeding programme between NIFA and SARS, Kaghan. Selections were based on plant height, number of primary branches per plant, number of pods, pod length, number of seeds per pod and yield per plant. The putative mutants were analyzed for quality traits through non-destructive quality analysis on NIRS system in Oilseed quality Laboratory at NIFA, Peshawar.

F_0/F_1 generations

The intra-specific crossing was achieved by hand pollination of 1570 rapeseed and 120 mustard buds totaling 1690 buds for 15 rapeseed and 01 mustard cross combinations developed to incorporate earliness, short stature, low erucic acid, glucosinolates and high yield in otherwise adapted varieties. Crossed pods were harvested combination wise separately as F1 seed.

The F_1 seed (2010-11) developed from 18 rapeseed and 07 mustard cross combinations were planted as F_1 generations in separate blocks cross combination wise at NIFA along with parents at extreme end. The progenies resembling exactly any of the parents and showing inferior performance as compared to their respective parents were discarded and rest harvested separately.

F_1/F_2 generation

Seed of different F_1 progenies of one mustard and eleven rapeseed cross combinations developed at SARS, Kaghan, 2011 were planted at NIFA the same year to grow F_2 generation for selection of desirable recombinants on the basis of visual observations. The parents were planted at two extremes of each plot for easy comparison. Total 46 single plants of both rapeseed and mustard were selected for early maturity, short stature, heavy bearing, and pest resistance/tolerance. The seed quality assessment of the selected recombinant plants was carried out through NIRS analysis in Oilseed Laboratory NIFA.

Quality characterization of oilseeds through NIRS

The oilseed quality analysis through Near Infrared Reflectance Spectroscopy (NIRS) of rapeseed and mustard crop is a regular feature of oilseed brassica breeding program at NIFA. During 2011-12, total 3568 seed samples of brassica species were analyzed for oil, protein, glucosinolate content and fatty acid profile on NIRS. The analyzed samples consisted of 467 samples of NIFA site and multi-location trial and rest were from other R &D departments and different Universities from all over Pakistan. Some of the institutions are listed below.

- Ayub Agricultural Research Institute, Faisalabad
- Quad-e-Azam University, Islamabad
- National Agricultural Research Centre (NARC), Islamabad
- National Institute of Biotechnology & Genetic Engineering (NIBGE), Faisalabad
- University of Agriculture, Faisalabad
- Khyber Pakhtukhwa (KP) Agricultural University, Peshawar
- Pir Mehr Ali Shah Arid Agriculture University, Rawalpindi
- Provincial Oilseed Development Board (PODB), Lahore
- Federal Seed Certification & Registration Department (FSC&RD), Islamabad

Pulses Group

Evaluation of promising lines in replicated yield trials

Forty eight chickpea advanced lines consisting of both recombinants and mutants developed at NIFA were evaluated for seed yield and other important agronomic traits in three sets of replicated yield trials along with check variety NIFA-2005 at NIFA during 2011-2012. Eighteen (18) advanced lines showed significantly ($p \leq 0.05$) higher seed yield (844-1294 $kg.ha^{-1}$) as compared to the check variety (average yield of 857 $kg.ha^{-1}$). Ranges for days to flowering and maturity after sowing were 116-138 and 172-185 days, respectively, while plant height and 1000-grain weight ranged from 33-52 cm and 17-23 g, respectively.

Segregating material

Six cross combinations viz., Thal-2006 x NIFA-2005, Balaksar x NIFA-2005, Dasht x NIFA-2005, NIFA-88 x NIFA-2005, NIFA-2005 x NDC-6-I-6 and NIFA-2005 x NDC-6-I-7 among seven chickpea genotypes were attempted to obtain suitable combination of genes for higher seed yield and its components during 2011-12. Hybridization among reported four exotic bruchids tolerant lines (V-1128, V-2709, V-2802 and V-2817) and locally-adapted varieties (Ramzan, NM 92 and NM 2006) was carried out to incorporate bruchids tolerant gene from the above-mentioned exotic bruchids tolerant lines into locally-adapted varieties (Ramzan, NM 92 and NM 2006) during summer 2012. F1 seed setting was successful in 11 cross combinations viz., V-1128 x Ramzan, V-2709 x Ramzan, V-2802 x Ramzan, V-2817 x Ramzan, V-1128 x NM 2006, V-2709 x NM 2006, V-2802 x NM 2006, V-2817 x NM 2006, V-2709 x NM 92, V-2802 x NM 92 and V-2817 x NM 92. M_2 plant progeny rows of a mungbean genotype NFM 5-91-21 irradiated at 300 Gy gamma rays were raised during summer 2012. Two thousand (2000) single plant selections were made on the basis of no or less flowers shedding under high temperature (above 40°C) and more number of pods per plant.

Plant Pathology

Disease resistance in wheat

Disease resistance in wheat is an important factor in attaining sustainable food security and is therefore, an integral component of the crop improvement program at NIFA focusing on surveillance, pathotyping, monitoring of novel sources and candidate genes.

Surveillance for wheat diseases

Wheat growing regions in the southern, central and northern zones of KPK province were surveyed to get real time information regarding disease status of rusts, barley yellow dwarf, powdery mildew along with resistance and trend of cultivated cultivars under wheat productivity enhancement project (W-PEP) in Pakistan. Fifteen districts were included in the surveillance program covering around 4500 acres of farmer fields.

Yellow and leaf rusts

Both yellow and leaf rust diseases were frequently observed with variable intensities on different cultivars in different regions of the province. Surveillance data of 700 acres of wheat analyzed for district Peshawar and Nowshera indicated that yellow rust damage was severe in Maghdarzai (Peshawar) and Azakhel Bala (Nowshera) areas, respectively while in case of leaf rust, damage was high in Utozai (Peshawar) and Aman Garh (Nowshara) areas, respectively. Both “Sehar-2006” and “Pirsabak-04” emerged as the major cultivars sown in both districts. Yellow rust resistance of “Sehar-2006” and “Pirsabak-04” is based on Yr9 and Yr9+27, respectively while for leaf rust, it is based on Lr1+26 and Lr26 respectively. Cultivation of these cultivars should be discouraged for avoiding rust epidemics in the region as resistance of both these cultivars is narrow and based on defeated genes.

Barley Yellow Dwarf

Barley Yellow Dwarf (BYD) has become a prominent viral disease of wheat in the KPK-Province. Occurrence and distribution of BYD was investigated at the provincial scale during the cropping season. Disease occurred during the season and was prevalent in all three

wheat production zones of the province. About 1400 farmer fields were scouted for BYD in the central, southern and northern zones of the province. Disease distribution was moderate in the southern zone where 31% of the fields were found infected. However, BYD prevalence was high in the central and northern zones where more than 50% of the fields were infected with high disease incidence and severity. Almost all cultivated cultivars were found sensitive to BYD.

Powdery mildew

Powdery mildew of wheat is caused by an obligate parasitic fungus *Blumeria graminis* f. sp. tritici which had its prevalence confined to the Malakand division during the season. Disease was observed with high intensities ranging from 60-100% in Marghozar, Kanjo Koza Banda, Kanjo Bara Banda, Koza Banda Swat, Bara Daroshkhela Matta, Landy Charbagh Swat, Bagh Deri, Nali Qala Khwazakhela and Boda Baba Swat regions. Almost all cultivars grown in Malakand division were found susceptible to powdery mildew which included Auqab-2000, Inqilab-91, Pirsabak-2004, Pirsabak-2005, Pirsabak-2008 and Sehar-2006.

Monitoring novel sources for rust resistance

In order to search for novel sources of yellow and leaf rust resistance, 600 wheat genotypes consisted of Set I (Released Varieties: 37; Candidate Varieties: 38 & NIFA Germplasm: 35) and Set II (Elite National Material: 327 & Land Races: 163) were monitored at six hotspot locations across KPK. Set I was assessed at five locations while Set II at a single location for yellow rust. For leaf rust, Set I was assessed at Peshawar only. Leaf rust compatibility was not observed on 50 genotypes of Set I while 33 genotypes had very low yellow rust severity (5 or <5%). Genotypes of Set I displayed high resistance against both rusts included Suleman-96, Bakhtawar-93, Karwan, Wafaq-2001, 93T347, RWM-9313, NRL-0731, NRL-0751, NRL-0806, NRL-0820, NRL-0832, CT-08054, CT-08024, WG-08030, WG-08020, CT-08022, WG-08018 and CT-09074. Remaining genotypes of Set I demonstrated variability in severity of both rust diseases with indication of slow rusting potential. Very low yellow rust severity (<5%) was observed in 356 genotypes belonging to Set II. This set included 44 elite genotypes belonging to NIFA and only two (i.e. NIFA-9 and NIFA-33) indicated the presence race nonspecific high resistance.

Pathotyping and effectiveness of yellow rust resistance genes

For field pathotyping and assessing effectiveness of resistance genes, biological trap nurseries including World, European and supplemental differentials along with Australian Avocet Near Isogenic Lines (NILs) were raised at six hotspot locations in the southern, central and northern zones of KPK. Field summary indicated the presence of five yellow rust pathotypes i.e. 0E0, 119E152, 119E184, 103E202 and 102E128 in KPK. Maximum number of virulence's was associated with pathotype 119E184. Five virulences were common in all pathotypes except 0E0. Pathotypes 119E152, 119E184 and 103E202 were able to infect supplemental differentials including Clement, Federation X 4 Kav, Anza, VPM1 and TP 981. Both Yr10 and Yr15 located on chromosome 1BS were found completely free of infection and were declared as effective and can be used in wheat improvement program for enhancing yellow rust resistance in the northwest of Pakistan.

Identification of slow rusting durable resistance

Adult plant resistance is long lasting and is often associated with slow development of rusts and is considered as a key strategy for its management. More than 70 candidate and released cultivars were studied for slow rusting trait. Slow rusting variables for yellow rust development were assessed over time in the presence of virulence's v1, v2, v3, v6, v7, v7+, v9, v9+2?, v17, vA, vSU, vSD, vSP, vGaby, vTP 981 along with a standard susceptible control. Several assessments were made at weekly intervals to understand pattern of disease development during the season. Area under disease progress curve indicated low to high levels of slow rusting resistance in the studied material. Some of the prominent cultivars which had area under disease progress curve up to 500 were Faisalabad-83, Bahawalpur-95, Suleman-96, Kaghan-93, Soughat, Bakhtawar-93, Saleem-2000, LJ01, J03, Chakwal-86, V-00125, CT-00231 and Tatara. All these cultivars may carry all stage or slow rusting or combination of both these resistances. Remaining cultivars were moderate to fast slow ruster.

ENTOMOLOGY DIVISION

The Entomology division is engaged in the integrated control of various insect pests of field and fruit crops such as fruit flies, termites, peach flat-headed borer, chickpea pod borer and medically important disease carrying insects such as mosquitoes and house flies. The division is also conducting R&D activities on integrated management of honey bee and honey production. Under integrated pest management system, different IPM components are employed to reduce losses caused by insect pests and the disease they transmit in plants and animals.

Fruit Fly Control

Fruit flies are the most destructive insect pests of fruits and vegetables throughout the world. Among various species of fruit flies, Bactrocera are predominant in Pakistan attacking pear, peach, plum, apple, guava, mango and other fruits and vegetables. Their pre harvest control largely depends on the application of male annihilation techniques and post-harvest as irradiation or hot treatment. Research on fruit flies is therefore, directed towards improvement in the control strategy through environment friendly techniques such as cultural control, biological control, male/ female trapping and fruit irradiation for larval mortality.

Effect of irrigation on adult emergence

Fruit fly larvae naturally pupate in the soil underneath. The adults emerge from these pupa buried in the soil. Laboratory bioassays were carried to investigate the effect of flood duration and pupal age on adult emergence from pupa subjected to various flood durations at fixed and aging pupa.

The effect of different flood duration on *B. cucurbitae* pupae of various ages

Laboratory bioassays were conducted on pupae of *Bactrocera cucurbitae* of various ages. Natural pupation was simulated in laboratory bioassays by allowing jumping stage larvae to pupate naturally in a loam soil contained in 1.5 l transparent plastic bottles called hereafter “pupal substrate”. The lower ends of the pupal substrates were closed with muslin cloth to drain water from it. Each bottle was 1/3 filled with loam soil. Fifteen jumping larvae were transferred to the pupation substrate through a camel hair brush. After pupation, age of the pupa was recorded daily. There were three replicates of each age cohort of pupae. The experiment was laid out in Completely Randomize Design (CRD) with 10 treatments. Pupal substrate with age specific pupa was put in plastic tubs. Field irrigation was simulated by flooding the pupal substrate by immersing it in water for 1 and 24 hr duration. At the end of each flood duration, the pupal substrate was removed from the tubs and water was drained out of it. The top end of the substrate was covered with a mesh. The effect of flood duration on different age pupae was noted on adult emergence. The whole experiment was conducted in an environmentally controlled laboratory set at 26±2 ^{0}C and 60±5% relative humidity. Results showed very strong effect of flood duration on emergence. There was significant reduction in the percent emergence of pupa flooded for either one hour or 24 hours duration. Pupa were also age sensitive to flooding for up to 48 hours. Beyond 48 hours the combined effect of age and flood duration was minimum.

Table 1: Effect of flood duration on adult emergence from aging pupae of *B. cucurbitae*

Flood Duration	Age (hours)	Percent Emergence (flood duration*age)
Control (0 hours)	12	94.18 a
Control (0 hours)	24	92.91 a
Control (0 hours)	48	93.33 a
Control (0 hours)	72	93.33 a
Control (0 hours)	96	93.33 a
One Hour	12	31.11 bcd
One Hour	24	28.89 bcd
One Hour	48	37.78 bcd
One Hour	72	**48.89 abc**
One Hour	96	**60 ab**
24 Hour	12	6.67 cd
24 Hour	24	0.01 d
24 Hour	48	24.44.bcd
24 Hour	72	**55.56 ab**
24 Hour	96	**62.22 ab**

Effect of different flood duration on 24 hours old *B. cucurbitae* pupae

Fifteen *B. cucurbitae* pupae of uniform age (24 hours old) were obtained from the stock culture and placed in pupal substrate at a depth of 15 cm. Each substrate having 15 uniform age pupae were immersed in water for various durations (1-4 hrs.). There were 5 treatments and three replications of each flood duration. Pupal

substrate with age specific pupa was put in plastic tubs. Field irrigation was simulated by flooding the pupal substrate by immersing it in water for 1- 4 hrs. duration. At the end of each flood duration, the pupal substrate was removed from the tubs and water was drained out of it. The top end of the substrate was covered with a mesh. The effect of flood duration on age specific pupae was noted on adult emergence. The whole experiment was conducted in an environmentally controlled laboratory set at 26±2 0C and 60±5% relative humidity. Results showed flooding has highly significant effect on the pupal emergence. At control, 91% emergence was recorded vs. 33% in one hour flooding. The effect of flood duration from 1-4 hours had significant effect on pupal emergence.

Table: 2 Effect of flood duration on pupal emergence when 24 hour old pupa was flooded for various durations

Flood Duration (Hours)	Pupal Age	Percent Emergence
No Flood (Control)	24 Hours	91.11 a
1 Hour	24 Hours	33.33 b
2 Hours	24 Hours	35.56 b
3 Hours	24 Hours	42.22 b
4 Hours	24 Hours	31.11 b

Effect of burial on pupal emergence

Pupa of *Bactrocera cucurbitae* were buried at various depths; 5, 15 25 and 30 centimeter depths in a loam soil retained in a 1.5L plastic bottle. Results indicated that pupa buried at a depth of 15 cm or more reduced adult emergence from soil. Due to nature of fruit flies pupation in the soil underneath the plant, all above experiments have very strong applications in a cultural control of fruit flies. Deep ploughing and irrigation for at least hour standing water under canopy can inflict high mortality to pupae hiding in the soil.

Effect of cue- lure and natural hosts extract on the attraction of *B. cucurbitae*

Four natural hosts of *B. cucerbitae* i.e. melon, sponge gourd, bitter gourd and round gourd (Tinda) were mixed @ 85% with 10% cue-lure and 5% toxicant (Dipterex). For this purposes natural hosts were crushed in electric mixer after cutting into small pieces by knife. A small amount (5ml) of water was added to get the squash easily till the material was finely crushed. This fine squash was passed through cotton cloth to get the extract in glass beaker. Sodium benzoate @ 1% was mixed as preservative to avoid spoiling of the extract. In this extract, Cue-lure and Dipterex were added @ 10 and 5% respectively. Standard Cue-lure trap (85:10:5) was also kept as check. The traps were installed at a height of about 2-2.5m above the ground in 0.61 ha bitter gourd field surrounded by 2.13 ha sponge gourd. The bitter gourd crop was raised in rows, in erected position with help of wood logs and steel wire mesh to support the crop. 20 ml of each test material was applied on cotton wick which was placed inside the trap. Each treatment was replicated four times. Data was recorded weekly from July 27 to October 13, 2011. The results indicated that fly population was more in all treatments as compared to check throughout 10 weekly observations. The interaction of various treatments and observation dates showed that maximum number of 248 flies/ trap/ week was recorded in Cue + bitter gourd combination in 2nd observation i.e. on August 8, 2011 while minimum number of 2.5 flies/ trap / week in standard Cue-lure trap on September 28. Overall mean total population of flies for 10 weekly observations showed maximum number of 943.75 flies $trap^{-1}$ in T2 (Cue + Sponge gourd) followed by 793, 787.5 and 725.3 flies in Cue-lure combination with melon, bitter gourd and round gourd respectively, while the corresponding figure in standard Cue-lure trap was 305.75 flies/trap. It is clear from the results that mixing Cue-lure in natural host extract enhanced it efficacy from 305 flies/ trap in Cue standard trap to 725 – 944 flies/ trap in Cue and natural hosts mixtures.

Effect of methyl eugenol and cue-lure mixtures on fruit fly attraction

Melon fly *B. cucurbitae*, Oriental fruit fly *B. dorsalis* and peach fruit flies *B. zonata* are the major fruit fly species in KPK attacking various fruits and vegetables causing tremendous losses. These three species are found in the same area if their natural hosts are sown near each other in inter cropping pattern. The methyl eugenol is luring flies species attacking fruits while Cue-lure attracts melon fly attacking cucurbit vegetables. To attract and kill these three species and some other minor species, both these lures were mixed @ 25, 50 and 75% with one another to see the effect of mixing fly lures on attraction and killing of fly species in a single trap. Pure methyl eugenol and Cue-lure were also installed for comparison of the results. Lures were applied on single 1g cotton wick @ 4 ml /trap. Data on fly attracted and mortality was recorded weekly. The results showed that 4 fruit flies species viz *B. dorsalis*, *B. zonata*, *B. cucurbitae* and one unidentified species of fruit flies were attracted to the traps. The interaction of lures and weeks indicated that

maximum number of 184.7 flies/trap/ week were observed on August 24, 2011 in pure methyl eugenol traps while minimum number of 1.5 flies/trap/ week in pure Cue-lure trap on August 18.The low number of melon fly was due to non availability of natural host in the area. Overall treatment mean population showed that maximum number of 104.6 flies/ trap/ week were captured in pure methyl eugenol trap followed by 85.9, 32.8 and 8.51 flies/ trap / week in 75, 50 and 25% Methyl eugenol in Cue-lure respectively. Minimum number of 4.55 flies/trap /week were capture in only Cue-lure trap. The overall week effect showed that maximum number of 88.33 flies/ trap/ week was caught on August 24 while minimum number of 26 flies/ traps on August 12. The species relative study indicated that all treatments attracted 4 species; however their percentage varied in different treatment. In pure methyl eugenol, *B. zonata* was dominant 71.2% followed 24.1% *B. dorsalis* and 4.7% *B. cucurbitae*. In treatment (T2) with 25% Cue-lure *B. zonata* was 55.2%, *B. dorsalis* 23.54% and *B. cucurbitae* 23%. In T3 (50:50 combination), the percentage of *B. zonata*, *B. dorsalis* and *B. cucurbitae* was 26.8, 46.6 and 25.50% respectively. In treatment 4 (75:25% combinations), the percentage of *B. cucurbitae* increased to 45.5% while pure Cue-lure trap attracted 72% *B. cucurbitae* ,13% *B. zonata* and 12.1% *B. dorsalis*. The percentage of unidentified species was very low i.e. it ranged from 0.1 – 2.5% in different treatments.

Synergistic interaction between torula yeast, protein hydrolyzate, ammonium bicarbonate and cue lure

Cue-lure is highly attractive to the males of melon fly, *B. cucurbitae* and other species of fruit flies attacking various cucurbits and fruits and is a commercial lure, recommended for the male annihilation of melon and other related flies through out the world. To enhance its attraction to flies, three chemicals torula yeast, protein hydrolysate and ammonium bicarbonate were incorporated in Cue-lure to see their effect on the attraction of flies. For this purpose, 20% water solutions of torula yeast, protein hydrolysate and ammonium bicarbonate@ 85 % were mixed with Cue-lure. 5 % Dipterex as toxicant was also added in the mixture. 20 ml of the test solutions were applied on cotton wicks inside the traps. These treatments were compared with the standard Cue-lure trap (Check, having 85% Cue-lure 10% sugar and 5% toxicant). In standard trap, 2 ml Cur-lure was used. Similarly in all these treatments, the quantity of Cue Lure was kept as 2 ml $trap^{-1}$. Beside these combinations, the efficacy of only these synthetic chemicals with 5 % Dipterex was also tested. Traps were installed in bitter gourd crop raised on steel wire and wooden supports, at height of 2 meter above ground level. The experimental field was encircled by infested sponge gourd crop to ensure the availability of maximum adult flies. There were 7 treatments, each replicated 4 times in completely randomized design. Data on number of flies/trap/week were recorded for 9 weeks starting 8 August to 13 October 2011. The results indicated that mixing these chemicals in Cue-lure has increased its attraction many fold than standard commercial trap. On the other hand attraction of flies towards these chemicals was significantly low than the standard trap. Interaction of time(weeks) with chemical combination showed that maximum number of 341 flies/week/trap were recorded in on September 9 in Cue–torula combination as compared to no flies in protein an Ammonium bicarbonate in 6th and 8th weeks respectively. Overall mean results after 9 weeks indicated that by combing torula with Cue- lure attracted 3 fold (96.96flies/ trap/ week) while protein and Ammonium bicarbonate attracted more than double i.e. 56.5 to 57 flies/trap/week) as compared to 26 flies in standard Cue –lure trap. On the other hand mean number of 3.6-7.0 flies were captured in synthetic chemicals. This indicated that the attraction of melon fly towards Cue-lure was significantly increased by the synergistic effect of the chemicals on the lure efficiency.

Effect of seed rate of wheat variety, Barsat on aphid infestation

Variety Barsat using 6 seed rates, 60, 75, 90, 105, 120 &135 $kg.ha^{-1}$ was sown to screen against aphid infestation. The results indicated that mean infestation was maximum (6.26 insect/ tiller) using 75 kg seed while minimum infestation of 5.39 with 60 Kg seed. . Maximum attack of 15.9 aphids/tiller was observed on March, 17 while lowest attack of 0.07 insect was noticed on 7th observation (April 28).

Screening of 20 wheat genotypes for resistance against aphids

The results of screening 20 wheat genotypes against aphids showed that 4 lines, CT-04192, CT-07043, WL-01869 and NIFA V-16 were highly infested (11.19- 12.73 aphids/tiller) while minimum attack of 8.32 insect/tiller was found in variety Bathoor. Aphid population was the maximum in first two weeks of March as compared to last weeks of March and April because it dropped significantly due to crop maturity.

Bruchid Beetles and Chickpea Pod Borer Management

Management of bruchid beetles damaging stored mungbean grains

Under Joint PSF Research Project with Mungbean Breeding Group at NIFA on "Breeding for Bruchid Resistance in Mungbean" preliminary research work was initiated with an objective to identify bruchid resistant genotypes and incorporation of resistant genes in local high yielding well adopted genotypes.

Bruchids (*Callosobruchus maculatus*) (F.) are the principal post-harvest pest of mungbean and other stored pulses. In storage, the adult female lay eggs directly on seed coat. The newly hatched larva bore through the egg shell and penetrates seed coat, continue to feed and complete their development inside the seed. After completion, the insects emerge as adult beetles leaving behind a hole at the exit point. Bruchids infestation causes reductions in the weight, seed viability, sale ability and infested grains unfit for human consumption. The alternative to chemicals and other control measures is to develop bruchids resistant genotypes.

Maintenance of bruchids stock culture

To obtain uniform age groups of bruchid adults required for lab experimentation, maintaining stock culture for continuous supply of insects is a pre-requisite. Culture of bruchids beetle was maintained on bold mungbean grains at 28 ± 2^{o}C and 70 ± 5% relative humidity. Insect of uniform age males and females were collected separately by isolating mungbean grains in small transparent glass test tubes mouth plugged with cotton. 10-15 pairs of newly emerged adults were collected within 24 hours and released in glass/plastic jars containing sound grains of mungbean. The jars were covered with muslin cloth to facilitate aeration. The stock culture maintained is being utilized for experimental purposes. In the present study, 3 sets of experiments comprised of local & exotic mungbean genotypes were screened for resistance to bruchids.

Evaluation of resistance in mungbean genotypes to bruchids (*Callosobruchus maculatus*)

To obtain uniform age groups of bruchid adults required for lab experimentation, maintaining stock culture for continuous supply of insects is a pre-requisite. Culture of bruchids beetle was maintained on bold mungbean grains at 28 + 2oC and 70 + 5% relative humidity. Insect of uniform age males and females were collected separately by isolating mungbean grains in small transparent glass test tubes mouth plugged with cotton. 10-15 pairs of newly emerged adults were collected within 24 hours and released in glass/plastic jars containing sound grains of mungbean. The jars were covered with muslin cloth to facilitate aeration. The stock culture maintained is being utilized for experimental purposes. In the present study, 3 sets of experiments comprised of local & exotic mungbean genotypes were screened for resistance to bruchids.

Relative susceptibility of mungbean varieties to bruchids

Four coded mungbean varieties supplied by Mungbean Breeding Group were screened against bruchids having 3 replications. In the present finding, no mungbean variety was found completely resistant to pest attack. The results indicated that mean adult population (27%) was high in coded variety V4 with damaged grain 6.16%, maximum no of eggs (68). Variety (V2) had 1.52% grain damage with minimum 7% adult emergence was observed as tolerant while V4 as susceptible one.

Screening of mungbean genotypes against bruchids

Five genotypes were evaluated to explore their resistance to bruchids under laboratory conditions. The genotypes used were NFM-92-2-31, NFM-5-63-48, NFM-5-91-33, NFM-5-91-21 and NFM-14-6. The parameters studied were number of eggs laid, developmental period, total adult eclosion, percent grain infestation, % grain damage and percent weight loss. In each glass bottle, 30 gm of un-infested mungbean grains were added along with 5 pairs of adult bruchids from day old adult culture. Each treatment (genotype) was replicated 3 times having RC design. The results showed that minimum adult emergence (16 adults) having, 2.04% grain damage, 4.47% grain infestation with 0.50 percent loss was recorded in NFM-5-63-48 while maximum grain damage 6.65% with 9.69% grain infestation and 1.63% weight loss in genotype NFM-92-2-31 . Genotypes NFM-5-63-48 proved tolerant.

Efficacy of insecticides for management of pod borer, *Helicoverpa armigera* attacking chickpea crop

Chickpea pod borer, *Helicoverpa armigera* is a serious pest causing economic losses to the tune of 70 to 95% in chickpea crop. The extent of damage inflicted by pod borer to chickpea

depends not only on the number of larvae but also on its developmental stages. The caterpillars have variable colors ranging from green, brown or yellow. The full grown larvae feed voraciously on developing pods with their bodies hanging outside. A single larva can consume 30-40 pods before reaching the pupal stage.

A field trial was carried out to determine the efficacy of different insecticides against the larval density of pod borer on chickpea crop. The experiment was laid out in a randomized complete block design with five treatments including control and 3 replications. The plot size was 20 m^2. Four insecticides viz. Curacron (800-1000 $ml.acre^{-1}$), Steward (175 $ml.acre^{-1}$), Lorsban (750-1000 $ml.acre^{-1}$) and Regent (480 $ml.acre^{-1}$) were sprayed twice at the onset of larval attack. Two pretreatment and 4 post treatment observations on larval populations were made. Data were recorded by counting the number of live larvae on randomly selected five plants per plot. At maturity stage, the crop was harvested and grain yield per treatment was recorded. The results showed that pretreatment larval population ranged from 6.4 – 8.4 during 1st spray. A sharp decline in larval population density i.e. 3.6 larvae & 2.8 larvae per 5 plants were recorded after 4 day of 1st and 2nd spray in Steward Treatment respectively. In treatment Regent, population was reduced i.e. 3.2 larvae after 4 day in the 2nd spray. On the whole, the larval population in treated plots remained lower in all the observed days after application of both sprays in comparison with control. Maximum grain yield (1068 $kg.ha^{-1}$) was recorded in treatment Steward followed by Regent (1043 $kg.ha^{-1}$) while in control, grain yield recorded was 739 $kg.ha^{-1}$. Steward proved best in reducing pod borer larvae and enhanced grain yield.

Stone Fruit Insect Pests and their Control

Climatic conditions of the Khyber Pakhtunkhwa are very congenial for the production of stone fruits, especially plum, peach & apricot. Peach flat-headed borer is the major economic pest; causing gummosis and D-shape holes in tree trunks of stone fruit orchards as shown in (Fig. 1-9). Due to pest severity, area & production of stone fruits is declining in this Province. In the present scenario, pest severity is enhancing while stone fruits production is declining with a dire need for developing IPM technology; otherwise KPK will be deprived of natural gifted stone fruits and export of this precious fruit commodity will be stopped.

Surveillance and monitoring of Peach flat-headed borer, *Sphenoptera dadkhani* (Oben.) infestation in stone fruit orchards at Khyber Pakhtunkhwa (KPK)

Survey of fourteen different Villages i.e., Musazai; Surazai; Urmar Payan; Mera Kachori; Tarnab, Lala kaley, Akbar Pura; Qasim Ali Baig,Wazir Garhi, Umar Dara, Mezara, Thana; Kota, Barikot; Manglor, Mingora; Nawakaley, Khuazakhela and Drushkhela, Matta were conducted in stone fruit orchards in Nowshera, Peshawar and Swat districts for Peach flat-headed borer infestation. Infestation level of gummosis was observed in all the villages of three districts. Highest level of gummosis 93.52% was recorded in plum orchards at Nowshera followed by Peshawar (82.39%) and Swat (47.66%). In peaches, 88.26% gummosis was recorded in Peshawar followed by Nowshera (82.02%) and Swat (66.71. In apricot, 91.02% gummosis was recorded in Peshawar followed by Nowshera (81.68%) and Swat (55.13%). Results indicated that maximum infestation gummosis was found in Nowshera followed by Peshawar and Swat.

Field efficacy of bordeaux mixture in combination with different pesticides against peach flat-headed borer infestation in plum orchard

Bordeaux mixture treatment is effective against Peach flat-headed borer infestation during dormant season. Peach flat-headed borer infestation is based on two types i.e., exited hole and gummosis. (a). Application of pesticides in combination with Bordeaux mixture showed that minimum infestation i.e., 0.4647 exit holes/m2 was recorded in Nurelle-D 505EC followed by Triazofos 40EC (0.6579), Neem oil + Hing (0.8661), Thiodan (1.0227), Steward 150SC (1.9215), Tenekil plus (2.2111), Cyren (2.8477) and Control (4.5135) in the month of February, 2012. Nurelle-D 505EC and Triazofos 40EC @ 75 ml mixed with Bordeaux mixture was found effective in reducing exit holes after 30 days as compared to other tested pesticides in the same orchard.

(b). Different pesticides in combination with Bordeaux mixture showed that low level of gummosis i.e., 0.9869 gum points/m2 was recorded in Thiodan followed by Triazofos 40EC (0.9968), Nurelle-D 505EC (1.3134), Neem oil + Hing (1.5601), Steward 150SC (2.0254), Tenekil plus (2.5327), Cyren (2.6939) & Control (4.4979) after 15 days in the month of February, 2012. After 30 days, minimum gummosis i.e., 1.2674

gum points/m2 was recorded in Thiodan mixed with Bordeaux mixture followed by Nurelle-D 505EC (1.5510), Triazofos 40EC (1.7056), Neem oil + Hing (1.8715), Steward 150SC (2.1517), Tenekil plus (2.7988), Cyren (2.9730) and Control (4.8748). All the treatments are significantly different from each other at 5% level of significance. Thiodan 35EC, Nurelle-D 505EC & Triazofos 40EC @ 75 ml mixed with Bordeaux mixture (Copper oxychloride 75 g + Lime 3 kg + water 10 L) were found very effective against gum points as compared to other tested insecticides.

Field efficacy of different synthetic insecticides against peach flat-headed borer infestation in plum

Field spray of different synthetic insecticides showed minimum gummosis i.e., 0.2245 gum points.m^2 in Fyfenon 57EC followed by Curacron 500EC (0.2525), Thiodan 35EC (0.6402), Lorsban 40EC (1.0854), Regent 5%SC (1.2303), Ematac 1.9EC (1.4467), Confidor 20SC (1.4506) & Control (2.1285) after 15 days. After 30 days, low level of gummosis i.e., 0.7172 gum points.m^2 was recorded in Fyfenon 57EC followed by Thiodan (0.8507), Curacron 500EC (0.9893), Ematac 1.9EC (1.5177), Regent 5%SC (1.5747), Confidor 20SC (1.6373) Lorsban 40EC (1.7275) & Control (2.7627) in the month of May, 2012. All the treatments are significantly different in their efficacy from each other at 5% level of significance. Based on results achieved Fyfenon 57EC (Malathion) followed by Curacron 500EC (Profenofos) and Thiodan 35EC (Endosulfan) @ 50 ml were found effective in reducing gum points as compared to other tested insecticides on plum trees trunks

Medical Entomology

Up gradation of medical entomology laboratory

Due to current scenario of Dengue epidemics in Pakistan, work on mosquito control was accelerated and expanded to the control of vectors of dengue viruses in KPK/Pakistan. As per instructions of PAEC Member Science and DG. Agric. & Biotech., the Medical Entomology laboratory of NIFA was up graded and made environmentally controlled and more secure for work on Dengue vector Aedes mosquitoes.

Artificial blood feeding of female mosquitoes

Blood feeding of female mosquitoes plays vital role in the rearing of mosquitoes. Blood feeding of female mosquitoes was shifted from feeding on live rabbit to artificial blood feeding through a membrane. A very simple device was designed and fabricated at very lo cost (Rs. 3000/- compared to Rs. 120,000 in the market) at the NIFA workshop for artificial blood feeding and automatic temperature control system for maintaining blood temperature equal to the human body temperature (37 ^{0}C). The blood feeding device is under trial for comparison with feeding from live animals.

Study on oils as mosquito larvicides

Oils in water stop mosquito's respiration causing larvae suffocation. Use of kerosene oils in water for mosquito's larval control has been abandoned in water reservoirs due to their health and environmental hazards. Various oils of safe nature from plants; Cinnamon- Cinnamomum zeylanicum, Canola, Clove- Syzygium aromaticum, Eucalyptus- Eucalyptus grandis, pine resin essential oil (turpentine), Jamama- Eruca sativa, mustard oil Brassica Juncea, neem- Azadirachta indica, and kerosene oils were tested for their mortality on early 4th instar larvae of Culex quinquefasciatus mosquitoes. In a laboratory bioassay at 48 hrs post treatment, the LD 50 and LD 90 values were calculated using SPSS statistical program. LD 50 for these oils as recorded were; cinnamon 0.35 ppm, canola 0.69, clove 0.32 ppm, eucalyptus 0.065, Jamamma 2.45ppm, mustard 3.64, neem, 0.67ppm, turpentine 0.29, and kerosene 0.71pmm. The LD 90 values were 11.52, 6.57, 374.24, 11.26, 9,25, 154.0, 1.81, 1.11 and 0.72 ppm for cinnamon, canola, clove, eucalyptus, jammama, mustard, neem, turpentine and kerosene oils respectively. LC 90 values for neem and turpentine, oils were comparable to kerosene oil and were equally toxic to 4th instar larvae of mosquitoes. Based on these results, we recommend the use of environment friendly plant based oils as mosquito larvacides in Pakistan as a future strategy in the control of dengue and malaria vectors.

Termite Control

Leufenuron (Match®), an insect growth regulator reported to disrupt the molting process in insects was tested to see its potential as slow-acting toxicant against Heterotermes indicola. Less than 50% mortality was recorded over a time of three weeks in termites exposed to all the concentrations of Leufenuron (100-10,000 ppm). Even 26 days after exposure to 10, 000 ppm of Leufenuron, mortality was less than 80%. Projected ELT 50 and ELT 90 values showed not only much prolonged lethal times but also narrow range of values for lethal time (18-21 d and 27-32 d). Studies conducted to find the acceptability (or

deterrence) of different concentrations of Leufenuron indicated that 5000 ppm or more were deterrent to H .indicola indicated by a significant difference (using paired t-test) in consumption of treated and untreated blotting paper. Mortality data recorded after two weeks showed significant mortality only in treatment units containing the blotting papers treated with 10,000 ppm. Due to a low lethal rate at concentrations < 10,000 ppm and deterrence of termite feeding at concentration equal to or greater than 5000 ppm, Leufenuron does not seem to be an appropriate toxicant to be used in a bait.

Hexaflumuron, a chitin synthesis inhibitor, is used as a slow-acting toxicant against different species of subterranean termites. We tested a commercial formulation Kolfin ® containing Hexaflumuron against *H. indicola* at concentrations ranging from 100 to 10,000 ppm. All the concentrations below 10, 000 ppm showed a low mortality rate (less than 50%) of H. indicola. At the highest concentration used (10, 000 ppm) too, mortality did not reach 80%. Due to the fact that adjusted mortalities were low, it was not safe to project the values of ELT 90 using probit analysis. Studies done to detect the deterrence of Hexaflumuron at different concentrations indicated a significant reduction (indicated by paired t-test) in the consumption rate of treated blotting papers at concentrations exceeding 1000 ppm. Mortality data recorded after two weeks did not show a significant mortality except at the dose of 10,000 ppm where around 80% mortality was observed. But as a general rule when the dose causing a significant mortality is greater than the minimum deterrence threshold, the toxicant is not considered as good candidate to be used in a slow-acting toxicant bait.

Various concentrations (100, 500, 1000, 5000 and 10000 ppm) were tested to see its potential as a slow-acting toxicant. Under the tested concentrations, ELT 50 values ranged from 2.7 to 5.4 days while ELT 90 were 4.5 and 9.1 days for the lowest and highest concentrations used in the trial. Choice feeding tested showed that food treated with all the above concentrations was acceptable to termites. At a concentration of 10000 ppm boric acid resulted in 90% mortality within 2 weeks when both the treated and untreated substrates were offered to H. indicola.

Different matrices including small slices of poplar wood, poplar saw dust, blotting paper and blotting paper in combination with poplar slices were tested for their acceptability to termite feeding. Termites fed on the toxicant happily when treated blotting paper was offered in combination with wooden slices.

FOOD SCIENCE DIVISION

The overall focus of R&D in the Food Science Division is to devise ways and means to ensure food safety and security. Scientists in this division are working on value addition and shelf life extension of agricultural commodities through gamma radiation and other modern techniques. These efforts involve R & D for microbial safety, detoxification and new product development. Furthermore, commonly consumed diets are nutritionally enriched to overcome malnutrition and to meet requirements of special target groups. Healthy foods and healthy food habits are promoted through awareness programs.

Food Irradiation & Microbiology

Assessment of toxic metals in agricultural products and their relation with nutritional status in Khyber Pakhtunkhwa – Pakistan

A three years ALP/PARC project on "Assessment of Toxic Metals in Agricultural Products and their Relation with Nutritional Status in KPK – Pakistan" was successfully completed. As a case study, Peshawar, which is the capital of KPK and densely populated, was considered for the present work. Heavy metals were analyzed in different food crops, milk, meat and blood samples collected from different age group subjects such as children (1-12 years), adolescent (12-18 years), adults (18-45 years) and old age (above 45 and 55 years for males and females, respectively) from polluted and relatively less polluted areas. From the present study, it was concluded that consumption of contaminated food crops, meat and milk has significantly increased the concentrations of toxic heavy metals in human blood as compared to the control area, indicating that these food chains may be one of the major pathways of exposure and sources of contamination of human blood with metals.

Radiation services

A total number of 1722 samples of water/soil/seed/food samples received from PAEC agricultural organizations including NIFA, PINSTECH and KPK/Punjab universities and other research organizations were irradiated using Co-60 source recently installed at NIFA.

RCA Projects on Food Irradiation

NIFA actively participated in RCA/IAEA project (RAS/5/050) "Irradiation for enhancing phytosanitary treatment of regional products for export"and nominated by PAEC as NPC to RAS5/057 on "Implementing best practices of food irradiation for sanitary and phytosanitary purposes" during 2009 – 2011. Dr. Ihsanullah acted as National Project Counterpart (NPC) to the project.

On behalf of Pakistan, NIFA is also participating in a new IAEA/RCA project (RAS05/057 from 2012-14) on "Implementing Best Practices of Food Irradiation for SPS purposes''. The project has been started in March 2012 and Dr. Ihsanullah has been assigned duties as NPC to the project.

NIFA Organizes 1st International Symposium at Bangkok, Thailand

In collaboration with International Atomic Energy Agency (IAEA), NIFA organized 1st International Symposium on "Commercial Applications of Irradiation Technology for Food Safety, Security and Global Trade" at Thailand Institute of Nuclear Technology (TINT), Bangkok from February 20-24, 2012. Objective of the group activity was to train a core team of the trainees who would then be able to disseminate the acquired knowledge to the planner, academia, traders and entrepreneurs in order to popularize irradiation technology and to help overcome enormous post-harvest losses in the country and to boost the food trade from Pakistan. Dr. Ihsanullah, Head Food Science Division was the Chief Organizer. Ten participants from PAEC Agricultural Centers and PARAS (Lahore) attended the event.

Thirteen (13) specialized lectures on "Fresh Fruit Irradiation for Export and Global Trade of Irradiated Food" were delivered. The technical visits made for practical demonstration during the Symposium to various facilities included Thai Irradiation Center (TIC), TINT, Pathumthani; E-beam Irradiation Center, TINT, Ongkharak, Nakhon Nayok; Private Food Company with irradiated food products and Synergy Health (Thailand), Chonburi.

Installation of high dose Co-60 research irradiator at NIFA Peshawar

NIFA is the only institute in the country mandated with the use of radiation technology in food and other agricultural research areas. It started radiation research with a small research irradiator provided by IAEA in 1983. As a result of R&D carried out at NIFA, the country got the first commercial food irradiator "PARAS FOODS" at

Lahore. Additionally technology on Meal Ready to Eat (MRE) was perfected with incorporation of irradiation treatment. Presently Pakistan Army is producing thousands of packets of MRE, worth millions of rupees.

Due to passage of several half-lives, the old research irradiator is no more capable to support the institute's R&D activities on irradiation. Hence a new High Dose Co-60 Research Irradiator (ISOGAMMA LLCo) having an activity of 24,600 curies was purchased from Institute of Isotopes Co., Ltd. Hungary. In this context, experts from the Institute of Isotopes Co., Ltd. Hungary visited NIFA from 2-15 August 2012 for installation, commissioning and imparting training regarding operation of the High Dose Co-60 Research Irradiator.

It is expected that with the arrival and commissioning of the new radiation source the R&D activities of Food Science and other divisions will be strengthened and vistas for new scientific breakthroughs will be opened.

Development of irradiated diets for immunocompromised patients and other target groups

In continuation of the previous work, under IAEA CRP, No.15116, different special meals were prepared and categorized as main and auxiliary diets. The major ingredient in main meals was beans which are relatively rich in zinc, acting as an immune booster and chicken. Auxiliary meals prepared from fresh vegetables and chicken were served for change of taste. Chicken that are rich in zinc and other nutrients, were prepared in cooking oil with relatively high vitamin E contents. Vitamin C, which is an important nutrient and an effective antioxidant, was fortified by adding some herbal materials in the meals. The meals were packed under vacuum and irradiated with 8 kGy of gamma radiation for shelf life extension and lowering the bacterial load to safe limits. After complete microbiological, chemical and sensory evaluation of the diets, efficacy trial was conducted at Institute of Radiotherapy and Nuclear Medicines (IRNUM), Peshawar. Before starting the study, approval of Ethical Committee, patient's willingness and consent were obtained. Two group viz. brain tumor and breast cancer patients were selected for the efficacy study of irradiated diets for immunocompromised patients. The selected patients were in stage III of the disease. Each group consisted of sixteen members, who were further divided into two groups of eight patients each, one was control and the other was test group. The patients were served with a breakfast, a lunch and a dinner. The patients remained hospitalized during the entire study period of one month. Study design was randomized complete block.

Parameters such as physical data (weight studied), hematological data (hb, wbc, platelets, blood sugar ®, serum albumin, alanine transaminase, alkaline phosphates serum. urea) and psychological data (meal appearance, color, flavor, taste, acceptability, digestibility, stomach acidity, constipation, sleep, relaxation, feel freshness, mental stress, change in bowl habit, allergy) were studied at 0-day and after each week for one month

Results indicated that average body weight of both the test patient groups had significant increasing trend while decreasing trend in control groups. Hematological data was statistically non-significant. However, there was interesting trend in some of the hematological tested parameters. The Al. Phos. test results showed decreasing trend in test groups as compared to control groups. In case of brain tumor patients, increasing trends were observed with regard to ALT, HB and WBC, while in breast cancer patients, the HB of test group showed increasing trend.

In case of Hematological study, it was observed that in both the cases brain tumor and breast cancer patients, the effect of the neutropenic diet served for four weeks was non-significant. However, some trends of increase and decrease were noted in the hematological profile during the efficacy trial on both groups of patients. Alkaline Phosphatase level was increased from 114-136 and 117-154 units-liter in brain tumor and breast cancer patients respectively, while decreasing trend of this enzyme was noted in both the test groups 160-123 and 150-133 units-liter respectively. In case of white blood corpuscles (WBC), an encouraging trend was noted in both the test group patients. WBC in patient groups of brain tumor and breast cancer ranged from 7.94-9.69 & 5.05- 5.38 $x10^{9}$.$liter^{-1}$, respectively. Hemoglobin contents of both the patient groups ranged from 10.43 -10.85 in control and 11.20-12.73 in brain tumor patients, Similar trend was recorded in breast cancer patients. It can be concluded from the efficacy study that some good indicators were recorded in cancer patients after a month long consumption of the diets. It is hoped that consumption of the cancer diets for longer period may achieve more in reducing the hardship/recovery time of the patients as well.

Pesticide residues in vegetables

Pesticides applied to the vegetables are often persistent in foods and can enter human food

chain leading to acute and chronic health issues. Change in the pesticide chemistry is often parallel to the changing pattern of the pest problems. Pest resistance and introduction of new pests, make it essential to introduce new pesticides for effective pest management. Therefore, pesticide residue monitoring is necessary to understand the nature and magnitude of potentially hazardous contaminants in vegetables. The information is also useful for devising plans for management or remediation of the pesticides residues. Hence, the producers, consumers and exporters can benefit from the data generated during these studies.

Vegetable samples were collected from different retail, wholesale vegetable markets and farmer fields in and around Peshawar. The vegetable samples were collected in summer and winter season. The vegetables were processed using QuEChERS extraction and cleanup method. The extracts were analyzed for organochlorine, organophosphate, carbamate and pyrethroid pesticide residues by gas chromatography with electron capture detection (GC-ECD).

The pesticide compounds had a linear response (r^2 = 0.95) to calibration range from 0.6 - 300 $\mu g.kg^{-1}$ with the limit of detection ranging from 1.0 – 3.4 $\mu g.kg^{-1}$ on GC-ECD. The winter vegetable samples were generally free from pesticide residues and only 10% sample were found contaminated with profenophos and cypermethrin residues that did not exceed maximum residue limits described by Codex Alimentarius Commission. The summer vegetables included tomato, okra, brinjal, bitter gourd and cucumber. Samples collected from market had comparatively low pesticide residue levels than those collected from the farmer field. Almost all the summer vegetable samples (100%) were found contaminated with pesticide residues and majority (53%) of them exceeded maximum residue limits (MRLs) (Figure 1). Okra samples had highest frequency (70%) and concentration of (> 1.2 $\mu g.kg^{-1}$), where > 50% samples exceeded MRLs. This was followed by 21% exceeding MRL in bitter gourd, 20% in cucumber, 9% in tomato and 7% in brinjal. The vegetable samples were predominantly contaminated with cypermethrin and profenophos residues. However, minor contamination of endosulfan and dimathoate were also found in bitter gourd and cucumber samples.

Nutrition & Food Engineering

Development of package of technology for poultry feed irradiation in Pakistan (PSF/NSLP/F-NIFA - 82)

The composition of poultry feed makes it a good medium for microbial growth. This can lead to poor biological performance of the consuming flocks, entailing in productivity as well as economic losses to the poultry farmers and ultimately to the

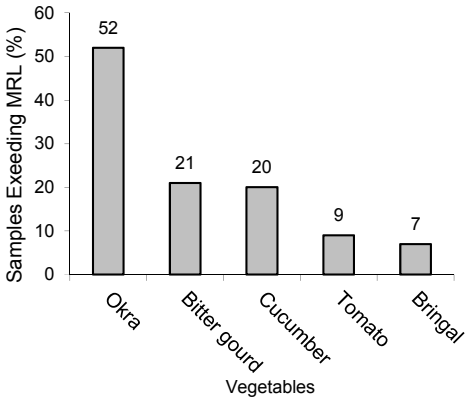


Fig. 1. Summer vegetable sample (%) exceeding MRL.

poultry industry in the country. As a cool process, gamma rradiation can be applied to inactivate spoilage and disease causing microorganisms of poultry feeds. There is a need to conduct industrial level application studies on adopting this technological intervention for better feed provision system. First year's work of the current project was aimed at studying the influence of gamma irradiation and storage on the microbial load and biochemical quality of poultry feed packed in different packaging materials.

Experimental antibiotic-free broiler feed was prepared in SB Feed Mills, Mandra and packed in polypropylene woven + polyethylene (2 layered) bags, polyethylene + cardboard cartons or polypropylene woven bags. The samples were irradiated at 5 kGy dose at Pakistan Radiation Services (PARAS) Lahore. All the samples were then transported to NIFA Peshawar for storage under commercial poultry farm conditions and were subjected to biochemical and microbiological analysis in the beginning and at 3 monthly intervals subsequently.

Results indicated that all parameters were significantly influenced to various extents by radiation treatment, packing type and storage. Moisture content of the experimental feed samples was influenced (P≤ 0.05) by all the three factors. It increased with storage time, more so in irradiated samples than in their respective

controls. Protein solubility in 0.5 M KOH in all the samples was influenced by packaging material ($P<0.01$), radiation treatment and their interaction ($P<0.05$). Nevertheless the packing PP+PE gave the highest average values both in control as well as treated samples. None of the factors brought in some significant changes in peroxide value of oil. Irradiation reduced the bacterial load of the samples. The fungal counts of all the control as well as irradiated samples was zero in the beginning, indicating a high biosafety at the mill. However, the counts increased during storage ($P<0.05$). The average phytic acid contents of all the samples ranged between 1.04 to 1.98%. However, within this narrow range the influence of irradiation, storage and their interaction was significant ($P<0.01$). Irradiation treatment increased the Fe, Na and K solubilities but for P a reverse trend was noted.

Rapid Test Kit (RTK) for spot testing of iodine contents in table salt:

On request of the Universal Salt Iodization/Iodine Deficiency Disorder USI/IDD Programme of Pakistan, a Rapid Test Kit was developed for spot testing of iodized salt in the market, production unit and at household level by the housewives. The kits so developed were provided in bulk quantity (41,000 kits) to the national USI/IDD Programme in two batches of 16000 kits (@ 62/- per kit) and 25000 kits (@ Rs. 72/- per kit).

Fortification of commonly consumed edible oils with non conventional oil

Vegetable oil is an important diet component. But some vegetable oils are not up to standards to meet consumer satisfaction. To improve the nutritional quality of commonly consumed edible oil, blending of oil with economical indigenous oil sources seems to be the only possible solution to meet the WHO recommendation. *Silybum marianum* oil (SMO) has lot of potential to fortify it in vegetable oils to improve their nutritional qualities as a rich source of essential fatty acids, sterols and tocopherols etc.

The crude test oil was refined; the quality indices of crude and refined oils were determined accordingly and blended as 20%, 40%, 60%, 80% w/w with Canola oil (CO) and sunflower oil (SFO). Stability of blends was determined under various stressed conditions i.e. ambient, fluorescent and sunlight for 04 months. The peroxide value (POV)) is considerd a quality indicator to measure the stability. The results are presented in Fig-1 & 2. Maximum increase in POV of both samples was observed stored under sunlight. The SMO: CO/SFO (60:40), blends exhibited greater stability under all the test condition than other blends. The results regarding β-carotene and vitamin E (tocopherols) are shown in Fig. 3 & 4. The data indicated a significant improvement in Vitamin E and β-carotene collectively known as biological antioxidants and possesses lot of health benefits, and act as free radical scavengers and impart oxidative stability.

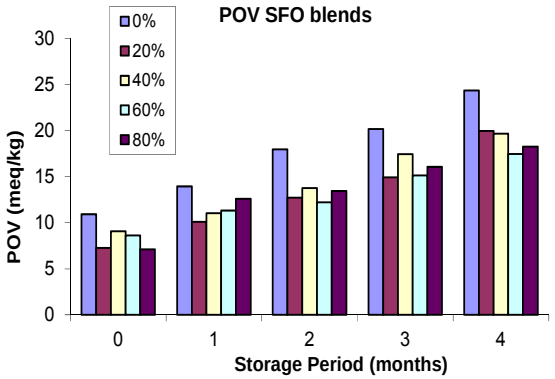


Fig. 1. Effect of blending on peroxide value of SFO

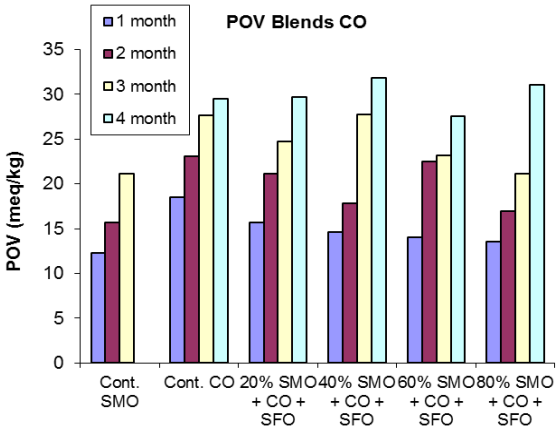


Fig. 2. Effect of blending on peroxide value of CO

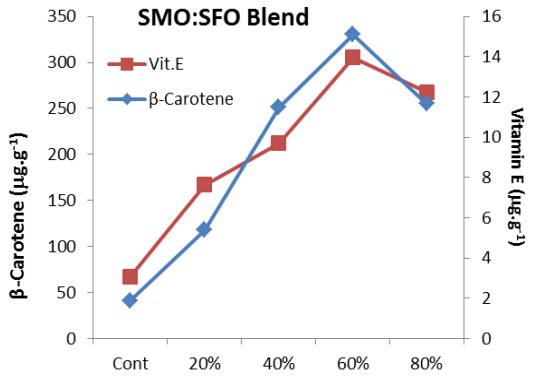


Fig 3. Effect of blending on vitamin concentration of SFO.

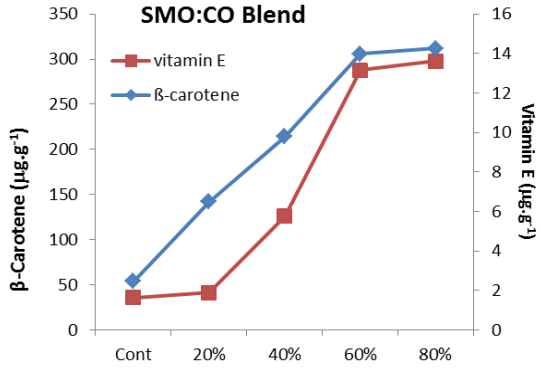


Fig. 4. Effect of blending on vitamin concentration of CO

Fats SMO, SFO and CO were used for repeated deep frying of potato fillets for 4 consecutive days for 20 minutes each day at 190-200 ^{o}C and then allowed to cool for 18 hours. This practice was repeated for 10 times. The tested oils were evaluated for physical & chemical deterioration. Quality index peroxide value (POV) of the samples was measured. Changes in peroxide value of test oils are shown in Fig. 5 & 6. Highest increase in POV was found in SFO and CO control. The highest stability during thermal process was observed in SMO: SFO (60:40) blend. Similar trend was observed in same blend of CO. The rate of oxidation was generally higher in polyunsaturates but SMO due to the presence of high levels of carotenoids & vitamin E (that primarily act as natural antioxidants) makes the blends less prone to oxidation, maintains its flavor longer and most suitable for frying purposes than control.

Blending is a good choice to manufacture edible oils of good characteristics and ensure their quality. The study resulted in the production of innovative, economically viable blends, with maximum nutrition as well as desirable physico-chemical properties. The use of blended oil would decrease the health related problems and would fulfill the body nutritional needs. The execution of the project would result in motivation for exploitation of non-conventional sources. Technology developed could be transferred to relevant end users and stake holders.

Development of Nutri-Biscuits

Enrichment of cereal-based foods with some non-conventional source of protein, fiber, and micronutrients has received considerable attention. The production of value added and nutrient enriched food products is need of the day. Some cereals anciently used by public (barley, oat etc.), agro waste (fruit peel, pomace) and some other non-conventional sources contain significant amounts of bioactive compounds, micronutrients

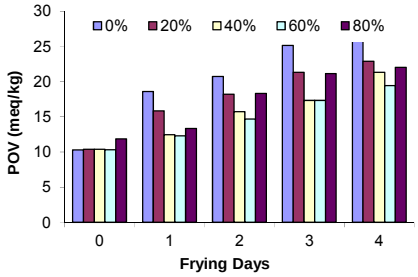


Fig. 5. Effect of frying time on POV of fried CO blends

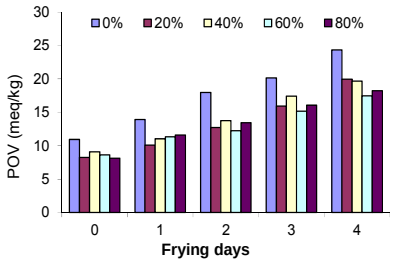


Fig. 6. Effect of frying time on POV of fried SFO Blends

and flavonoids imparting them considerable nutritional value. They have ability as free radicals scavenger and prevent lipid peroxidation, leading to many degenerative diseases.

Oat, barley and *Silybum marianum* was grown at NIFA experimental farm, fine wheat flour, was purchased from market. Barley and Silybum seeds were grinded to flour. Wheat, *Silybum marianum*, oat and barley flour were blended for the formulation in the ratios given in Table 1, sugar and ghee or oil was mixed thoroughly, baking powder were added and the ingredients were blended in a mixer and kneaded. The dough was then shaped into biscuits and baked in laboratory oven at 180°C for 25 min, cool down and stored in a polypropylene container.

Table 1. Formulation (g.100g^{-1}) of Test Biscuits

Sample	Wheat	Silybum	Oat
A	100	-	-
B	70	20	10
C	50	30	20
D	30	40	30

Proximate composition of the formulations were analyzed using AOAC standard methods. Sensory attributes (color, texture, taste, odor and general acceptance) using five point hedonic scale involving trained judges were evaluated.

Results of proximate composition of the biscuits prepared with various composite flours are presented in Figure 1. The data revealed a significant increase in protein content of the biscuits ranging from 7.9% (A) to 17.8 (D). Similar tendency of increase in fiber content was also noted 1.8 (A) to (5.67)

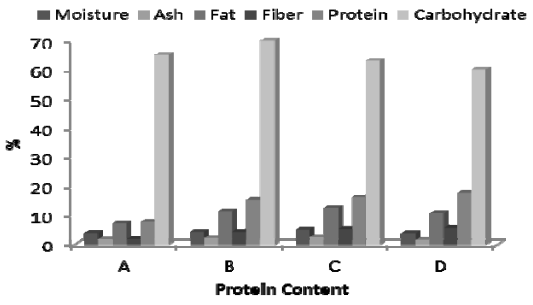
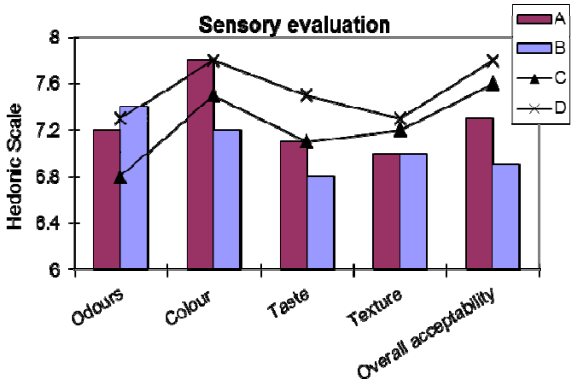


Fig. 1. Proximate composition of supplemented Biscuits

The samples were evaluated for color, taste, flavor, texture and overall acceptability. The results are shown in Figure 2. Sensory characteristics of sample C and D were most preferred as compared other samples.



The mentioned sources contain large amounts of micro/macro nutrients and health providing natural antioxidants that can reduce the risk of chronic diseases. It has been reported that these specific properties of dietary fiber play an important role in the prevention and treatment of obesity, atherosclerosis, coronary heart diseases, colorectal cancer and diabetes.

Development of low cost weaning food formulations

Balance nutrition is very much important in general and specially for infants or early childhood, for the development and full human potential. Many weaning foods mixes are nowadays available in supermarkets being used by majority of elite population but they are out of reach of majority belonging to the lower socio-economic strata.

The need for weaning foods to feed babies from six months to two years old is now being met through commercially produced weaning foods prepared by extrusion or roller-drying processes. Weaning foods thus prepared are excellent products and meet the nutritional requirements of the infant in both developed and developing countries. However, the products as marketed are too expensive for the target groups who need such a product in developing countries. It is therefore, desirable to study ways and means of developing less costly but equally nutritious weaning foods that may be within the reach of the wider population. The basic bulk raw materials for developing such foods should be locally available staple cereals and legumes.. The process or technology for production should not be sophisticated and should be highly adaptable.

Whole Wheat flour, Green gram, Groundnut, Maize, Lentil and Sugar were purchased from the local market. The test material was sorted to remove dirt, dust and any foreign particle and stored properly. Food formulation based on

germination and roasting is presented in Table 2. All germinated/ ungerminated and roasted ingredients were dried at 60^0C and grinded. The flours were thoroughly mixed and homogenized hygienically. Developed formula was subjected for proximate analysis, acceptability and stability.

Fig. 2. Sensoric characteristics of test biscuits

Table 1. Foods formulation of complementary diet.

Formulation	Wheat(g)		Mungbean (g)		Maize (g)	Lentil (g)	Ground nut(g)	Sugar (g)
	Sprouted	unsprouted	Sprouted	unsprouted				
F1	-	100	-	30			20	50
F 2		60		25			15	20
F 3	100		50					50
F4					100	30	20	50

Proximate composition of the test formulation is shown in Fig-1. Result revealed that maximum increase in protein and fiber was observed in F_2 formulation (Wheat, roasted Mungbean and Groundnut). While maximum iron contents was found in F_{f4} formulation (Sprouted wheat and sprouted Mungbean), the possible explanation for the reason is that sprouting reduce the phytic acid concentration and increase the iron availability.

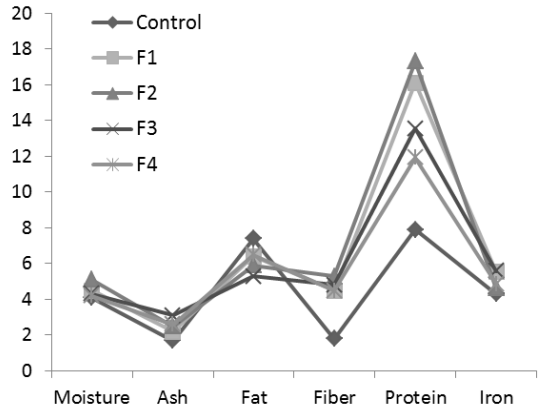


Fig. 1. Proximate composition of weaning Formula

Sensory evaluation was carried out to select the most acceptable diet from each of the four formulations. The gruels prepared for this purpose were made with a standardized recipe using 15 g of the mix per 100 ml of water,

The results of sensory evaluation are presented in Figure 2 .The results revealed that highest scores for all the sensory parameters was noted in F_2 formulation followed by F_3 and F_1. The overall acceptability of F_2 was at par with control.

Countries like Pakistan where hidden hunger is widely prevailing, efforts have been made to develop low-cost weaning foods that can be prepared by simple technology, socially accepted and easily adaptable.

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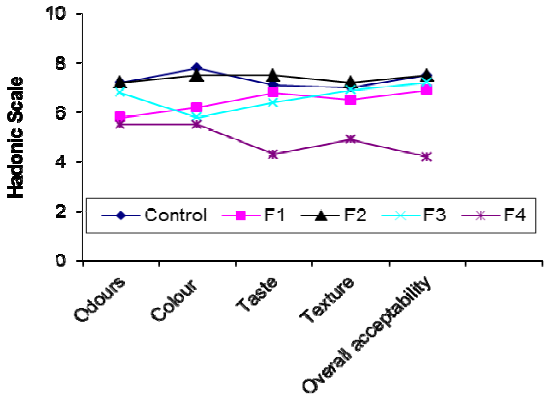

Fig. 2. Sensory evaluation of weaning formula

Extraction and storage stability of antioxidant content from fruits/vegetables and their products

Selection of proper solvent for maximum extraction of antioxidant content

There has been growing interest in food components which may inhibit or interrupt the oxidation process and are capable of counterbalancing free radical activities that cause cell injuries. To extract maximum content from antioxidant rich fruits and vegetables, a study on screening of different solvents was conducted for extraction of apple antioxidants.

Apple was purchased from local market followed by washing, cutting, extract preparation with different solvents (water, methanol, acidic methanol (1% HCl), methanol: water (1:1), acetone, acidic acetone (1% HCl), acetone: water (1:1) followed by periodic assay of major antioxidants (Total phenol, Total flavonoids, Total flavonol, and Total reducing power) for estimation of solvent with maximum extraction. The data reveled that total phenol content (catechin equivalent) were 50.54, 55.76, 54.94, 51.84, 125.14, 120.36 and 74.90 $mg.kg^{-1}$ for water, methanol, acidic methanol (1% HCl), methanol: water (1:1), acetone, acidic acetone (1% HCl), acetone : water (1:1) extracts respectively. The assayed flavonol content was 33.28, 71.08, 74.84, 69.42, 229.69, 226.31 and 81.98 $mg.kg^{-1}$ for water, methanol, acidic methanol (1% HCl), methanol: water (1:1), acetone, acidic acetone (1% HCl), acetone: water (1:1) extracts respectively. It can be inferred from the study that more useful extract for antioxidant content is acetone followed acidic acetone, acetone: water, methanol, acidic methanol and methanol: water with same order of reducing power 1.173, 1.17, 1.62, 1.16, 1.16, 1.16 and 1.15 ($mg.kg^{-1}$ of ascorbic acid equivalent).

Utilization of agro waste for their phenolic extracts: study of phenolic content of guava leaves at different growing stages

Agro waste (leaves, bark, stem and roots) are rich sources of antioxidants e.g. guava leaves and bark are rich in tannin (10% in the leaves on a dry weight basis, 11-30% in the bark).

Based on numerous evidences on the strong biological activity of phenolic compounds of fruits /vegetables and agro waste, the aim of the current study was extraction of antioxidants from agro waste (leaves, skin and seed) for further use in different food products. The study included preparation of aqueous extracts from guava leaves followed by periodic (monthly) assay of total phenol, total flavonoids, and total reducing power. Total phenols content (catechin equivalent) decreased from 65 $mg.kg^{-1}$ in January to 31 $mg.kg^{-1}$ in September during a nine months study. The total flavonoids content (quercetin equivalent) also decreased from 207 (young leaves) to 198 $mg.kg^{-1}$ with increase in leaf maturity. The data revealed that reducing power is positively correlated with total phenol and total flavonoids content. About 50% of the reducing power decreased during the studied period. The higher concentration of antioxidants and antioxidant activity in younger leaves as compared to older leaves may be due to changes of phenolic compounds and extractability with maturity.

Extrusion cooking

In order to develop a nutritious snack product for children, corn starch, sugar, chickpea flour, peanut flour and Sodium-bi-Carbonate formulation was prepared. The ingredients were dry mixed, ground and passed through a 40 mesh screen. Moisture content was adjusted to 20 and 30% in separate experiments. The extruder was run at 150 rpm and heating was provided through the extruder barrel. When the product temperature reached above 95 ^{o}C at the die, the extrudate expanded and came out as continuous rope. Although the product was expanded and cooked, its texture was very hard. Addition of cooking oil and liquid milk to the formulation improved its texture. Also an extrudate cutter with variable speed was developed and tested during extrusion cooking of rapeseed as a student's project. The rapeseed extrudate could be easily cut. Starch based extrudates were sticky and its cutting needed higher speed.

Canning of fruits and vegetables

Peach and diced tomato fruits were preserved in tin cans using thermal processing. The peach were canned in 20 and 30% sugar solutions while the diced tomatoes were canned in water. The canned products retained their texture and color during 12 months storage. No signs of spoilage or microbial contamination were detected. Organoleptic evaluation of peach slices after nearly 1 year of storage showed no loss of flavor or texture. All the slices had a shining yellow color immediately after opening the cans. However, the color began to fade afterwards. The peach canned in 30% sugar solution had a better taste.

Mushroom & Medicinal plant

Popularization of mushroom cultivation as cottage industry in Khyber Pakhtunkhwa

The outcome of a project should be gauged from the tangible impact it has created on the downtrodden communities. This should be a crystal clear performance indicator in countries, like Pakistan where on one hand the population is living below the poverty line and the budgetary allocation for Science and Technology is very low, on the other hand. In real sense we cannot afford to transform the meager allocations just on basic type of R&D or merely on projects which culminate on some reports or publications full of technical jargons which no body bother to read or fathom. In this backdrop, we were fortunate to have a PSF project on "Mushroom Cultivation" which is continuously spreading the light of

information and technical skills to make the poor communities of the country financially empowered, including both male and female growers. Until now we have been able to train more than 1800 farmers and NIFA mushroom farm is gaining tremendous popularity among the growers. For the same reason unprecedented number of potential growers are approaching daily to acquire the know-how of mushroom cultivation. In the same pattern, NIFA mushroom team was lucky enough to competitively win a project from Directorate of Science and Technology (DoST) KPK recently to transfer the mushroom cultivation program to farmers of Swat and adjoining areas for popularization with the sole aim to improve their quality of life. In this regard out of 8 planned workshops on "Mushroom Cultivations", 1st spell of 4 workshops were held in the month of September in different Tehsils of mountainous Districts of Buner and Swat. These areas are highly conducive for the growth of this nutritious commodity requiring small inputs but yielding high economical outputs. A total of about 240 participants including notables, ulema, unemployed youth and farmers with small land holdings took part in the workshops. In charge NIFA Mushroom team apprized the participants about the salient achievements of PAEC in the fields of defense, power generation, industry, medicines and Biotech/Agriculture. Detailed theoretical and hands-on practical lectures on mushroom cultivation were delivered and model mushroom farms as a source of inspiration and for sustainable provision of spawn to the needy growers of the area were also established under the control of master trainer in each 4 locations. The feedbacks received from the participants were an overwhelming encouragement. They lauded the role of PAEC for significantly contributing in various techno-economic sectors of the country. They also spoke very high of NIFA to develop a low cost technology aiming to overcome the widely prevalent malnutrition problems in the area with added bonus of substantially increasing the take home income of the poor communities. They appreciated the role of DoST in sponsoring such type of Technology Transfer Programs in the northern regions of the country which have a direct and practical impact on the livelihood of the down trodden strata of society.

Proximate composition, phytochemical profile and free radical scavenging activity of radiation processed *Emblica Officinalis*

Emblica Officinalis Gaertn is among the widely used medicinal plants throughout the world. It belongs to family Euphorbiaceae. The specie is found in Pakistan, Bangladesh, India, Sri Lanka, China and Malaysia. In Pakistan it is known as amla and amlaki. It has small, fleshy and edible fruits. The fruits have astringent, sour and bitter taste. These are extensively used in pickles, chutneys, jams, jellies, vinegar and juices. The fruits are useful for the treatment of diabetes, cough, asthma, bronchitis, cephalalgia, ophthalmopathy, dyspepsia, colic, flatulence, peptic ulcer, erysipelas, leprosy, inflammations, dizziness, anemia, emaciation, hepatopathy, jaundice, strangury, diarrhea, dysentery, hemorrhages, leucorrhoea, menorrhagia, cardiac disorders, intermittent fevers and greyness of hair. Scientific investigation on the plant showed a wide spectrum of biologically active compounds like alkaloids, phenolics, saponins, glycosides, steroids, lignans, resins, tannins, flavonoids and vitamin C.

The present study also showed that radiation treatment up to the dose level of 12 kGy showed increase in the levels of phenolics and flavonoids (Table 1).

No effect of irradiation was observed on the concentrations of saponins and alkaloids. Tannin content remained unaffected at low doses. Gamma irradiation enhanced the DPPH scavenging activity and extraction yields of the methanol and aqueous extracts of treated samples (Fig. 1 and 2). The data suggest that gamma irradiation up to 12 kGy could safely be used to sanitize the *Emblica Officinalis* fruits and it may also be beneficial for enhancing certain biological activities and phytochemicals.

Table 1. Effect of different doses of gamma irradiation on the phytochemicals of *Emblica Officinalis*

Phyto-chemicals	Radiation doses (kGy)				
	Control	3	6	9	12
Phenolic	193.7 ±7.0a	215.7 ±5.7b	213.7 ±1.5b	228.3 ±3.1c	236.0 ±0.0d
Tannins	199.0 ±6.6a	203.0 ±4.0a	207.0 ±7.2a	207.3 ±3.2a	221.7 ±2.1b
Saponin	0.4 ±0.0 a	0.4 ±0.1 a	0.4 ±0.0 a	0.5 ±0.0 a	0.5 ±0.0 a
Flavonoid	30.0 ±2.6a	33.2 ±1.5a	38.6 ±0.6b	43.1 ±1.5c	47.8 ±1.2d
Alkaloids	3.5 ±0.2a	3.6 ±0.3a	3.8 ±0.1a	3.7 ±0.1a	3.8 ±0.2a

The values are means ± standard deviations of three determinations. Means with different letters within the same row are significantly different ($p < 0.05$).

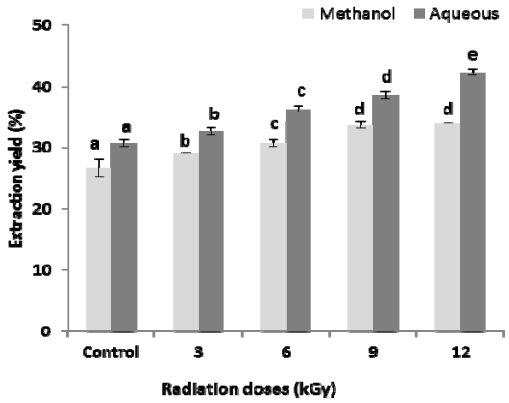

Fig. 1. Effect of different doses of gamma radiation on the extraction yields of *Emblica Officinalis* fruit.

Values are means of triplicate determinations (n=3) ± standard deviations. The vertical bars represent the standard deviation for each data point. Values with different superscript letters are significantly different ($p < 0.05$).

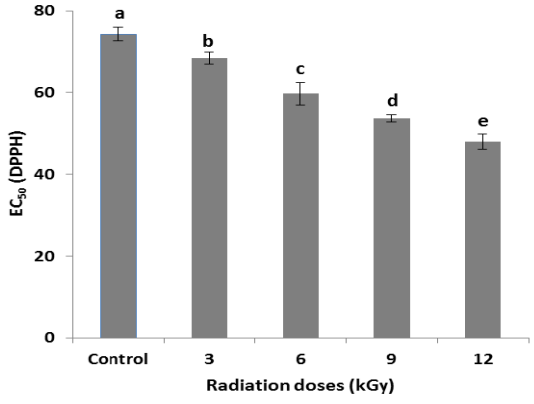

Fig. 2. Effect of different doses of gamma radiation on the EC50 value (µg/ml) of the DPPH scavenging activity of *Emblica Officinalis* fruit.

Values are means of triplicate determinations (n=3) ± standard deviations. The vertical bars represent the standard deviation for each data point. Values with different superscript letters are significantly different ($p < 0.05$).

Microbial and biochemical studies of irradiated almond and peanuts/ ground nuts stored at different temperatures

Almond and Peanut are important dry nuts, are a rich source of minerals, fats and proteins. The kernels/seeds of these nuts are eaten fresh or as desert and are extensively used in confectionary and in preparation of milk. The oils of the nuts are used for pharmaceutical and cosmetic preparation.

The effect of combination treatment to extend shelf life of dry nuts stored at different temperatures has been studied. Microbial load has been found to grow on almond during marketing. There are reports where mold growth can be prevented through the use of antifungal agents such as propionic acid and sodium hypochloride, as well as irradiation and sealing in under normal/vacuum condition. Refrigeration of shell and un-shelled nuts is used to maintain the quality of kernels from the time of harvest until distribution to food processors and retailers. Refrigerated storage can retard molding, kernel quality can be maintained when stored at refrigeration and freezing temperature.

Different treatments with respect to irradiation doses and packaging were tested to extend the shelf life of whole nuts and their products. So the project was planned to determine the fungal infestation percentage, total fungal counts and biochemical changes such as moisture %, free fatty acid % and oxidative rancidity meq.kg^{-1} of the irradiated samples (5 kGy) incubated at different temperatures.

The combination treatment resulted is the improvement of overall quality and hence the acceptability of dry fruits. The good and proper

packaged and subsequently stored samples of dry fruits maintained their nutritional quality. Temperatures played a major role microbiologically and biochemically. A decrease was observed in microbiological parameters that is total fungal count and fungal infestation %age in irradiated samples with the advancement of storage time. Combined treatment i.e. radiation and temperature caused no adverse biochemical effects except a slight increase in free fatty acid, oxidative rancidity and slight increase in moisture content during storage. Higher radiation dose 5 KGy and low temperature 5oC the viable fungi decreased considerably. The storage at low temperature is recommended inhibiting spoilage in the samples after irradiation treatment. The Percent Kernel infestation was increased progressively with increase in temperature (ambient temperature). The control samples stored at ambient temperatures showed more infestation then the treated ones.

It was concluded that the combination treatment indicated improvement in overall quality and hence the acceptability of proper packed dry nuts during storage to maintain their nutritional quality and extended its shelf life up to 2 years safe storage and founded wholesome/ fit for human consumption.

SOIL SCIENCE DIVISION

The proper management and conservation of natural resources (soil and water) with a view to maximize their use efficiencies are needed for sustainable increase in crop productivity and environmental protection. Improving soil productivity for sustainable agricultural production requires special attention not only to avoid nutrients mining but also to promote soil conservation measures. These measures mitigate the land degradation and enhance the accumulation of soil organic matter (SOM) which act as a store house of nutrients for plant growth and enhances both soil quality and water storage capacity. The major thrust of soil science division is to devise strategies to combat low soil fertility menace, soil degradation, plant nutrition and water conservation by elevating SOM content in soil and by selecting nutrients/water efficient varieties. Several goal oriented research projects have been initiated to enhance crop production, improve nutrients/water use efficiency and soil health. Soil Science Division is also a helping the breeders of NIFA by evaluating nutritional requirements and providing fertilizer recommendations for new crop varieties.

Plant Nutrition Group

Enhancing stone fruits (peach, plum and apricot) orchards productivity through integrated nutrients (NPK) management (ALP-CS-306)

The reasons for poor yield and early decline of the deciduous fruits orchards may be many but improper and imbalanced nutrients and water management is one of the major causes. These fruit orchards need careful consideration to maintain a proper balance between various elements in fruit tree nutrition. Deficiency or excess of one or more nutrient(s) result in an imbalance, which indirectly affect yield, quality and age of orchards. Poor health, attack of insect pests, less formation of fruit buds, flower shedding, fruit drop, alternate bearing, early decline of deciduous fruit orchards, low yield and quality also dependent on balanced nutrition. In order to overcome these problems systematic work was initiated at this Institute aiming to increase the production and quality of fruit. For this purpose six orchards two each of plum, peaches and apricot of different farming communities were selected at Peshawar and Nowshera district (KPK province). Nitrogen, PK and FYM were applied in different combinations along with control. Half of N and all the PK and Zinc (@ 100 g per tree) were applied at about half meter away from tree trunk and between the drip lines after fruit picking in mid-summer each year. Farm Yard Manure and half of the nitrogen were applied in dormant season. Eight treatments of NPK/tree comprising of i) control, ii) 0.75-0.5-0, iii) 1.0-0.5-0, iv) 0.5-0.5-0.5, v) 0.75-0.75-0.5, vi) 1.0-0.75-0.5, vii) 0.75(75% mineral N & 25% FYM) -0.5-0.5, viii) 1.0 (75% mineral N & 25% FYM) -0.5-0.5+FYM) with three replications and two tress per treatment. In this way 48 trees of uniform size, age and vigor were selected in each orchard.

Yield: The results showed that integrated nutrient management significantly improved the yield of peach orchards, the mean yield of two sites increased from 53.5 kg.tree^{-1}to 133.5 kg.tree^{-1}in different treatments during the period of study. Although the pattern of yield increase was different each year, integration of NPK and FYM improved the yield significantly. Yield of apricot increased from 38.2 to 191.9 kg.tree^{-1} due to proper nutrient management ending in double yield in each treatment except control at completion of the project (three years). The yield of plum was very low due to high temperature during the 1st year of study and was negligible to note however, it was improved from 33.3 to 149.7 kg.tree^{-1} for rest of the period. The fruit harvest of apricot was also doubled in balanced and integrated NPK and FYM treatments.

Soil analysis: The soil analysis (0-30cm) indicated that soil organic matter (SOM) content in these orchards soils significantly improved compared to the pre experimental treatment analysis. In peach orchard, the mean SOM of two sites increased from 0.93 to 2.03% during course of study. Similar improvement in other orchards under study was also found. At the completion of project, mean nitrogen concentrations in soil of peach, plum and apricot orchards ranged from 0.1 to 0.103%, phosphorus 12.3 to 20.5 mg kg^{-1}while potassium from 141.25 to 197.5 mg kg^{-1} ,respectively in the treatments receiving NPK + FYM. The concentrations of NPK in the soil profile before application of experimental treatments ranged from 0.025% to 0.06%, phosphorus ranged from 3.0 to 7.0 mg.kg^{-1}and potassium ranged from 50 to 160 mg.kg^{-1}, respectively.

Leaf analysis: The analysis of leaf indicated that nutritional status of fruit trees was improved by application of NPK and FYM. At the conclusion of the project, the N concentration in apricot leaves at 2.49 %, P at 0.31% and K at 3.1% for the treatments receiving NPK + FYM. Likewise, in peach leaves the N concentration of 2.69%, P

0.3% and K 3.1% was recorded. While NPK concentrations in leaf samples collected before the imposition of experimental treatments in peach, plum and apricot orchards ranged from 1.8 to 2.3 %, 0.1 to 0.13 % and 1.4 to 2.0% respectively. In general in all the above orchards (peach, plum and apricot) the integrated nutrients management improved the yield by reducing the fruit drop and improving quality.

Promotion of high tunnel farming with high efficiency irrigation and nutrient management system for growing off-season vegetables in rainfed area of Khyber Pakhtunkhwa

Growing of traditional crops with traditional methods of irrigation is common practice in KPK despite small land holdings and scarce water resources. Pakistan is already facing issues of food and these practices further intensify the problem of low food production. The adaptation of high efficiency irrigation system and tunnel farming using high quality certified seed may fulfill the food demand of ever increasing population. Growing of off-season vegetables in tunnels with high efficiency irrigation system in moisture deficit areas is an important sub sector of the agricultural economy of Pakistan and it has been declared as one of the priority areas of research sector by the Government.

Keeping the above problems in view, a project was initiated at NIFA to popularize the high tunnel farming having micro-drip or sprinkler system for growing off-seasons vegetables among the farming community. During 2012, the effect of integrated NPK and FYM treatments was studied on yield of hybrid tomatoes. The recommended rate of FYM was applied before transplanting nursery while NPK was applied after establishment of crop at different intervals. The first season hybrid tomato crop was successfully grown and demonstrated to farmers in a workshop held at NIFA on March 8, 2012. The yield data indicated that maximum fruit yield (100.5 $t.ha^{-1}$) was recorded in the treatments receiving NPK 80 N + 80 P_2O_5 + 90 K_2O $kg.ha^{-1}$ after 30 days interval starting from nursery transplantation till last picking. In another experiment, under walk-in-tunnel the same treatment with the addition of 5 kg $Zn.ha^{-1}$ gave a tomato yield of 121 $t.ha^{-1}$ which was higher than rest of the treatments.

Effect of organic amendments and NPK fertilizer on yield, nutrient use efficiency and soil fertility in tomato-potato cropping system

The significance of organic wastes application in enhancing soil organic matter and integrated nutrient management in sustainable production of potato and tomato along with treatments details have already been reported in NIFA annual report 2010-11. A field experiment was conducted for the second time during 2011-12 at NIFA Research Farm with the objectives to investigate the effect of organic wastes i.e. Farm Yard Manure (FYM), Sugar Industry waste (Filter cake), municipal solid waste (MSW), crop (potato/tomato) residues with and without NPK (mineral fertilizer) on potato/tomato yields, N-utilization and its effect on available N-pool in soil. All organic wastes were analyzed for total organic carbon and nitrogen. All the wastes were applied @ 3 t C ha^{-1} with full NPK (recommend-ed) and half NPK to potato and tomato crops. All wastes and full dose of PK + ½ N were applied before sowing and ½ N at earthing up time. The data showed that organic wastes improved the yield of both crops significantly compared to control. The integration of organic wastes i.e. FYM, Filter cake and MSW with mineral fertilizer further improved the yield of potato and tomato significantly. Maximum potato tuber yield (19.2 $t.ha^{-1}$) and tomato fruit yield (24.7 $t.ha^{-1}$) was recorded in treatment receiving MSW + half NPK compared to all other combinations. These results showed that half of the NPK fertilizer requirements of potato and tomato crop were fulfilled by the application of filter cake and municipal solid waste@ 3 t $C.ha^{-1}$.

Screening of advanced wheat genotypes for high yield and quality on low fertility soils

Soil fertility plays a vital role in crop production and it can be maintained either by enhancing organic matter in soil or by the application of mineral fertilizers which lead to higher crop production, improved nutritional status and quality. As the balance of fertilizer application for wheat production in KPK is in favor of N and P only, it has resulted in mining of micronutrients from soil. Intensive cropping, cultivation of micronutrient inefficient genotypes and flood irrigation system have also contributed in greater depletion of soil available micronutrients. The application of micronutrients fertilizers along with macronutrients in major cropping system may enhance production but it is not a sustainable strategy due to economic, environment and agronomic aspects. It is essential to find a sustainable, economical and environmental friendly solution for micronutrients deficiencies which can be the development of micronutrient-efficient genotypes. Such genotypes can be grown more efficiently on micronutrient deficient soil which would reduce fertilizer inputs and protect the environment.

Keeping in view the importance of wheat crop in food security of the country and role of micronutrients in yield and quality improvement, a pot experiment was conducted to identify micronutrient-efficient wheat genotypes that can be grown more efficiently on micronutrient deficient soil. Cultivation of such genotypes can reduce cost of micronutrients fertilizer inputs of wheat crop and protect the environment. Three advanced wheat genotypes (NRL- 0517, NRL-0707, NRL-0832) suitable for rainfed areas were obtained from the Plant Breeding & Genetic Division of NIFA and were sown on November 11, 2011 at research farm of NIFA. These lines were screened out under controlled moisture condition for response to Zn and B. The nutrients levels details are as follow: (1) Control (2) Zn at 5 kg.ha^{-1} (3) B at 1.0 kg.ha^{-1} (4) NPK at 120-90-60 kg.ha^{-1} (5) NPK + Zn (6) NPK + B. The experiment was conducted in CR design (factorial) and was replicated three times. The crop was harvested at maturity and data were recorded on yield and yield components. The grain and straw samples were analyzed for macro and micronutrients. Micronutrient efficiency was calculated as the ratio of yield (shoot dry matter or grain yield) produced under micronutrient deficiency (control) to yield produced with micronutrient fertilization (treatment),

The yield data showed that NRL- 0517 and NRL-0832 were found to be zinc and boron efficient wheat genotypes as these genotypes produced significantly higher biomass at micronutrients deficient levels as compared with third genotype (NRL-0707).

The results from pot experiments are only reliable when they have been tested under field conditions. So a field study was executed to confirm the results of previous year (2010-2011) pot experiment with the objective to identify micronutrient-efficient wheat genotypes that can be grown more efficiently on micronutrient deficient soils. The rates of fertilizer application and wheat genotypes were the same as for pot experiment. Among three wheat genotypes (CT 03457, CT 04192, NIFA-V15) tested for micronutrients efficiencies, CT 03457 and NIFA-V15 were found zinc and boron efficient genotypes. The recommendations about these genotypes were conveyed to plant breeding and genetic division for further testing to release the Zn and B efficient wheat variety for low fertility soils of KPK.

Effect of foliar application of urea, humic acid and micronutrients on potato crop

Field experiment was conducted during 2011-12 at research farm of NIFA to study the influence of foliar feeding on potato crop. The foliar applied nutrients were urea, humic acid, Zn, and B, which were applied alone and in combination with full and half NPK. There were eight treatments; 1). Control, 2). Full NPK soil App, 3). ½ NPK + H.A (0.03 %), 4). ½ NPK + urea (0.5%), 5). ½ NPK + Zn, 6). ½ NPK + B, 7). ½ NPK + Zn+ B, 8. ½ NPK + Zn+ B+ H.A (0.03 %). Potato variety cv. Aror was sown in RCB design with three replications in plot measuring 4 x 4.8 m^2. Distance between rows was 80 cm. The nutrients were sprayed at vegetative, flowering, tuber formation and ripening growth stages. The experiment was harvested at physiological maturity in January 2012. Result showed that maximum tuber yield (20.8 t.ha^{-1}) was obtained in treatment where half NPK + H.A (0.03%) were applied followed by the treatment where half NPK + Zn was applied (20.7 t.ha^{-1}). The percent increase in yield of these treatments over full dose of NPK was 4.35 % and 3.74 % respectively. Highest N-uptake (34.7 kg.ha^{-1}) and P-uptake (19.3 kg.ha^{-1}) were obtained in treatment where half NPK+ HA (0.03%) was applied, followed by the treatment where half NPK + Zn were applied. These results indicated that treatments where half NPK+ H.A 0.03% and half NPK + Zn were applied as foliar is economically beneficial for the farmers of the area.

Effect of various levels of NPK on yield of advanced wheat lines evaluated at NIFA

Fertilizer (NPK) requirements of advanced wheat lines (CT-04192 and NIFA-V15) developed at NIFA were determined in a field experiment during rabi 2011-12. The experiment was a factorial combination of three N (0, 70,140 kg.ha^{-1}applied as urea), two P (60, 90 kg.ha^{-1} applied as SSP) and two K rates (30, 60 kg.ha^{-1} applied as SOP) making 13 treatments per replicate including control. Row to row distance was 30 cm. The required quantities of P and K were applied at time of sowing and N was applied in three splits at sowing, with first irrigation and at booting stage. Experiment was executed in November, 2011 and harvested at physiological maturity in June 2012. The result showed that yield of both lines increased with increasing level of nitrogen up to 140 kg.ha^{-1}. The data showed that maximum grain yield (6717 kg.ha^{-1}) of wheat line CT-04192 was found in treatment where NPK was applied at rate of 140-60-30 kg.ha^{-1}respectively. In case of NIFA-V15, the maximum grain yield (5270 kg.ha^{-1}) was also found in the same treatment. Among these lines CT-04192 produced the higher grain yield than NIFA V-15. Nitrogen uptake (117 kg.ha^{-1}) and P uptake (30 kg.ha^{-1}) in wheat grain were also

higher in CT-04192 than NIFA V-15 when NPK applied at the rate of 140-60-30 kg.ha^{-1}. The performance of the wheat lines CT-04192 was better than NIFA-V15 when studied at NIFA experimental research farm.

Effect of boron application on oilseed brassica yield and quality

The experiment was conducted at NIFA experimental farm. Four varieties/advanced lines i.e. two from Napus group (Durr-e-NIFA and NH-975/2-4) and two from Juncea group (NIFA Raya and 7x1/05-4) were tested. The experiment was laid out according to split plot design, keeping varieties/lines in main plot and boron levels in sub plot. Recommended rates of NPK were applied to the entire experimental site at the time of sowing. Recommended cultural practices were adapted throughout the study. The treatments of boron were applied as foliar spray on crop in three splits at vegetative growth, flowering and pod formation stage. The treatments were (1) Control, (2) B at 100 g ha^{-1}, (3) B at 400 g ha^{-1}), (4) B at 700 g ha^{-1}), (5) B at 1000 g ha^{-1}), (6) B at 1300 g ha^{-1}and (7) B at 1600 g ha^{-1}. The trial was harvested in the last week of April, 2012 and after drying in field, the biological yield and grain yield of each plot were recorded. Plant height was recorded at the time of maturity before harvesting. The results showed that the height increased with the increase in boron application up to B 700 g ha^{-1} and then decreased with further increase in boron rates. The results also showed that grain yield of all genotypes increased by the application of B over control. The yield of NH-975/2-4 was increased by 34.4% over control followed by NIFA-Raya, (27%), Durr-e-NIFA (16.7%) & for 7x1/05-4 (11.8%) at 700 g B.ha^{-1}. There were no significant differences among other quality parameters such as % oil content, % protein, GSL (umol.g^{-1}) % moisture, % oleic acid, (%) lenolenic acid, % erucic acid for each genotype due to boron application.

Soil Biology/Biochemistry

Improvement in agro-waste compost and Bio-geyser

Three tons of compost were prepared from agro-waste of NIFA campus and experimental field in two piles. Two tons of this agro-waste compost were converted to a value-added product by suitable supplementations with rock phosphate, humic acid and other nutrients. Value addition was accomplished by spraying 0.5 % urea, 0.1 % humic acid solution and by addition of 2% rock phosphate on air dried weight basis. Effect of this value added compost was then investigated in field/pot experiments on vegetables.

Studies were conducted on the improvement of the design and efficiency of NIFA bio-geyser by replacing metallic water drums with brittle plastic drums (free of corrosion). Moreover the shape and look of the model bio-geyser (for demonstration in exhibitions) has been improved by modifying the shape of the geyser from rectangular to circular. Inbuilt thermometers showing the temperatures of both composting feed and water in the drums were also fixed. A case to make the geyser a patent was submitted to the patent office Karachi and has been registered vide No 332/2012 via IPO notification posted on 04-06-2012.

Applied and residual effect of agro-waste compost (ordinary and value added) and NPK on vegetables

In a field experiment the effect of ordinary and value added compost with and without NPK was studied. Seven treatments were replicated three times in RCB design. The treatments were i) control ii) NPK(recommended dose) iii) half NPK iv) 1% value added compost v) 1% ordinary compost vi) half NPK + 0.5% value added compost and vii) half NPK + 0.5% ordinary compost. A local cultivar of potato was used as a test crop. The study revealed that in case of freshly applied nutrients, highest tuber yield (8883 kg.ha^{-1}) was recorded in treatment receiving 1% value added compost followed by full dose of NPK (7767 kg.ha^{-1}) and 1 % ordinary compost (7600 kg.ha^{-1}). The increase over control was 74, 52 and 49 % respectively. The results of residual effect of compost applied to previous year tomato crop revealed that highest and similar tuber yield was recorded in treatments receiving 1% value added (6385kg.ha^{-1}) and 1% ordinary compost (6383 kg.ha^{-1}). The increase over control was 25 % in both cases.

Effect of compost tea on growth and yield parameters of Cauliflower

Compost tea is the popular term for an infusion where compost is steeped in water for a period of time with the aim of transferring soluble organic matter, beneficial micro-organisms and macro- and micro-nutrients into solution. The use of compost tea in organic agriculture is gaining popularity for improving soil biology and fertility. The concept of compost tea is relatively new and there are very few research reports documenting

its effectiveness. Research has shown that compost tea suppresses diseases in organic systems. Other benefits of compost tea are the stimulation of root and vegetative growth. Compost teas have been also found to increase crop yields and enhance quality. Keeping in view the above benefits, compost tea was prepared in laboratory both in aerobic condition (aerated tea, with aquarium pump) and anaerobic conditions (non-aerated tea). Effect of both types of tea was investigated in a field experiment using Pool Gobi (hybrid variety, RS-5340) as a test crop. Plot size was 9 m^2 and numbers of treatments were 5 with 3 replications in RCB design. The treatments were i) control, ii) NPK, iii) 1 % compost, iv) Aerobic tea and v) anaerobic tea. The study revealed that maximum fresh plant biomass (53.1 $t.ha^{-1}$) was recorded in treatment receiving anaerobic tea followed by NPK (51.7 $t.ha^{-1}$). The increase over control was 22.5 and 18.7%, respectively. In case of cabbage (inflorescence), maximum yield of 28.1 $t.ha^{-1}$was recorded in NPK treatment followed by treatment receiving anaerobic tea (26.6 $t.ha^{-1}$). The increase over control was 22 and 16 %, respectively.

Effect of humic acid on vegetables

Cauliflower: A pot experiment on the "effect of foliar application of humic acid on vegetables" was conducted during the period under report using cauliflower (hybrid variety RS-5340) as a test crop. Six treatments were applied with three replications in RCB design. The data revealed that maximum plant weight (343.3 $g.plant^{-1}$) and number of leaves (14.0 per $plant^{-1}$) were recorded in treatment receiving 0.05% coal base humic acid which is 47% and 10.6% higher than control respectively. Maximum flower head yield (176.6 $g.pot^{-1}$) and root weight (83.3 $g.pot^{-1}$) was recorded in treatment receiving half NPK + 0.05% peat based humic acid.

Potato: A field experiment on potato entitled "Response of potato plants to different rates of humic acid and NPK fertilization" was carried out. Six treatments were applied with three replications in RCB design. The data revealed that maximum tuber yield of 6.65 $t.ha^{-1}$ was recorded in treatment receiving half NPK + humic acid (10 $kg.ha^{-1}$ soil applied) followed by treatment receiving 10 $kg.ha^{-1}$ humic acid alone (soil applied) showing 28% and 12.6% increase over control, respectively.

Effect of organic amendments & NPK fertilizer on yield, nutrient/water use efficiency and soil fertility in irrigated wheat –maize cropping system

Research project entitled ''Effect of organic amendments and NPK fertilizer on yield, nutrient/water use efficiency and soil fertility in irrigated wheat - maize cropping system'' is in progress. The experiments were comprised of four organic wastes [Farm yard manure (FYM), Sugar industry waste (Filter cake), Municipal solid waste (MSW) and maize/ wheat crop residues)] alone and in combination with half and full NPK recommended doses. The results regarding wheat water use efficiency (WUE) indicated that all organic wastes (except maize residues) had almost similar effect on straw and grain WUE of wheat as NPK fertilizer. Among organic/inorganic sources, maximum grain WUE was obtained from NPK full dose (16.4 $kg.ha^{-1}mm^{-1}$) with 23.3 % increase over control. Integration of wastes with half and full dose of NPK improved the straw/ grain WUE. Filter cake integrated with full NPK resulted into maximum straw (45.2 $kg.ha^{-1}mm^{-1}$) and grain (17.3 $kg.ha^{-1}$ mm^{-1}) WUE.

After wheat harvest, maize was sown on July 22, 2011 on the same layout with the same treatments along with wheat residues. All organic wastes were applied @ 3 t $C.ha^{-1}$and NPK @ 140-90-60 $kg.ha^{-1}$. The results obtained so far showed that among organic wastes, maximum straw yield (16.2 $t.ha^{-1}$) was obtained by filter cake while minimum by wheat residues (13.6 $t.ha^{-1}$). Grain yield data revealed that filter cake and MSW alone increased the grain yield by 92.5 % and 80. 7 % over control. Solid waste materials integrated with half and full NPK enhanced the straw/grain yield. Highest maize straw (18.1 $t.ha^{-1}$) and grain yield (4.6 $t.ha^{-1}$) were obtained by filter cake along with full NPK dose.

SOCIO-ECONOMIC IMPACT

Plant Breeding and Genetics Division

NIFA wheat varieties have a yield advantage of 10-15% over the existing varieties. During the 2012 Rabi season, a total of 12.748 tons of Pre-Basic seed was supplied to Agricultural Extension Department and farming communities that were planted on 318 acres in KPK. This area is expected to produce about 500 tons worth nearly Rs.18.0 million in return to the growers. Proposed rapeseed variety NIFA Gold will help enhance domestic edible oil production that will help curtail expenditures on edible oil imports. Basic seed of chickpea variety NIFA-2005 was planted on 5 acres by Arid Zone Research Institute, D. I. Khan, and 30 and 5 acres by two progressive growers in D. I. Khan. They respectively, harvested 2500, 20,000 and 3200 kg certified seed for further multiplication. Twenty (20) kg breeder nucleus seed of NIFA-2005 was also produced at NIFA farm to maintain the purity of this variety. Breeding for disease resistance in wheat during 2012 aimed at targeted wheat disease development in different regions/cultivars, identifying effective genes, characterizing new sources of resistance, germplasm screening and enhancement of resistant sources.

Entomology Division

Adoption of the environment friendly MAT coupled with other IPM components will lead to the availability of pesticide and maggot infestation free fruit commodities in the market. Generic irradiation doses for citrus and mango pests that will lead to overcoming quarantine barriers to exports are being developed. More than 50,000 simple and economic traps for mass trapping of termite workers have been distributed throughout the province. Hundreds of farmers and Agricultural Extension staff have been trained on effective methods of management of subterranean termites. The timely treatment for the control of Peach flat-headed borer reduced the borer infestation and increased plum production at NIFA fruit orchards from Rs.0.59 million to 0.83 million. Trainings were imparted on basic management of honey bee colonies to Agric. Extension staff, unemployed rural youth, farmers and fruit orchard growers. Practice & adoption of this package of technology both by males and females will create a wide range of job opportunities. More than 250 participants from hospitals, researchers, entomologists, and biologists from universities and various R&D organizations were trained in the epidemiology, vector surveillance and clinical management of malaria and dengue diseases. NIFA Housefly bait for fly control was registered for patent. Its application will achieve a higher level of hygiene.

Soil Science Division

The improper management of natural resources (soil, water and nutrients) and imbalance application of mineral fertilizers are contributing significantly to low crop productivity in Pakistan. A package of optimum and economical level of fertilizer and integrated nutrient management practices for field (chickpea, rapeseed, wheat) and horticultural (orchards/vegetables) crops have been disseminated to the farmers. During the period two farmer's days were arranged by soil science division to benefit the farming community. The technology of agro waste composting with bio-geyser as a by- product was demonstrated to farmers at different locations at their fields in Khyber Pakhtunkhwa.

Food Science Division

An efficacy trial of the irradiated diets for immunocompromised patients was conducted in a joint study of NIFA and IRNUM. Earlier, protocols developed/standardized for meals ready to eat (MRE) at NIFA have been adopted by Pakistan Army for the commercial production of meals ready to eat. This venture has led to savings of millions of rupees annually. Nine (9) technical trainings on "Food Preservation" were organized for Field Assistants, house wives, farmers and other stakeholder. Under the public /private partnership activities on food products, 700 kg of tomato pulp was prepared @ Rs.10/Kg with the aim of starting small scale business by the entrepreneur. About 1240 individuals including women were trained on mushroom farming. New commercial mushroom farms have been opened in the vicinity of Peshawar. Medicinal and Aromatic Plants (MAP) section of FSD is in active collaboration with the public and private entrepreneurs to develop value added MAP products enabling the sector to boost the economy of about 35000 families involved in collection of 6000 plus MAP species in the province. On the request of the Universal Salt Iodization/Iodine Deficiency Disorder USI/IDD Programme of Pakistan, a Rapid Test Kit

was developed for spot testing of iodized salt in the market, production unit and at household level. This modified RTK has an edge of longer stability and better identification of the iodized salts than the existing kits in the market. In view of the need for the national programme on iron fortification of wheat flour, an instant test kit was developed for spot testing of fortified flour at mill, market or household level to assist the consumers in purchasing properly fortified wheat flour. A process was developed and optimized for decontaminating poultry feed using gamma radiation, substantiating the effectiveness of this physical process cost effectively and excluding the indiscriminate use of harmful chemical antibiotics in the poultry. The practical application of the process will lead to reduction of cost of poultry production on the one hand and reduction in economic loss incurred due to mortality and morbidity in poultry flock on the other. A laboratory size single screw extruder was designed and fabricated which is being used for extrusion of agricultural raw and semi processed ingredients into high value food, feed, and non-food products.

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Total Impact Factor of Publications during the Report Period = 13.123

FUNDED RESEARCH PROJECTS

S. No.	Title of the Project	Duration	Allocation	Principal Investigator
1.	Pak-US Wheat Productivity Enhancement Initiative. PAK-US.	2011-2013	$ 113,572	Mr. Tila Muhammad, CS
2.	Development of Wheat Mutants for Higher Yield and Improved Efficiency of Water and Nitrogen Use. IAEA.	2011-2014	€ 9,000 (PA)	Mr. Abdul Jabbar Khan, DCS
3.	Improvement of Stevia through induced mutations and in vitro somaclonal variations. PSF	2011-2014	Rs. 2.170 m	Mr. Shahid Akbar Khalil, SS
4.	Development of locally adapted canola (*Brassica napus* L.) F_1 hybrids using induced mutations and double haploidy techniques. PSF.	2012-2015	Rs. 2.463 m	Mr. Iftikhar Ali, DCS
5.	Breeding for Bruchids Resistance in Mungbean (*Vigna radiata* (L.) Wilczek). PSF.	2011-2014	Rs. 2.430 m	Dr. Gul Sanat Shah, PS
6.	Development of slow acting toxicant bait for elimination of underground colonies of crop and building termites PSF/ NSLP.	2010-2013	Rs. 2.4 m	Dr. Abid Farid, PS
7.	Development of standardized mass rearing system for male Anopheles mosquitoes used in SIT program. IAEA.	2005-2011	€ 35,000	Dr. Inamullah Khan, PS
8.	Use of Irradiation as Phytosanitary Treatment for the Control of *Citrus psyllids, Diaphoronia citri* and Scale Insects". IAEA.	2011-2012	€ 10,000 (PA)	Dr. Inamullah Khan, PS
9.	Integrated management of Peach Flat-headed borer, Sphenoptera dadkhani damaging trees of stone fruit orchards. PSF.	2011-2014	Rs. 1.9 m	Mr. Muhammad Zahid, SS
10.	Irradiation for Enhanced Sanitary and Phytosanitary Treatment of Regional Products for Export. RCA/IAEA.	2009-2011	-	Dr. Ihsanullah, DCS
11.	Best Practice for Phytosanitary Applications of Food Irradiation (RAS5057)	2012-2014	-	Dr. Ihsanullah, DCS

12.	Assessment of toxic metals in agricultural products and their relation with nutritional status in Pakistan. ALP/PARC No. CS-336	2008-2011	Rs. 2.920 m	Dr. Ihsanullah, DCS
13.	Development of package of technology for poultry feed irradiation in Pakistan. PSF.	2010-2013	Rs. 2.834 m	Dr. Aurang Zeb, DCS
14.	Development of irradiated foods for Immunocompromised patient and other potential target group. IAEA.	2010-2015	€ 35,500	Mr. Misal Khan, SS
15.	Design and Fabrication of a laboratory size single screw extruder for conversion of agro-based materials into value added food and feed products. PSF.	2007-2012	Rs. 0.718 m	Dr. Maazullah, PE
16.	Standardization of market life enhancement technology of persimmon and its dissemination to growers. ALP	2012-2015	Rs. 4.737 m	Ms. Nizakat Bibi, DCS
17.	Establishments of National Institute for Emerging Medicinal Plant Sciences & Technologies at Khyber Pakhtunkhwa. DoST.	2012-2013	Rs. 0.60 m	Dr. Khanzadi F. Khattak, PS
18.	Proposal for Human Resource Development Through Transfer of Technology “to Arrange Training Courses for “Mushroom Cultivation” In Various Zones of Khyber Pakhtunkhwa DoST.	2012-2013	Rs. 1.2 m	Mr. Fazal Mahmood, DCS
19.	Development of innovative Nutraceutical Products from Indigenous Herbal Ingredient for Improving Socio-economic status of Communities, PSF/NSLP/KP-NIFA	2012-2014	Rs. 3.9 m	Dr. Khanzadi F. Khattak, PS

SCIENTISTS /ADMINISTRATION

Manpower Position at NIFA

A. Scientists/Officers

S. No.	Officers	Sanctioned	In Position	Vacant	Total
1.	Scientists	48	46	02	48
2.	Engineer	01	01	-	01
3.	Non-technical	06	06	-	06
	Total	55	53	02	55

B. Staff (Technical/Non-technical)

S.No.	Staff	Sanctioned	In Position	Vacant	Total
1.	Scientific Staff	41	41	-	41
2.	Technical	16	14	02	16
3.	Non-technical	66	64	02	66
4.	Security & Chowkidars	24	24	-	24
	Total	147	143	04	147

C. Details of Present Scientific Strength

S.No.	Category	CS	DCS	PS	PE	SS	SRO	JS	ARO	Total
1.	Male	02	09	10	01	15	-	02	03	42
2.	Female	-	01	01	-	01	01	-	-	04
3.	Ph. Ds	-	04	06	01	04	-	-	-	-
4.	Abroad for Ph. D	-	-	-	-	02	-	02	-	-
	Total	02	10	11	01	16	01	02	03	46

D. List of Officers

	Name	Designation
I.	Mr. Tila Mohammad	CS/Director
II.	PLANT BREEDNG & GENETICS DIVISION	
	Mr. Syed Anwar Shah, M.Sc. (Agric)	CS/Head PBGD
	Mr. Abdul Jabbar Khan, M.Sc. (Botany)	DCS/Head TSD
	Mr. Iftikhar Ali, M.Sc. (Hons.) Agric.	DCS
	Dr. Syed Jawad Ahmad Shah, Ph.D. (Plant Pathology)	PS
	Mr. Roshan Zamir, M.Sc. (Hons.) Agric.	PS
	Dr. Gul Sanat Shah Khattak, Ph.D. (Botany)	PS
	Dr. Fazle Subhan, Ph.D. (Agronomy)	SS
	Dr. Muhammad Irfaq Khan, Ph.D. (Plant Breeding & Genetics)	SS
	Mr. Hafiz Munir Ahmad, M.Sc. (Hons.) Agric.	SS
	Mr. Muhammad Amin, M.Sc. (Statistics)	SS
	Mr. Farooq-i-Azam, M.Sc. (Hons.) Agric.	SS
	Mr. Shahid Akbar, M.Sc. (Hons.) Agric.	SS
	Mr. Muhammad Ibrahim, M.Sc. (Hons.) Agric.	SS
	Mr. Iqbal Saeed, M.Sc. (Hons.) Agric.	JS
	Mr. Syed Tariq Shah, M.Sc. (Hons.) Agric.	JS
	Mr. Akhtar Ali, M.Sc. (Hons. Agric.)	ARO
III.	FOOD SCIENCE DIVISION	
	Dr. Ihsanullah, Ph.D. (Chemistry)	DCS/Head
	Mr. Fazal Mahmood, M.Sc. (Chemistry)	DCS
	Dr. Aurang Zeb, Ph.D. (Nutrition)	DCS
	Mrs. Nizakat Bibi, M. Phil. (Physical Chemistry)	DCS
	Dr. Taufiq Ahmad, Ph.D. (Chemistry)	DCS
	Dr. Maazullah, Ph.D. (Agricultural Engineering)	PE
	Dr. Khanzadi Fatima Khattak, Ph.D. (Chemistry)	PS
	Mr. Misal Khan, M.Sc. (Hons.) Agric.	PS
	Dr. Azhar Rashid, Ph.D. (Biology)	PS
	Mrs. Tasnim Sharafat, M. Phil. (Microbiology)	SRO
	Mr. Zahid Mehmood, M.Sc. (Hons.) Agric.	SS
	Mr. Saeed Gul, B. Sc. (Chemistry)	ARO
	Mr. Tariq Nawaz, M. Sc. (Chemistry)	ARO

IV. ENTOMOLOGY DIVISION

Mr. Alam Zeb, M.Sc. (Hons.) Agric.	DCS/Head
Mr. Amanullah Khan, M.Sc. (Zoology)	PS
Dr. Abid Farid, Ph.D. (Entomology)	PS
Mr. Muhammad Zahid, M.Sc. (Hons.) Agric.	PS
Dr. Inamullah Khan, Ph.D. (Entomology)	PS
Mr. Misbahul Haq, M.Sc. (Hons.) Agric.	SS

V. SOIL SCIENCE DIVISION

Dr. Wisal Mohammad, Ph.D. (Soil and Envir. Science)	DCS/Head
Mr. Haider Khan, M.Sc. (Botany)	PS
Dr. Imtiaz Ahmad, Ph.D. (Soil Science)	PS
Mr. Mukhtiar Ali, M.Sc. (Hons.) Agric.	SS
Dr. Amir Raza, Ph.D. (Agric. Sciences)	SS
Dr. Syed Azam Shah, Ph.D. (Agronomy)	SS
Mr. Zahid Ali, M.Sc. (Hons.) Agric.	SS
Miss. Samreen Shahzadi, M.Sc. (Hons.) Agric.	SS
Mr. Parvez Khan, M.Sc. (Hons.) Agric.	SS

VI. ADMINISTRATION & ACCOUNTS

Mr. Latif Zaman, B.Sc. MBA (HRM)	Pr. Admin Officer
Mr. Muhammad Jamil, MBA	Accounts Officer
Mr. Riaz Hussain, M.A.	Sr. Admin Officer
Mr. Raufullah, M.L.I.Sc.	Sr. Librarian
Mr. Rashid Nawaz, MA (English), MBA (HRM)	Jr. Executive (Admin)
Mr. Wahid Gul, BA, LLB	Superintendent

PROMOTIONS/TRANSFERS/RETIREMENT

Promotions

S.No.	Name	From	To	On
1.	Mr. Syed Anwar Shah	DCS	CS	01-12-2012
2.	Mrs. Nizakat Bibi	PS	DCS	01-12-2012
3	Dr. Taufiq Ahmad	PS	DCS	01-12-2012
4.	Mr. Misal Khan	SS	PS	01-12-2012
5.	Dr. Inamullah Khan	SS	PS	01-12-2012
6.	Mr. Muhammad Zahid	SS	PS	01-12-2012
7.	Dr. Azhar Rashid	SS	PS	01-12-2012
8.	Mr. Raufullah	Librarian	Senior Librarian	01-12-2012
9.	Mr. Habib Khan	Asstt. Admin.	Sr. Asstt. Admin.	02-05-2012
10.	Mr. Athar Zia Siddiqi	Jr. Asstt. Admin-II	Jr. Asstt. Admin-I	02-05-2012
11.	Mr. Sher Alam	Jr. Asstt. Admin-II	Jr. Asstt. Admin-I	02-05-2012

Transfers/Posting

	Name	From	To	On
1.	Dr. Abus Sattar, DCS	NIFA, Peshawar	A.W.K Univ.	08-05-2012
2.	Mr. Hikmat Shah, Sec. Sold.-II	NMC-1, D.G. Khan	NIFA, Peshawar	21-05-2012
3.	Mr. S. Aurang Zeb, Sec. Sold-II	CENAR, Quetta	NIFA, Peshawar	10-05-2012
4.	Dr. Amir Raza, SS	NIA, Tandojam	NIFA, Peshawar	15-08-2012
5.	Mr. M. Yousaf, Sec. Sup.-IV	NIFA, Peshawar	CPC, D.G. Khan	31-08-2012
6.	Mr. Latif Khan, Sec. Sup.-IV	CPC, D.G. Khan	NIFA, Peshawar	26-09-2012
7.	Mr. Zafarullah, SA-IV	NIFA, Peshawar	BINOR, Bannu	31-10-2012
8.	Mr. Ajmal Shah, Stenographer	PAEC, H.Q. ID	NIFA, Peshawar	15-11-2012
9.	Mr. Abid Mehmood, Steno typist	NIFA, Peshawar	PAEC, H.Q. ID	15-11-2012
10.	Mr. M. Ilyas, Sec. Sold.-I	UML, Islamabad	NIFA, Peshawar	19-11-2012
11.	Mr. Mulk-e-Aman, Sec. Sold.-I	NIFA, Peshawar	CPC, D.G. Khan	30-11-2012

Retirement

	Name	Date
1.	Mr. Mehmood Shah, DCS	
2	Dr. Anwar Ahmad, PS	23-05-2012
3	Mr. Bukhari Shah, Sec Soldier-II	01-07-2012
4.	Mr. Shah Muhammad, Ch. Tech	01-08-2012

Abbr.: CS: Chief Scientist, DCS: Deputy Chief Scientist, PS: Principal Scientist, PE: Principal Engineer, SS: Senior Scientist, SRO: Senior Research Officer, JS: Junior Scientist, ARO: Assistant Research Officer, PSA: Principal Scientific Assistant, SSA: Senior Scientific Assistant, SA-I: Scientific Assistant-I, SA-II: Scientific Assistant–II, Pr. Tech.: Principal Technician, Sr. Tech.: Senior Technician, Tech-I: Technician-I, Tech-II: Technician-II, Jr. Asstt. Accts.: Junior Assistant Accounts; Adm. Asstt.: Administration Assistant

Nuclear Institute for Food and Agriculture (NIFA), Peshawar

Scientific Events Calendar 2012

Workshops | **Farmer's/Field Day** | **Trainings** | **Symposia**

http://www.nifa.org.pk

January

11-12 JAN
Two-day Workshop on Mushroom Cultivation (On separate days for Gents and Ladies)
Organizer: Food Science Division
Contact: *Mr. Fazal Mahmood, DCS*
Cell: 0301 8580108
E-mail: fazalmahmood@nifa.org.pk

25 JAN
One-day Training Workshop of Lab Technicians on Quantitative Analysis of Salt for Iodine Contents
Organizer: Food Science Division
Contact: *Dr. Aurang Zeb, DCS*
Cell: 0333 9014498
E-mail: drzebkhattak@gmail.com

February

15 FEB
Field Day on Agro-waste Composing with Biogeyser as a Bi-Product at Farmer Field (Swat)
Organizer: Soil Science Division
Contact: *Haider Khan, PS*
Cell: 0334-9138064
E-mail: haider_khan@nifa.org.pk

22-24 FEB
International Workshop on Commercial Applications of Irradiation Technology for Food Safety, Security and Global Trade, Bangkok, Thailand
Organizer: Food Science Division
Contact: *Dr. Ihsanullah, DCS / Head FSD*
Cell/phone: 0301-8580029, +92 91 2964796
E-mail: ihsanullahdrnifa@yahoo.com

March

8 MAR
Farmer's workshop on Tunnel Farming for Growing Off-season Vegetables
Organizer: Soil Science Division
Contact: *S. Mahmood Shah, DCS/Head SSD*
Dr. Wisal / Mohammad, DCS
Cell: 0301-8580898/0345-7666611
E-mail: wisalyasir@hotmail.com; mahmud_nifa@yahoo.co.in


Front View of NIFA Campus

March

15 MAR
Field Day on NIFA Developed Crop Varieties/ Other Technologies at Swabi
Organizer: Plant Breeding & Genetic Division
Contact: *S. Anwar Shah, DCS / Head PBGD*
Cell: 0301-8580070
Email: sashah53@yahoo.com

22 March
One-day Workshop on "Diagnosis and research methodology of wheat rusts"
Organizer: Plant Breeding & Genetic Division
Contact: *Dr. S. Jawad Ahmad Shah, PS*
Cell: 0333-9266447
Email: jawadshah@hotmail.com

April

18 -19 APR
Two-day Training on Honey bee Management
Organizer: Entomology Division
Contact: *Mr. Alamzeb, DCS / Head*
Cell: 0333-9407406
E-mail: alamzeb@nifa.org.pk

May

9-10 May
Two-day Training Workshop on the "Application of Tissue culture techniques in crop improvement"
Organizer: Plant Breeding & Genetic Division
Contact: *Mr. Roshan Zamir, PS*
Cell: 0301-8580109
E-mail: roshanzamir2004@yahoo.com

June

6 - 7 June
Two-day Workshop on Preparation of Value-added Fruits and Vegetable Products
Organizer: Food Science Division
Contact: *Mrs. Nizakat Bibi, PS*
Dr. Shaheen Atta, PS
Phone: 091 2964060-2 (Ext) 221
E-mail: nizakatbibi@yahoo.co.uk

July

4 JUL
One-day Training on Integrated Management of Crops and Building Termites
Organizer: Entomology Division
Contact: *Dr. Abdus Sattar, DCS*
Cell: 0333-9111335
E-mail: sattar_nifa@nifa.org.pk

September

25-27 September
Three-day Training Workshop on Field Layout and Statistical Data Analysis Techniques
Organizer: IT Cell / Plant Breeding & Genetic Div.
Contact: *Muhammad Amin, SS*
Mr. Iftikhar Ali, DCS
Cell: 0333 9156518,03339102990

October

3 - 4 OCT
Two-day workshop on Insect Pests of Medical Importance and their Control
Organizer: Entomology Division
Contact: *Dr. Inamullah Khan, SS*
Cell: 0334-9059180
E-mail: inamullah_nifa@yahoo.com

15 -19 OCT
Five-day Training Course on Spectroscopy and Atomic Absorption Spectrophotometry
Organizer: Soil Science Division
Contact: *Dr. Wisal Mohammad*
S. Mahmood Shah
Cell: 0345-7666611, 0301-8580898
E-mail: wisalyasir@hotmail.com; mahmud_nifa@yahoo.co.in

November

15 NOV
Nutrient Management of Field Crops
Organizer: Soil Science Division
Contact: *Mr. Mukhtiar Ali, SS*
Dr. Syed Azam Shah, SS
Cell: 0346-9072113
E-mail: mukhtiaraliswabi@yahoo.com azamsbpn@hotmail.com

December

12-13 DEC
1st Two-day Training on Water Quality for Plant & Human Health
Organizer: Food Science / Soil Science Division
Contact: *Mr. Misal Khan / Mr. Pervez Khan*
Cell: 0334-8807660/0333-9386824
E-mail: misalkhattak@yahoo.com Parvez08@yahoo.com


A View of NIFA Research Farm

Contact Information: *Fazal Mahmood*
Cell: 0301 8580108

Nuclear Institute for Food and Agriculture (NIFA), Peshawar, KPK
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NIFA in Pictures

NIFA Barsat Planted at Malik Seed Company Farms Mardan. 2012

Director NIFA Visits wheat varieties demonstration plots at Swabi

Training workshop on tissue culture techniques

Provincial Seed Council Technical committee visit for spot examination of NIFA Gold 2012

Oilseed brassica trials at NIFA, 2011-12

Hybridization in oilseed brassica at NIFA, 2011-12

High tunnel technology for growing of off season vergetables at NIFA

Micronutrients analysis on atomic absorption spectrophotometer in progress

Demonstration of NIFA bio-geyser at Asefal Bandai (Marghuzar) Swat

Artificial blood feeding device

Training workshop on honey beekeeping

Termites counting

Preparation of Rapid Iodine Test Kit (RTK)

Training workshop on field layout and statistical data analysis techniques

Training on food product development

Preparation of mushroom compost

Dr. S. Chongkum, Director and participants of symposium at TINT, Bangkok, Thiland

Hungarian experts visiting for installation of high dose research irradiator

Visit of DDG IAEA and Chairman PAEC to NIFA

Inauguration of High Dose Research Irradiator

Diginitories along with Director NIFA and Heads of Divisions

Visit to Biotechnology Lab

Visit to Entomology Lab

Visit to Tissue Culture Lab

NIFA Scientists along with Director

Plant Breeding and Genetic Division

Food Science Division

Entomology Division

Soil Science Division

Technical Services Division

Administration Section

Accounts Section

IT Cell

Director's Staff

Field Staff

Sanitary Field Staff

ISO 9001 : 2008 Certified

Nuclear Institute for Food & Agriculture

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