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NUCLEAR INSTITUTE FOR FOOD AND AGRICULTURE (NIFA)
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NIFA

Annual Report 2023

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NIFA ANNUAL REPORT 2023

PREFACE

Pakistan being a developing country is facing grave challenge of food insecurity. This challenge is intensified under rapidly changing climate, degradation of land & water resources and increased demand of food for meeting domestic requirements. It becomes more relevant for Khyber Pakhtunkhwa (KP) where up to 80% of the population is associated with agriculture or relevant industries. National food security is anticipated to become even more vulnerable due to increased incidence of climate change in the coming years. Addressing the food security concerns requires an integrated and articulate approach while keeping relevant stake-holders in loop. For the agriculture sector to perform better in a changing climate, a new approach in research and development is obligatory.

Nuclear Institute for Food and Agriculture (NIFA) is taking lead to address the issues faced by farming community of the province and at national level. Scientists at NIFA use integrated approaches that involve development and deployment of climate resilient crop varieties & technology packages, climate smart farming practices targeting enhancement in efficiency of water and fertilizers use, integrated pest management and value addition to the agricultural produce. NIFA is undertaking applied research on current and future challenges of the agriculture sector in the province of Khyber Pakhtunkhwa. NIFA is committed to achieve food security and ensure food safety through research and development (R&D) by nuclear and other contemporary advanced techniques in the areas of Food and Agriculture. The key activities and findings of applied research conducted by scientists of the institute are described in the preceding sections of the report.

PLANT BREEDING AND GENETICS DIVISION

Development and release of new high yielding, disease resistant and well adapted wheat varieties are imperative to increase wheat production in the province. To achieve this objective, continuous efforts are made by the breeders. Recently two (02) new improved high yielding wheat varieties, Fakhre-NIFA 2023 and NIFA NIJAT-23 were approved by the KP Seed Council in its meeting held on 20th of March 2023. These varieties are well adapted to both irrigated and rain-fed areas of KP and have different genetic background from the existing cultivars. New candidate line NRL-

1812 showed excellent performance in national trials and produced 5-9 % higher grain yield than the checks (Arooj 2022 & Akbar 2019) on KP basis and 3-5 % on Pakistan basis under rain-fed conditions respectively. Similarly, two (02) wheat genotypes CT-18062 and CTHN-172114 were evaluated in 1st & 2nd year mandatory evaluation, respectively in the National Yield Trial (NUYT) and as per NUYT pooled analysis, CTHN-172114 stood 5th (4414 kg ha^{-1}) while CT-18062 stood 9th by producing 4381 kg ha^{-1} on Pakistan level. Five genotypes (CT-19078, CT-19293, CTHN-19101, CIBW-2 and CIBW-4) were tested at 12 locations of KP, including NIFA, under irrigated conditions. As per results of Director Outreach of the KP Agricultural Research System, the genotype CIBW-2- stood 4th (6104 kg ha^{-1}) on KP level in comparison to high yielding check (5742 kg ha^{-1}). Based on high yield and disease resistance, 16 wheat genotypes were selected from preliminary and advanced trials. With the help of Federal Seed Certification and Registration Department (FSC&RD) 19200 kg quality seed was produced at the Institute. With the involvement of DDA Buner 123,450 kg seed of NIFA Lalma 2013 and NIFA Awaz 2019 was produced and certified at Buner. DUS studies of CTHN-172114 have been completed and variety proposal will be submitted to Varity Evaluation Committee (VEC).

DUS studies/tests of 04 green-seeded mungbean candidate lines (NFM-98-119, NFM-99-2, NFM-103-16, NFM-103-30) and 01 black-seeded mungbean candidate line (NBM-5-3-6) were carried-out by FSC&RD in kharif-2022 and spring-2023. Sixty-eight (68) advanced green-seeded recombinants and mutants were evaluated for yield and yield related traits in 04 sets of replicated yield trials in kharif 2022. A total of 21 genotypes produced statistically significant ($p \leq 0.05$) average higher seed yield of 694-1963 kg ha^{-1} against average seed yield of check varieties NIFA Mung-19 (850 kg ha^{-1}), Abbas Mung (756 kg ha^{-1}) and AZRI Mung-21 (803 kg ha^{-1}). Mungbean NUYT comprising of 20 entries was planted at NIFA in kharif 2022. Two out of 16 black-seeded mungbean genotypes produced statistically significant average higher seed yield (1876 and 1841 kg ha^{-1}) against average seed yield of check varieties NIFA Mung Sikaram-21 (1747 kg ha^{-1}) and NIFA Mung Spinghar-21 (1735 kg ha^{-1}).

In Case of kidney bean, DUS study of single kidney bean candidate line NKB-Kenya was carried-out by FSC&RD in spring-2023. Three out of 09 kidney bean genotypes produced statistically significant average higher seed yield at ($p \leq 0.05$) (1956-2047 kg ha^{-1}) against average seed yield of highest check variety NIFA Lobia Red-22 (1792 kg ha^{-1} in spring 2023.

In case of chickpea, 20 advanced genotypes were screened for physiological traits related to heat tolerance under field condition at NIFA. 08 genotypes showed better performance for the physiological traits as well as grain yield.

A new high seed yielding rapeseed variety "NIFA Sarson-T23" was approved by the Provincial Seed Council for general cultivation in the KP during its 42nd meeting held on 20.03.2023. First and second years of the two years' mandatory Distinctness, Uniformity and Stability (DUS) was successfully conducted in respect of a rapeseed recombinant RR-8-2 and a mustard mutant MM-31-5. Four rapeseed advanced recombinants/mutants were evaluated in National Rapeseed Yield Trial 2022-23 for the first year. The rapeseed mutant RR-1-5 out yielded the national check on overall 17 locations mean seed yield basis. In adaptability performance trial at selected locations in the KP; 09 out of 13 rapeseed and 01of 03 mustard elite lines out yielded respective checks by 02 to 16%. Various breeding generations (F1 – F5/M1 – M5) were maintained in pursuit of generating genetic variability, selection of the desirable variants based on agronomic, quality traits and subsequence advancement of generations to achieve genetic stability leading to development of new variety.

Peach local and exotic germplasm were evaluated in the orchard and exotic germplasm Plawhite-5 (white-fleshed peach) picking time is 13-15 days earlier than the picking time of early grand. Local germplasm were studied for the evaluation of desirable characters in the orchard. Maximum average fruit weight 115.0 g, fruit shape is oval, fruit colour yellowish with red blushes, TSS 10.4 ° brix and plant height 16.0 ft were noted as compared to check variety early grand. A total of nine mutants of plum Fazli Manani along with 04 local germplasm were evaluated in the orchard for morphological characteristics.

FOOD AND NUTRITION DIVISION

The primary objectives of the R&D activities of Food and Nutrition Division (FND) are to achieve food security and safety, and mitigate malnutrition in the country. The development of hybrid indirect type solar dryer has been under taken as an ALP funded project. The project team visited drying and other food processing facilities in Mingora Swat to study existing drying systems/practices. The drawing of the proposed hybrid solar dryer has been finalized and it consists of a drying chamber (10 ft high, 10 ft long, and 5 ft wide) with frames for drying trays. In study of low energy radiation, dosage of 3.5 kGy of Gamma as well as X-ray radiation effectively extended

the shelf life of shelled walnuts up to 6 months. These findings were shared with ATCOP for commercial-scale applications. Global demand for Low Calorie Ready-to-Serve (RTS) beverages is surging due to a widespread shift towards healthier living. Sugar was replaced in peach and guava-based ready to serve (RTS) beverage with Stevia powder. Comprehensive analyses confirmed the product's quality and its acceptability highlighting the success of using natural sweeteners in response to changing consumer preferences. Mushroom cultivation gained traction as a cottage industry following on-farm training at NIFA, benefiting 75 farmers across 9 districts in Pakistan. NIFA produced Grey Oyster and Pear Oyster spawn, distributing 113 kg to farmers, while successful cultivation of a new species, Pink Oyster, was achieved on an experimental scale. The food testing laboratory of FND attained ISO 17025-2017 accreditation on October 23, 2023 for its microbiology laboratory as a manifestation of its dedication to achieve higher standards. Facing alarming levels of micronutrient deficiency in the country, the govt has started food fortification programs. For its share, the Food & Nutrition Division has developed rapid test kits for qualitative iodine assessment in salt samples. Through extensive research, experiments, and validation, these kits proved effective for both sea salt and table salt and also from different regions. Zinc, a crucial trace mineral, plays catalyst, structural, and regulatory roles in vital metabolic functions. The National Nutrition Survey 2018 found an 18.6% prevalence of zinc deficiency in the Pakistani population. In this background, a study was aimed to develop a rapid test kit for qualitative zinc analysis in wheat flour. Experiments on different wheat flours identified reagents for kit development, with the best-performing reagents selected for further processing.

SOIL AND ENVIRONMENTAL SCIENCES DIVISION

Land and water are precious natural resources that must be optimally utilized for future. Current changes in climate and competitive demands of scarce resources by agriculture, industrial, real estate and commercial sectors necessitate to devise technologies for making efficient use of natural resources. Our lands are already low in organic matter and available plant nutrients and climate change extremes are anticipated to further lower their productivity by triggering loss of soil fertility. Under these scenarios, it becomes relevant to identify research based solutions that may help the farming community to improve the productivity of farmlands with minimal or no loss of their productive capacity. Soil & Environmental Sciences Division (S&ESD) is abreast to manage these challenges through applied research endeavors using conventional as well as nuclear and

isotopic techniques. The key project themes of S&ESD research include climate smart agriculture, vertical farming, zinc biofortification, integrated nutrient and water management, bio-fertilizer and organic farming.

Under the zinc biofortification project, findings from the hydroponics study depicted that Zn efficiency ranged from 27-76%. Zn application at the rate of 5 kg ha^{-1} increased wheat yield by 19%. Climate smart technology packages for improving wheat productivity were demonstrated at farmer's field using farmers' participatory approach. The findings of on-farm trials conducted at five locations in KP depicted that average grain yield (4.32 t ha^{-1}) of NIFA practice was better than climate smart agriculture (CSA) practice (4.16 t ha^{-1}). Cost-benefit ratio of NIFA practice (3.42) was found to be better than CSA (2.62) as well.

Technology packages for off-season vegetable production were perfected and popularized amongst relevant stake-holders through a training workshop. The highest marketable tomato yield (1.67 t / 250 m^2) and NP & K uptake (5.19, 2.49 & 7.31 kg / 250 m^2) were recorded where NPK was applied @ 75-75-90 kg ha^{-1} at 30 days intervals. Maximum cucumber yield (2.9 t / 250 m^2) and uptake (8.68, 4.34 & 8.83 kg / 250 m^2) were found under 10-10-15 kg ha^{-1} at 7 days intervals.

Preliminary findings from the ongoing long term trial on organic farming depicted that soil fertility can be maintained under organic farming systems without compromising wheat grain and potato tuber yield to a greater extent. Field experiments conducted under IAEA TC project revealed that varieties had higher water use efficiency and uptake of nutrients under irrigated conditions than under rain-fed conditions. Lalma was found the most water use efficient variety followed by Aman and Awaz under irrigated conditions. Under the rain-fed conditions, Awaz was found the most water use efficient variety followed by Aman and Lalma. Different organic materials have been analysed for their nitrogen and phosphorus contents with the intent to further utilize these natural substances for improving nutritive value of compost and compost tea. A series of studies were conducted to exploit possibility of use of these nutrient rich materials in the development of nutrients enriched compost tea. Preliminary finding revealed encouraging results that may help to develop a bio-fertilizer product for nurseries.

PLANT PROTECTION DIVISION

The Plant Protection Division (PPD) spearheads groundbreaking research to mitigate the impact of economically significant insect pests and crop diseases. PPD primary focus is on developing

eco-friendly control measures, reducing reliance on traditional pesticides. Optimal conditions for Trichogramma parasitism, longevity, and developmental time were observed at 23-25ºC. Fakhr-e-Sarhad and NIFA Insaf wheat varieties were identified as ideal hosts for Sitotroga rearing. A highly effective chickpea flour-based artificial diet facilitated successful lab rearing of tomato fruit worms. Fungal strain-1 exhibited notable effectiveness in controlling fruit worms. A 1% concentration of clove bud extracts demonstrated high efficacy against subterranean termites. The 50% methyl cellulosic bait within the solid bait matrix exhibited superior termite attraction and consumption under both lab and semi-field conditions. Additionally, the addition of methyl eugenol significantly enhanced the attractiveness of food baits to male fruit flies by 70%. A guava juice formulation attracted 30-40% higher populations of both fly species compared to other bait blends. In the Peshawar region, B. zonata infestation was three times more prevalent than B. dorsalis, with peach being the most affected.

Khan's modified diet notably increased reproductive rates and the intrinsic rate of increase in Aedes spp. Heat exposure experiments highlighted potential resistance in specific Aedes colonies. Exposure to 40°C and 41°C for 3 hours proved effective in identifying mutations. PF04f formulations of Parthenium resulted in a 100% mortality rate of mosquitoes within 72 hours. Yellow rust severity peaked at 50% by early April. Barley yellow dwarf disease impacted 10% of genotypes with severity levels between 30-80%. Twenty-four genotypes demonstrated moderate rust resistance, recommended for strategic deployment to manage the pathogen. The untreated control group exhibited the highest yellow rust severity (AUDPC value of 1520), while among the treated groups, Tilt had the least effect. A laboratory study on seeds of 195 wheat varieties unveiled alarming incidence rates of 15% for black point and 7% for karnal bunt.

PLANT BREEDING AND GENETICS DIVISION

Wheat Irrigated

A new improved high yielding wheat variety, NIFA NIJAT-23 was approved by the KP Seed Council in its meeting held on 20th of March 2023.

Field view of NIFA NIJAT-23

Maintenance of NIFA released wheat varieties

NIFA since its establishment has released 05 improved varieties (NIFA NIJAT-23, NIFA Aman-17, Bathoor-08, Fakhr-e-Sarhad and Bakhtawar-92) for general cultivation in the irrigated areas of Khyber Pakhtunkhwa (KP) in order to meet the increasing demand of quality seed from the government organizations, seed companies and farming community. In addition, continuous efforts of the group are in progress for maintenance of the genetic purity of the released wheat varieties for irrigated areas of the province. One hundred and forty (140) progeny rows and sixty two (62) blocks of NIFA Aman as well as 80 blocks and 100 rows of NIFA NIJAT-23 were planted at the experimental field of NIFA. Unwanted Rows / blocks with off-type/non-uniform plants were rejected while the desired ones were harvested and threshed for quality seeds production during the coming cropping season (2023-24).

Evaluation of candidate wheat genotypes in National Uniform Wheat Yield Trials (NUWYT) under irrigated conditions

Provincial/country-level field evaluation of candidate wheat genotypes is an inevitable activity for interaction between genetic improvement and the environment. On the basis of higher grain yield and disease resistance in Khyber Pakhtunkhwa Wheat Yield Trial (KPWYT) and National Uniform Wheat Yield Trial (NUWYT), two genotypes CIBW-2 and CT-18062 were sent to the 1st & 2nd year evaluation, respectively in the National Uniform Wheat Yield Trial (2023-24).

Evaluation of advanced wheat lines in Khyber Pakhtunkhwa Yield Trials (KPWYT) under irrigated conditions

Zonal trials / Multi-location testing of advanced wheat genotypes is essential for development of new genotypes with wider adaptability and selection of suitable candidate varieties for evaluation in

NUWYT. Based on the performance in MPT, five (5) promising genotypes (CT-19078, CT-19293, CTHRN-19101, CIBW-2 and CIBW-4) along with commercial checks were tested at 12 sites of KP, including NIFA, under irrigated conditions. As per results communicated through the Director Outreach, KP Agricultural Research System, the genotype CIBW-2 stood 4th all over KP with mean grain yield of 6104 kg ha^{-1} with an increase of 6.3% over high yielding local check (5742 kg ha^{-1}).

Microplot Yield Trials (MPT) under irrigated conditions

Twenty (20) wheat genotypes including two checks (Zarghoon-21 & NIFA Aman) were evaluated for yield and response to diseases resistance. Five (05) selected elite wheat genotypes (CTES-107, CTES-114, CTES-136, CTES-141 and CIBW-5) out yielded the check cultivars NIFA Aman & Zarghoon-21 (5889 to 6944 kg ha^{-1}), by producing grain yield in the range of 7005 to 7228 kg ha^{-1} and exhibited resistance to *Yr*, *L*r & *Sr*. These genotypes will be further evaluated in KPWYT (2023-24).

Agronomic evaluation of elite wheat genotypes in Advanced Yield Trials (AYTs)

Based on higher yield and response to *Yr*, *Lr*, *Sr* and *BYD* in preliminary yield trials, evaluation of desirable genotypes in Advanced Yield Trials (AYTs) is a prerequisite for further evaluation in MPT and KPWYT. The selected genotypes are being tested in AYTs conducted at NIFA.

A total of 60 genotypes including 02 checks (NIFA Aman and Zarghoon-21) were evaluated in three sets of Advanced Yield Trials (AYTs). In all, 20 genotypes out-yielded the check cultivars by producing grain yield in the range of 6611-8055 kg ha^{-1}. Grain yield of the check cultivars was recorded in the range of 5722-6000 kg ha^{-1}.

Agronomic evaluation of genotypes in Preliminary Yield Trials (PYTs) under irrigated condition

Sixty six (66) genotypes were evaluated in 3 sets of preliminary yield trials (PYTs). Based on higher grain yield and disease resistance, 40 genotypes out-yielded both the check cultivars (NIFA Aman and Zarghoon-21). The selected genotypes produced grain yield in the range of 7111–7744 kg ha^{-1} as compared to the check cultivars NIFA Aman (Ave. 6288 kg ha^{-1}) and Zarghoon-21 (Average. 6333 kg ha^{-1}). The selected genotypes will be subjected for further evaluation in AYTs during the next cropping season (2023-2024).

Agronomic evaluation of genotypes in Observation Nursery under irrigated conditions

A total of 90 stable genotypes F_6 / M_6 were evaluated for higher yield performance and against prevailing disease (*Yr*, *Lr*, *Sr* and BYD). Fifty (50) genotypes out of 90 were selected for further evaluation in PYTs (2023-24). The selected genotypes out yielded the check cultivar NIFA Aman (Average yield: 6326 kg ha^{-1}) by producing grain yield in the range of 6660-9058 kg ha^{-1}.

Field evaluation of local / exotic wheat germplasm

NIFA Disease Screening Nursery (NDSN) consisting of 140 genotypes included in station trials from NUWYT, KPWYT, MPT, AYTs and PYTs (2022-23) was evaluated for disease reaction against yellow rust (*Yr*), leaf rust (*Lr*) and loose smut (*Ls*) using standard checks Morocco as disease spreader.

Pak-China Project

Three genotypes with higher yield and desirable disease response were evaluated in KPWYT (CIBW-2 & CIBW-4) and MPT (CIBW-5). As per KPWYT results, Genotype CIBW-2 stood 4th throughout the province by producing grain yield of 6104 kg ha^{-1} with an increase in grain yield of 6.3% over high yielding local check (5742 kg ha^{-1}). The genotype CIBW-5 has been sent to KPWYT (2023-24) and CIBW-2 to NUWYT (2023-24) for further evaluation.

Genetic variability through induced mutation and conventional hybridization

Based on higher yield, early maturity and disease resistance, 34 out of 37 F_3 families were selected for further evaluation. The population was resulted from 11 cross combinations. The selected genotypes were included in Observation Nursery for further evaluation in the next cropping season (2023-24).

Based on disease resistant with high tillering capacity, medium plant height, early maturing and bold seeded trait, 34 desirable recombinants were selected from F_2 / M_2 (initially irradiated with 100 Gy of gamma rays) population resulted from 11 cross-combinations. The recombinants will be confirmed for their desired traits during cropping season 2023-24.

F_1 generation resulted from 6 cross combinations (irradiated with 100 Gy of gamma rays) was harvested for raising as F_2/M_2 population during the next cropping season (2023-24).

M_1 generation resulted from the seed treatment of two varieties Bakhtawar-92 and Fakhr-e-Sarhad each with 250 Gy dose of gamma rays was harvested for raising as M_2

population during the next cropping season (2023-24).

Seventy seven (77) genetically variable genotypes were planted in the field as gene pool on two different dates. Ten fresh cross combinations were attempted and seeds from the cross combinations were separately harvested to be raised as F_1 during cropping season 2023-24.

Demonstration Plots and Seed Multiplication on Farmers' Field

Demonstration plots on farmers' fields always plays an important role in varietal proliferation and it also helps the farming community to have easy access to the quality seed on their door step. In the year 2022-2023, 400 kg of NIFA Aman, NIFA-NIJAT-23, CTHN-172114 and CT-18062 was provided to 9 farmers of Peshawar, Bannu, Lakki Marwat, Mardan and Charsadda districts free of cost with an undertaking that the produced seed will be provided to the neighboring farmers. The reports from the farmers revealed that 17.758 tons of seed was produced from 9 plots in these districts and this will be available for cultivation during 2023-24. Deputy Director Agriculture (DDA) Buner was provided 1100 kg seed of NIFA Aman on cash payment. The produce of the certified seed will be available to the farmers during 2023-24 through DDA Buner.

Wheat Rainfed

A new improved high yielding wheat variety, Fakhre-NIFA 2023 was approved by the KP Seed Council in its meeting held on 20th of March 2023.

Field view of Fakhr-NIFA 2023

Early Generation Seed production

Consistent efforts are being made by NIFA rainfed wheat breeders to develop improved cultivars coupled with potential wheat germplasm helping in boosting farm productivity and ensuring food security in the country. The research activities along with the desired goals are summarized as under:

Seed Production

A total of 19200 kg quality seed of NIFA rainfed wheat varieties Fakhre NIFA 2023, Awaz 2019, and NIFA Lalma 2013 was produced and certified by FSC&RD for fast proliferation through active involvement of public/private entrepreneurs in Khyber Pakhtunkhwa.

Variety	Seed Class	Quantity (kg)
Fakhre NIFA 2023	Pre-Basic	500
NIFA Awaz 2019	Pre-Basic	2500
NIFA Awaz 2019	Approved	3100
NIFA Lalma 2013	Pre-Basic	13100
Total		**19200**

NIFA wheat varieties popularization / demonstration

Demonstration plots on farmer's field always play an important role in varietal proliferation and helping the farming community of easy access to the quality seed. In the year 2022-23, 700 Kg seed of Fakhre NIFA 2023, NIFA Awaz 2019, NIFA Lalma 2013 and advanced lines was provided to 19 farmers in Districts of Nowshera, Charsadda, Lower Dir, Peshawar, DI Khan, Mardan and Malakand. The seed was provided free of cost with an undertaking that the produced seed would be provided to the neighboring farmers. The feedback from the farmers revealed that 28000 kg of seed was produced from these 19 demonstration plots that would be available for cultivation during 2023-24.

Involvement of District Director Agriculture Extension Buner in seed production / certification of NIFA rainfed wheat varieties (2022-23)

A total of 1,23,450 Kg certified seed of wheat varieties i.e., NIFA Awaz 2019 and NIFA Lalma 2013 was produced by District Director Agriculture Buner with the help of FSC & RD officials. The details are as under:

S#	Variety	Quantity (Kg)	Lot No.
01	NIFA Awaz 2019	30000	2169193
02	NIFA Awaz 2019	30000	2169194
03	NIFA Awaz 2019	1350	2169195
04	NIFA Lalma 2013	30000	2169197
05	NIFA Lalma 2013	30000	2169198
06	NIFA Lalma 2013	2100	2169199
	Total	**123450**	

Performance of wheat genotypes in various yield trials under rainfed conditions

Twenty (20) promising genotypes including NIFA Awaz 2019 as standard check were assessed for grain yield, yield components and disease resistance in 02 advanced yield trials at the institute. Based on grain yield and disease resistance 06 promising genotypes were selected. NRL 2123 produced the highest mean grain yield of 7111 $kgha^{-1}$ followed by NRL 2125 (6759 $kgha^{-1}$) The overall grain yield in Advanced yield trials was in the range of 5474 kg ha^{-1} to 7111 kg ha^{-1}.

Sixty (60) newly selected genotypes were tested for grain yield, disease resistance, and other agronomic traits in 05 Preliminary Yield Trials under moisture stress conditions at the institute. Wheat variety NIFA Awaz

2019 was included as standard check in each trial. On the basis of high yield and disease resistance, a total of 10 genotypes were selected from these trials. The grain yield of selected genotypes in these preliminary yield trials ranged from 2711 kg ha^{-1} to 3500 kg ha^{-1}. These selected lines will be further tested in advanced yield trial during the coming growing season i.e. 2023-24.

The relative effects of environment, genotypes and their interaction on grain yield and agronomic attributes were assayed using 60 promising bread wheat genotypes grown in replicated trials in the plains, southern and northern parts of Khyber Pakhtunkhwa. Wheat variety "PS 19" was used as a grand check. The trails were conducted with standard cultural practices with no irrigation. NIFA five elite wheat lines (NRL 2001, NRL 2007, NRL 2009, NR 2031 and NRL 2032) were among the contested genotypes. Two NIFA elite lines NRL 2031 and NRL 2032 produced at par grain yield with the checks.

NIFA candidate varieties, NRL 1929 and NRL 1812 were subjected for 1st year and 2nd year mandatory evaluation in National Uniform Wheat Yield Trials (NUWYT-Rainfed) at different sites in the country. Candidate variety NRL 1812 produced 5-9 % higher grain yield than the grand checks (Arooj 2022, Akbar 2019) on Khyber Pakhtunkhwa basis and 3 - 5 % on Pakistan basis under rainfed conditions respectively. The candidate variety NRL 1812 was declared resistant to both yellow and leaf rust (CDRI 2023).

Evaluation of segregating material and creation of genetic variability for desired traits

Continued raising of different segregating populations achieved through gene pyramiding and single gene mutation is the most important breeding strategy that ultimately results in the availability of homozygous genotypes. A crossing block consisting of 15 genotypes was planted on three different dates for acquiring floral synchrony among early and late flowering parents.

Based on transfer of genes for disease resistance and other economically important traits to otherwise well adapted cultivars/genotypes, fresh crosses among different wheat cultivars / genotypes were carried out. F_1 generation comprised of 04 different cross combinations were raised. Each cross combination was planted in 02 rows with 2.5 m length and having 25 plants per row. Seed of the F_1 population was harvested, bulked and stored after proper labeling. In F_2 generation 11 cross combinations having about 1500-2000 plants

per cross were space planted. Based on field performance 99 desirable plants were selected and threshed individually. F_3 generation of 08 cross combinations was raised in the field for isolating desirable plants. Sixteen (16) best progenies were selected. In F_4 generation (08 cross combinations) seventy two (72) progenies were selected. F_5 to F_8 populations comprised of 94 entries were raised in the form of observation nursery (5^{th} NIFA Wheat Observation Nursery) and 37 genotypes were finally selected for further confirmation in preliminary yield trials during Rabi 2023-24.

Breeder Nucleus Seed production of NIFA rainfed varieties

Consistent efforts were made by the NIFA wheat breeders to maintain seed purity and to produce Breeder Nucleus Seed by growing progeny blocks / rows of these varieties on the available land at the institute. In total 220 progeny blocks and 250 progeny rows were grown for these varieties. After regular observations 212 progeny blocks and 234 progeny rows were selected and the rest were discarded. A total of 600 kg breeder nucleus seed of NIFA rainfed wheat varieties Fakhre NIFA 2023, NIFA Awaz 2019 and NIFA Lalma 2013 was produced. These cultivars showed resistance to prevailing yellow and leaf rust races. The BNS seed will be used for the production of Pre-Basic seed in the coming Rabi season (2023-24).

Pulses

Mungbean

Evaluation of mungbean advanced lines in various yield trials

A total of 17 green-seeded recombinants and mutants along with 03 check varieties NIFA Mung-19, Abbas Mung and AZRI Mung-21 were evaluated for yield and yield components in Advanced Lines Yield Trials (ALYT) in kharif 2022 at NIIFA. Out of these, 04 genotypes produced statistically significant ($p \leq 0.05$) higher seed yield of 694 to 903 kg ha^{-1} against average seed yield of NIFA Mung-19 (590 kg ha^{-1}), AZRI Mung-21 (590 kg ha^{-1}) and Abbas Mung (556 kg ha^{-1}). Fifty-one green-seeded recombinants from 05 different cross-combinations (6601 x Ramzan, NFM-5-36-24 x NFM-5-63-18, NM98 x NFM-5-36-24, V2802 x Ramzan, and V2709 x NM92) were evaluated for yield and yield related traits in 03 sets of Preliminary Yield Trials (PYTs) along with 03 check varieties i.e. NIFA Mung-2019, Abbas Mung and AZRI Mung-21 in kharif 2022 at NIFA. Of these, 17 recombinants produced statistically significant ($p \leq 0.05$) higher seed yield of 1146 to 1963 kg ha^{-1} as compared to average seed yield of NIFA

Mung-19 (1110 kg ha^{-1}), AZRI Mung-21 (1017 kg ha^{-1}) & Abbas Mung (956 kg ha^{-1}).

National Mungbean Uniform Yield Trial comprising of 20 test entries was planted at NIFA in kharif 2022, and the results were sent to National Coordinator (Food Legumes), PARC, Islamabad.

In case of breeding black-seeded mungbean, 16 recombinants from a cross-combination Kurram Black Mung x NIFA Black Mung along with 02 black-seeded check varieties NIFA Mung Spinghar-21 and NIFA Mung Sikaram-21 were evaluated for yield and related traits in Advanced Yield Trial at NIFA in kharif 2022. A total of 02 recombinants (NBM-5-3-6 and NBM-5-3-10) produced statistically significant ($p \leq 0.05$) higher seed yield of 1876 and 1841 kg ha^{-1}, respectively against seed yield of NIFA Mung Sikaram-21 (1747 kg ha^{-1}) and NIFA Mung Spinghar-21 (1735 kg ha^{-1}).

Adaptability yield trial comprising of 06 green-seeded genotypes along with 02 checks NIFA Mung-19 and Jumbo Mung was conducted at ARS, Karak in kharif 2022 for testing wider adaptability of yield and related traits of these lines. Of these, 03 genotypes produced statistically significant ($p \leq 0.05$) higher yield of 1424 – 1479 kg ha^{-1} as compared to check varieties NIFA Mung-19 (1327 kg ha^{-1}) and Jumbo Mung (1299 kg ha^{-1}). Similarly, the same genotypes were also evaluated in adaptability yield trial conducted at AZRC, D.I. Khan. Four genotypes produced statistically significant ($p \leq 0.05$) higher yield of 1491 to 1547 kg ha^{-1} as compared to check varieties Jumbo Mung (1371 kg ha^{-1}) and NIFA Mung-19 (1358 kg ha^{-1}).

Evaluation of mungbean segregating material

Early generation segregating material (F_2/M_2 generation) comprising of 11 different cross-combinations i.e. NBM-2-14-4-1 × MPP-15024 (22 single plants), NBM-2-2-4-5 × NFM-19 (22 single plants), NFM-19 × NBM-2-2-4-5 (23 single plants), MPP-15024 × NBM-5-3-4 (22 single plants), NBM-2-14-4-5 × NFM-19 (04 single plants), MPP-15024 × NBM-2-14-4-1 (07 single plants), NBM-2-2-4-8 × AZRI Mung-18 (11 single plants), NBM-2-14-4-1 × NFM-19 (07 single plants), NFM-19 × NBM-2-14-4-5 (10 single plants), NBM-5-3-4 × MPP-15024 (12 single plants) and NBM-5-3-4 × NFM-19 (02 single plants) were evaluated at NIFA in kharif 2022. Based on seed color, better plant type, MYMV resistance and high per plant grain yield, a total of 684 single plants were selected for evaluation in next season. Similarly, F_3/M_3 generation comprising of 04

different cross-combinations i.e. Ramzan × NBM-2-14-4-6 (52 single plants), NBM-2-14-4-6 × Ramzan (27 single plants), NBM-2-14-4-6 × NFM-19 (73 single plants) and NBM-2-14-4-6 × V2817 (89 single plants) were evaluated at NIFA in kharif 2022. Based on seed color, better plant type, MYMV resistance and high per plant grain yield, a total of 192 single plants were selected for evaluation in next season. Similarly, 09 single plants from 05 cross-combinations (NFM-5-63-3 x KBM, NIFA Mung-2017 x KBM, AZRI Mung-06 x KBM, Ramzan x KBM and NM-2016 x KBM) were evaluated in F_4/M_4 generation. A total of 13 single progenies were selected for evaluation for yield and related traits.

In case of creation of new genetic variability, 07 new cross combinations were attempted in spring-2023.

In case of quality seed production, 515 kg of pre-basic seeds of NIFA mungbean green and black-seeded varieties i.e. Ramzan, NIFA Mung-17, NIFA Mung-19, NIFA Mung Spinghar-21 and NIFA Mung Sikaram-21 was produced in 2022-23.

Kidney bean

Evaluation of kidney bean genotypes in adaptation yield trials

DUS study of a candidate line NKB-Kenya was carried-out by FSC&RD in spring-2023.

In spring 2023, 09 kidney bean genotypes along with 03 check varieties i.e. NIFA Lobia Red-22, Himalaya-1 and Swat Red were evaluated for yield and yield components in replicated yield trial at NIFA. Of these, 03 genotypes "NKB-Kenya, NKB-22-4 and NKB-21-1 produced statistically significant ($p \leq 0.05$) higher average seed yield of 1956 to 2047 kg ha^{-1} as compared to check varieties NIFA Lobia Red-22 (1972 kg ha^{-1}), Swat Red (1344 kg ha^{-1}) and Himalaya-1 (1245 kg ha^{-1}).

NIFA Lobia Red-22 and NIFA Lobia yellow-22 were evaluated using multiple sowing dates at 10 days' interval started from 20 January, 2023. The study is still going-on to identify the most suitable sowing time and effects of sowing dates on yield and yield traits.

Evaluation of kidney bean segregating material

F_1/M_1 generation derived from 04 cross-combinations i.e. NKB-BL-2 × NKB-Kuram Local, NKB-BL-2 × NIFA Lobia Red-22, NIFA Lobia Red-22 × NKB-BL-2 and NIFA Lobia Yellow-22 × NKB-G-4495 were planted in spring-23. All single plant recombinants-cum-mutants were separately picked and bagged individually cross-combination wise. Early generation segregating material (F_2/M_2) comprising of 03 different cross-combinations i.e. NIFA

Lobia Red × NKB-G-4729 (17 single plants), NIFA Lobia yellow × NIFA Lobia Red (21 single plants) and Himalaya-1 × NKB-Kenya (16 single plants) were evaluated at NIFA in spring 2023. Based on seed color, semi erect plant type and high per plant grain yield, a total of 16 single plant recombinants-cum-mutants were selected for evaluation in next season. Similarly, M_2 generation derived from NIFA Lobia Red-22 (75 Gy) and NKB-Afghani (25 & 50 Gy) was evaluated at NIFA in spring 2023. A total of 81 mutants from M_2 generation of NIFA Lobia Red-22 (75 Gy of γ rays) were selected on the basis of desired criteria while both populations of NKB-Afghani were discarded for not fulfilling the desired criteria. In order to create new genetic variability for semi erect type, seed color and high yield, M_1 generation of Himalaya-1 (100, 150 & 200 Gy) was created and planted at NIFA in spring 2022. Similarly, 02 new cross-combinations were successfully attempted at NIFA in spring 2023. All crossed pods were picked cross-combination wise.

Evaluation of Kidney Bean Germplasm

In spring 2023, 34 local and 45 exotic genotypes as germplasm were evaluated for semi erect type plant growth, seed color and high yield, out of which 07 and 11 genotypes, respectively were selected for use in induced mutation and hybridization for creation of genetic variability for the traits mentioned above.

In case of quality seed production, 110 kg of pre-basic seeds of NIFA Lobia Red-22 and NIFA Lobia Yellow-22 was produced in 2022-23.

Chickpea

Screening of chickpea genotypes for physiological traits related to heat tolerance

20 advanced chickpea genotypes initially screened for physiological traits i.e. net photosynthesis rate, membrane injury index and canopy temperature depression at flowering, pod formation and grain-filling stages in Rabi 2020-21 and 2021-22 under PSF Project were evaluated in replicated yield trial at NIFA and ARS, Karak for yield and yield components. Four genotypes (NDC-18-20-7, NDC-18-22-2, NDC-18-21-3 and NDC-18-20-5) produced significant higher seed yield ranging from 1123 to 1840 kg ha^{-1} at both locations against NIFA-2005 (average seed yield of 1216 kg ha^{-1})

Oilseed Brassica

A new high seed yielding rapeseed variety "NIFA Sarson-T23" was approved by the Provincial Seed Council for general cultivation in the KP during its 42nd meeting held on 20.03.2023.

Field view of NIFA Sarson-T23

Evaluation of oilseed brassica mutants/ recombinants in various yield trials

Four rapeseed mutants/recombinants viz. RR-016-49, RM-3-5, RR-016-62 and RM-1-5 were contributed in National Uniform Rapeseed Yield Trial (2022-23) for the first-year mandatory evaluation for seed yield performance and stability studies across diversified locations in the country.

The rapeseed mutant RR-1-5 produced higher seed (1705 kg ha^{-1}) and out yielded the national check (Super Canola) on overall mean seed yield of 17 locations.

Based on high seed and oil yields performance; 13 rapeseed recombinant/ mutants advanced lines (RM-6-10, RM-10-24, RR-6-4-14/18, RR-15-1-33/18, RR-18-1-48/18, RM-6-3-11/18, RM-7-4-13/18, RM-9-1-16/18, RM-9-2-17/18, RM-9-3-18/18, RM-14-5-34/18, RM-20-5-41/18 and RM-23-5-48/18) and 03 mustard mutants (MR-2-5, MR-3-6 and MR-57-1-82/18) were assessed in multi-location adaptation trial at selected 05 sites in the KP (NIFA, Peshawar, ARI, Mingora, ARS, Buner, AZRC, D.I.Khan, and BARS, Kohat). The results of the five locations demonstrated that 09 out of 13 rapeseeds exhibited higher seed yield (1603 – 1847 kg ha^{-1}) against Super Canola (1595 kg ha^{-1}) while one mustard mutant MR-57-1-82 /18 could produce high seed yield (1457 kg ha^{-1}) than Super Raya (1427 kg ha^{-1}).

At station; in five sets of preliminary yield trials; forty-one (41) rapeseed mutants / recombinant four mustard advanced recombinants were tested for seed yield performance against Super Canola (rapeseed) and Super Raya (mustard). Fifteen (15) rapeseed rec./mutants achieved higher seed yield (02 – 19%) than check Super Canola (avg. 2300 kg ha-1). Two (02) mustard entries viz. F-10-8 and MM-34-12 significantly out yielded the check by achieving 1944 and 2083 kg ha^{-1}, respectively, while rest 02 mustard mutants also achieved high seed yield (02 – 36%) than check (1528 kg ha^{-1}).

Thirteen hundred (1300) samples of replicated trials and breeding materials were analyzed for quality profiling while 206 sample were analyzed on payment to other stakeholders.

Selection and advancement of breeding materials

One hundred twenty-five (125) out of two hundred sixteen (216) plant to progeny rows were selected based seed yield performance and phenotypic stability in F_3/M_3 to F_5/M_5 for advancing to next generations. F_2 and M_2 generations were developed from 04 crosses combinations and through irradiating Abasin-95 at 0.5 kGy respectively. One hundred fifty-one (151) single plant selections were made in line with purpose of raising recombinant & mutant specifically centering on more branches, grains per pod, low ramification, early maturity, disease tolerance and high seed yield. F_1 generation of thirteen (13) cross combinations and M_1 of two genotypes radiated at two gamma radiation doses (1 & 1.2 kGy) were raised and bulk harvested separately. To create genetic variability and to transfer the desired quality and agronomic characters in a variety of interest; four hundred fifty (450) stigma were pollinated in nine different combinations.

Oilseed Brassica - varietal maintenance program

Quality seed production is the key to high seed yield. Therefore, a varietal purity upkeep cycle was maintained through raising progenies rows and progeny blocks to produce Breeder Nucleus Seed (BNS). True to type progeny blocks were selected on the basis of varietal characteristics. A total of 20 kg basic seed (B.S.) of NIFA Sarson-T20 were produced at NIFA and certified by FSC&RD. Private seed companies viz., Tarnab Seeds, Gala Seeds, North South Seeds and Broad Way Seeds produced 650, 6800, 200 and 3700 kgs seeds of NIFA Sarson-T20 in certified class.

Distinctive, Uniformity & Stability Studies (DUS)

Second year DUS for mustard mutant (MM-31-5) and first year for RR-8-2 were executed at NIFA in collaboration with FSC&RD, Regional Office- Peshawar.

Okra

A new project with funding from ALP has been initiated on Breeding Okra for higher yield with the aim to develop high yielding okra genotypes. Khyber Pakhtunkhwa province has enough potential to produce variety of vegetables and a reasonable acreage is available for okra cultivation, but per unit yield is very low. Diverse germplasm of okra (20 genotypes) was collected from various local and international sources and evaluated for yield and other quality traits in field at NIFA, during 2021. Eight genotypes were initially selected based on consumer-preferred traits like short stature, green fruits, prolonged fruiting ability and tolerance to

diseases. Two genotypes NBL-1 and NBL-2 were finally selected for further evaluation in adaptation yield trial on various locations i.e. Agriculture Research Station (ARS) Swabi, Agriculture Research Station (ARS) Harichand, Charsadda, Agriculture Research Station (ARS) Serai Naurang, Agriculture Research Institute (ARI), Mingora, Swat and on famer's filed at Bajaur during spring 2023 season. The genotype NBL-1 showed high yield, short stature, green fruits, prolonged fruiting ability and tolerance to diseases in all locations. Similarly, 15 okra genotypes in spring 2023 were collected from various local and international sources and evaluated for yield and other quality traits in field at NIFA. Five genotypes were initially selected based on consumer-preferred traits like high yield, short stature, green fruits, prolonged fruiting ability and tolerance to diseases. Two varieties/ genotypes were irradiated (200 Gy) and raised M_1 generation at NIFA farm.

Horticulture

Peach

Plawhite-5 & Zincle-4 Peach exotic genotypes were evaluated for early blooming, fruit maturity and short stature. Plawhite-5 (white-fleshed peach) picking time is 02 weeks earlier than the picking time of early grand. It is semi-dwarf growth habit, plant height 9.8 ft, average fruit weight 95.0 g, TSS value 9-10 °Brix, attractive fruit colour and shape. Zincle-4 - good looking, plant height 10.0 ft, high TSS value (10.0 °Brix), fruit shape is round, average fruit weight 74.0 g and early maturing (harvest in 3rd week of April) were recorded as compared to early grand check variety i.e., maximum average fruit weight 83.78 g, fruit shape is oval, fruit colour yellowish with red blushes, TSS 9.0 ° brix and plant height 15.0 ft. Local germplasm were studied for desirable characters/evaluation. Maximum average fruit weight 115.0 g, fruit shape is oval, fruit colour yellowish with red blushes, TSS 10.4 ° brix and plant height 16.0 ft were noted as compared to check variety early grand. Mutants plants from each variety i.e., early grand & florida king were studied for further evaluation in NIFA peach orchard. Data on flower initiation, full bloom, fruit setting, days to fruit setting and number of fruits of individual mutant plants were recorded.

Effect of Biochar amendments on Peach Replant Disorders

Research study was carried out to enhance the germination and survival percentage of peach nursery plants by application of various doses of biochar in the soil at Nuclear Institute for Food and Agriculture Peshawar (NIFA) during the year 2022-2023. The layout for peach stone nursery is Randomized

Complete Block Design (RCBD) and each plot size is about 272sq.ft. Different doses of biochar (control, 15, 20 and 25 kg/plot) were mixed in the soil before sowing of peach stone. All culture practices such as irrigation, fertilizer, weeding etc. were kept uniform for all the treatment. Data were recorded on various parameters including seed germination percentage, plant height (cm), girth of seedling (mm), number of leaves, growth habit, plant survival percentage, success budding percentage, height of bud seedling (cm), budding plant diameter (mm), number of nodes, number of leaves, number of branches, number of roots, root length (cm) and weight of budding plant (g). The results data showed that application of 20kg/plot biochar dose have best result for seed germination percentage (31.03 %), plant height (18.12 cm), width of seedling (1.42 mm), number of leaves (15.06), growth habit (20.44/72.33), survival plant % (90.02 %) and post-budding data bud success percentage (81 %), buddling height (12.37 cm), buddling diameter (1.09 mm), number of nodes (3.56), number of leaves (13), number of branches (1.44), number of roots (7.78), root length (16.68 cm) and buddling weight (8.62 g) compared to others treatment of biochar and control. Therefore it is inferred that application of biochar at the rate of 20kg/plot had better results in the germination and survival percentage of peach stone nursery.

Plum

A total of nine mutants of Plum Fazli Manani, 06 of 20 Gy and 03 mutants of 30 Gy doses were evaluated in the orchard. All mutants have yet not started fruiting, however their morphological characteristics were studied. In irradiated populations of 30 Gy treatments the earliest sprouting 4-5 days was recorded in control plants. The lowest plant height of 175 cm was recorded as compared to control (185 cm). The lowest internode length of 1.7 cm was recorded as compared to control (2.0 cm). The highest stem diameter of 36.8 (mm) was recorded as compared to control (24.4 mm). While In irradiated populations of 20 Gy treatments the earliest sprouting was also recorded the control plants as compared to irradiated plants. The lowest plant height was recorded in irradiated plants while the lowest internode length of 1.7 cm was recorded as compared to control (2.0 cm). In local germplasm, 09 plants of Red Beauty, 08 plants of Santa Rosa and 02 plants of Blisting Star are under evaluation in the orchard.

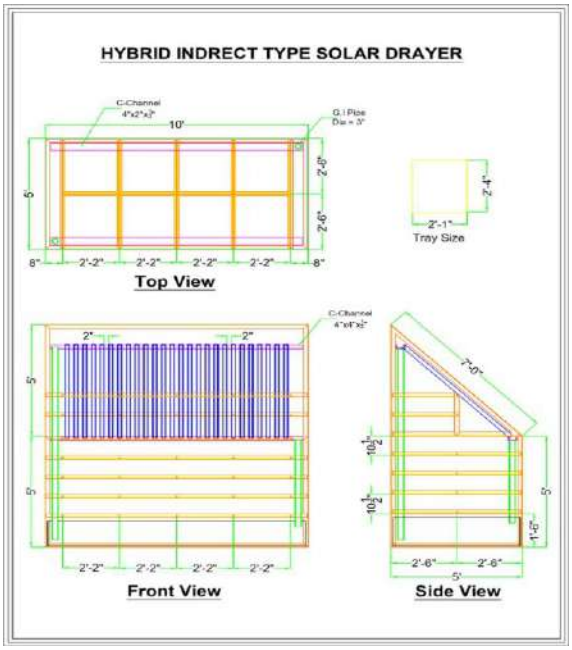
FOOD AND NUTRITION DIVISION

Development of hybrid indirect type solar dryer for drying of fruits and vegetables

The development of hybrid indirect type solar dryer has been under taken as an ALP funded project. In order to study the existing drying systems/practices, the project team visited Drying and other Food Processing Facilities in Mingora Swat on October 05-6, 2022. Solar drying facilities of a local grower for persimmon fruit in Saidu Sharif, and Food Dehydration Unit (FDU), a large scale electric drying facility installed by SMEDA in collaboration with Ministry of Industry and Production in 2018 on Takht Band Road Mingora, were visited. The FDU was presently non-operational due to its large capacity and power supply issues. The team also visited peach and apple grading line, fruit pulp making facility and a solar dryer used for drying persimmon and apple in the Agricultural Extension Office in Matta, Swat. The team also met with a private entrepreneur working on fruits drying. In an effort to create awareness among the farmers about drying technology, the Food and Nutrition Division (FND) of NIFA organized a one-day training workshop on "Drying of Fruits and Vegetables" on May 30, 2023, at NIFA, Peshawar. The event was attended by 35 people, the majority of whom were farmers. Students from surrounding universities and workers of KP Agri. Extension department were also present.

The drawing of the proposed hybrid solar dryer consist of a drying chamber (10 ft high, 10 ft long, and 5 ft wide) with frames for drying trays as shown in figure give below. It will have the capacity to dry about 70 kg of fruits/vegetables in a single batch within 2-3 days.

The water will be heated in pipes at the top of drying chamber through direct sunlight and then stored in tanks inside the chamber. The dryer has an energy storage capacity of 126 mJ for a 30°C change in temperature. The fan and pump for air and water circulation will be operated through solar panels.



Adaptation of low energy machine generated radiation sources for surface decontamination and disinfestation of food in Pakistan

Low Energy Electron Beam (LEEB) technology is now commercially available for aseptic packaging for polymer curing (polymers cross linking), printing ink curing, medical device sterilization, and aseptic food packaging. Presently, low energy e-beam units for spice treatment have been developed, tested, and are now commercially available. There is a growing pressure on the food industry to reduce its environmental impact namely, carbon footprint (CO_2 release in the environment), reduced physical footprint (land usage), and reduced water usage, avoiding chemicals, and reducing energy demands. This has led to the beginning of a new approach of radiation processing of food and agricultural products using low energy beams. In the present study, dosage of 3.5 kGy (Gamma & X-ray) radiation was optimized to extend shelf life of shelled walnuts up to 6 months. The findings were subsequently shared with ATCOP for potential commercial-scale applications.

Labelled Walnut Samples and irradiation with low energy (X-rays)

Mitigation of post-harvest losses and value addition of fruits and vegetables

The global push towards healthier living has ignited a surge in the demand for Low Calorie Ready-to-Serve (RTS) beverages.Consumers are increasingly conscious of their calorie intake and its impact on overall health, leading to a marked shift away from sugary drinks laden with artificial sweeteners. As a result, the beverage industry is under immense pressure to reformulate and innovate their offerings. The Low Calorie Ready-To-Serve (RTS) beverages segment, characterized by use of natural sweeteners, fewer preservatives, and functional ingredients, is on the rise. Experiments were conducted to optimize specific parameters for the formulation of a peach and guava based Ready-To-Serve (RTS) beverage. Instead of using sugar (sucrose), we incorporated Stevia powder as a sweetener. The formulated product was then subjected to comprehensive physicochemical and sensory analyses to assess its quality and were found acceptable to the panel of judges

Low Calorie RTS from Guava and its Physico-chemical analysis

Popularization, yield enhancement and cultivation optimization of edible mushroom

Mushroom cultivation was popularized as cottage industry through on-farm training/training workshop at NIFA for 75 farmers from 9 districts including Chiral, Peshawar, Nowshera, Charsadda, Mardan, Upper Dir, Orakzai, Khyber and Attock of Pakistan (KP and Punjab). Moreover, mushroom cultivation benefits as quality nutritive food/medicine and profitable business was broadcasted and discussed through Radio talks and Food and Nutrition Expo, respectively. Spawn (113 Kg) of Grey Oyster (Pleurotus sajor caju) and Pear Oyster (Pleurotus ostreatous) was developed/ produced at NIFA and was provided to farmers for cultivation and developing their own private farms. New mushroom specie (Pink Oyster) was successfully cultivated on experimental scale at NIFA. Improved Oyster mushroom cultivation techniques were developed through R&D for yield enhancement and the technology will be transferred to end users (growers). Pear Oyster yield enhancement trial was evaluated under CRD, compost dimension of 12x17″ yielded best with 68.73 % Biological Efficiency (BE) followed by dimension of 16x22″ and 9x45″ with BE of 49.5%, 42.3%, respectively.

Pink Oyster (Pleurotus djamor) is successfully cultivated on experimental scale at NIFA

ISO 17025-2017 Accreditation of Food Testing Laboratory NIFA

The Food and Environmental Safety Group provides essential water and food testing services to R&D organizations, food companies, and individuals. Recognizing the growing demand and necessity for laboratory accreditation, the Worthy Chairman of PAEC graciously approved a grant of Rs. 14.00 million in 2015. This funding was allocated for essential renovations, equipment acquisitions, and the pivotal accreditation of the food testing laboratory. This accreditation serves as a testament to the lab's competence and reliability in delivering food and water testing services to R&D organizations, food

companies, and individuals while meeting international standards for food testing and analysis.


Pakistan National Accreditation Council
Ministry of Science & Technology
Government of Pakistan
Islamabad

Certificate of Accreditation

is awarded to
Food Testing Laboratory,
Nuclear Institute for Food and Agriculture (NIFA),
Peshawar, Pakistan

In accordance with the requirements of ISO/IEC 17025:2017
The accreditation is subject to regular surveillance and compliance to the requirements of PNAC.
For scope of accreditation, see appendix.

Accreditation Certificate Number: Lab 293

Date of Issue: 11-09-2023
Director General
Valid until 10-09-2026

Dr. Gul Sanat Shah, Director NIFA, Peshawar receiving ISO/IEC 17025:2017 Certificate of Accreditation from Ismat Gul Khattak, DG PNAC on Oct. 23, 2023

Validation of Iodine rapid test kit for assessment of iodine in salt

Micronutrient deficiency within the Pakistani population has reached alarming levels. Recognizing the severity of this situation, the government has initiated a fortification program aimed at adding iodine to salt during processing. To facilitate this endeavor, Food & Nutrition Division has developed rapid test kits designed for the qualitative assessment of iodine levels in salt samples. Extensive research and experimentation were conducted to validate the effectiveness of these iodine rapid test kits for both sea salt and table salt. A series of experiments were conducted to identify the optimal combination of reagents for rapid and accurate testing. Once the desired results were achieved, the kits were tested against salt samples from various regions. Iodine rapid test kits successfully detected the presence of added micronutrients in all the salt samples.

Testing of Iodine RTKs against various type of salts

Development of Rapid Test Kit for On-spot Detection of Zinc (Zn) in Fortified Wheat Flour

Zinc is one of the most important trace minerals in living organisms, with three major biological roles, a catalyst, structural unit, and process regulatory ion for completion of vital metabolic functions in the body. Effects of its deficiency can lead to oxidative damage, alterations in immune system, neuropsychological impairment and dermatitis. Recommended Dietary

Allowance (RDA) for zinc intake is 11mg & 8mg for men and women, respectively.

According to National Nutrition Survey (NNS) 2018, prevalence of Zn deficiency is 18.6% among Pakistani population. Zinc fortification in wheat flour can be an effective tool to curb its deficiency and current study was aimed to develop a rapid test kit/tool to assist relevant stakeholders for qualitative analysis of zinc in wheat flour. A series of experiments were conducted on different types of wheat flours to identify the reagents for kit development and best performing reagents were selected for further processing.

Pictorial view of screened reagents color development for detection of zinc in wheat flour samples

SOIL & ENVIRONMENTAL SCIENCES DIVISION

Biofortification of zinc (Zn) in wheat for balanced human nutrition

Micronutrients deficiency has a prominent impact on human diets and is the leading concern for malnutrition globally. In developing nations, the hidden hunger drives severe health concerns and has become an urgent economic load on the health care system. This alarming situation is also challenging the agricultural scientific community because of the rising global population and augmenting food demand. Agricultural strategy used to improve the nutritional value of crop plants is known as biofortification. Biofortification through agronomic approach (optimized fertilizer applications) is a feasible and cost-effective means of delivering micronutrients to populations that may have limited access to diverse diets and other micronutrient interventions and to enhance the crop yield as well.

Screening of wheat genotypes for Zn efficiency in chelate-buffered nutrient solution

Surface sterilized seeds of ten wheat genotypes were germinated on moist filter papers in petri dishes in an incubator at 20±1°C. Two seedlings of each germinated cultivar were transplanted into white thermopore sheets placed in stainless steel containers of 50 L capacity filled with 40 L of the chelate-buffered nutrient solutions having Zn^{2+} activities of 2, 10 and 40 pM. Initially plants were grown in solutions prepared with half strengths of all macro and micronutrients, except for Zn and K_3HEDTA (which were at full strength) until day 10 following transplantation and afterwards full-strength solutions were used. The nutrient solutions were replaced with fresh mixtures on days 10, 15, 19, 24, 28 and 32 following transplantation. The pH values of the solutions were adjusted to 6.0±0.01 with 0.1 M HCl or 0.1 M KOH as required. Plants were harvested on 35th day after transplantation. The tissue samples were then air dried on paper towels and later dried in a forced draught oven at 70±1 °C for 48 hours (until constant weight) and were analyzed for micronutrients and P by standard procedures of analysis.

The wheat genotypes under study depicted variable response to increasing level of Zn^{2+} activity and with increase in Zn concentration in the growth medium increased the growth of plants. The variable response of these genotypes to Zn application was exploited to determine the Zn efficiency. The Zn efficiency of these genotypes ranged from 27

to 76%, NRL-2112 being the most efficient one and NRL-2101 being the least. Under Zn stress condition (2 pM), the significantly (P≤0.05) higher dry biomass (7.9 g) was recorded for NRL-2112 and the minimum for NRL-2101 (2.6 g). The genotype NRL-2112 has absorbed maximum Zn (18.9 µg g^{-1}) at 2 pM Zn^{2+} activity that was significantly (P≤0.05) higher than rest of the genotypes under study. The highest concentration of P (1.69 mg $100g^{-1}$) was observed in NRL-2101.

Evaluation of Zn efficiency under field conditions

Chelate-buffered nutrient solution (used in above study) provides Zn activities similar to that of zinc deficient soil for plants growth, however many other factors in soil also contribute towards the plant growth. It is necessary to evaluate the response of few genotypes under field conditions to validate the findings of hydroponics studies. Therefore, the field experiment was carried out with three wheat genotypes (1 Zn-efficient, 1 medium and 1 Zn-inefficient) at two levels of Zn (0, 5 kg ha^{-1}) in Split Plot design. Soil samples were collected from the experimental plots to assess the initial level of Zn concentration and other physico-chemical parameters of soil. The available Zn in experimental site was found to be 0.20 µg g^{-1}. The recommended rates of P (90 kg ha^{-1}) and K (60 kg ha^{-1}) were applied as basal dose at the time of sowing whereas recommended N (120 kg ha^{-1}) was applied in two splits, at sowing time and with first irrigation. The significantly (P≤0.05) higher grain yield (5344 kg ha^{-1}) was produced by *cv.* CTHN-162056 without applying Zn, whereas Zn-inefficient genotype (NRL-1928) produced significantly (P≤0.05) lower yield of 4022 kg ha^{-1} at Zn-deficient level. However, this genotypes showed 19% increase when treated with 5 kg Zn ha^{-1}. The Zn-efficient genotype (CTHN-162056) showed only 6% increase with Zn application.

Demonstration of productivity enhancement through climate smart agriculture through on-field trials (OFTs)

Wheat is the staple food crop of Pakistan. The annual wheat production at national level is not enough to meet the food requirements of rapidly growing population. National yield of wheat is very low compared to reported achievable yield of high yielding approved varieties by agricultural scientists in the country. It can be attributed to a variety of factors like untimely and imbalanced use of chemical fertilizers and little know-how about recommended production technology packages at farmers' level are the key factors responsible for low wheat productivity. There exists enormous potential to enhance

productivity by narrowing the yield gap between achievable and average yield. This yield gap can have serious repercussions for national food security situation but it can be bridged by adopting the novel production technology developed by national and international institutions. The objective of the project was to compare farmers' existing practices with NIFA and IAEA climate smart agriculture technology (CSA) package for enhancing the overall production of wheat in the country and to reduce the gap between achievable and national average yield.

To achieve the project objectives, five (05) sites at different locations of Khyber Pakhtunkhwa were selected for establishing the on-field demonstration trials (OFTs). Prior to the sowing of the field trials, soil samples were collected and analyzed for various physico-chemical properties. The wheat variety (NIFA Lalma) was sown at normal sowing time using four fertilizer treatments i.e. control (no fertilizer), farmer's practice (80-25-0 kg NPK ha^{-1}), NIFA practice (120-37-0 kg NPK ha^{-1}) and IAEA practice (230-30-50 kg NPK ha^{-1}). The OFTs at all locations received usual agronomic management and recommended input applications (water, fertilizer, weedicides etc.) as admissible under a given practice.

Sowing of wheat under OFT at Charsadda

Pictorial View of OFT at Mardan

Data recording of OFT at Charsadda

The trials were harvested at physiological maturity and data on yield and yield components were recorded. The findings of OFTs depicted that average grain yield (4.32 t ha^{-1}) of NIFA practice was better than CSA (4.16 t ha^{-1}). Cost-benefit ratio of NIFA practice (3.42) was found to be better than CSA (2.62) as well.

Integrated nutrient management of deciduous fruit (peach) orchards

A field experiment on deciduous fruit (peach) having two varieties (Early Grand and Florida King) is in progress at NIFA farm. The objective of study is to develop an appropriate combination of organic and inorganic fertilizers for young deciduous fruits orchards. In the experiment there are six treatments with three replications in Randomized Complete Block design and one tree per treatment. NPK were applied at the rate of N, P, K & Zn @ 90, 75, 60 & 30 g $tree^{-1}$ respectively to peach trees. Treatments include i) control, ii) 100% NPK from mineral fertilizer (MN), iii) 75% MN+ 25% Farm Yard Manure (FYM), iv) 50% MN+ 50% FYM v) 25% MN+ 75% FYM, vi) 100% FYM. All mineral fertilizer and FYM were applied to the periphery of tree canopy. Half of N fertilizer and FYM was applied before flowering, remaining half MN and full P K and Zn were applied in the month of August. The data of peach variety 'Florida King' demonstrated that treatment T5 which combined the application of 75% FYM and 25% MN, recorded the significantly longest branch length (286 cm) and weight of the product after pruning (35 kg/plant). Significantly highest levels of N (2.50%), P (1367 ppm), and K (5750 ppm) were recorded in the leaves of the treatment T5 that included 75% farm yard manure and 25% mineral fertilizer. Flowering in *cv.* Florida King started from 1st February and continued to full bloom up to 22nd February. Only seven out of the total 18 experimental plants gave fruit yield in 2023. Less than ten fruits per plant were recorded, while the treatment T5 of replication 2 with 75% farmyard manure and 25% mineral fertilizer recorded the highest number of fruits (22). Soil analysis of the fruit orchard under *cv.* Florida King revealed that field applied with 25% mineral fertilizer and 75% farmyard manure had the significantly highest levels of organic matter (1.21%), nitrogen (0.06%), available phosphorus (6.43 ppm), and potassium (127 ppm). The field under *cv.* Early Grand when treated with 75% farmyard manure and 25% mineral fertilizer, the plants had significantly longest branch length (206 cm) and weight of the pruned product (26 kg/plant). Significantly maximum leaf N (2.26%), P

(1450 ppm), and K (5450 ppm) concentrations were obtained in treatment T5. Flowering in Early Grand variety started from 16th January and continued to full bloom up to 14th February. Sixteen out of 18 experimental plants produced fruit in 2023. Maximum number of fruits (74) were reported in treatment T5. Significantly higher organic matter (1.22%), nitrogen (0.061%), available phosphorus (6.46 ppm), and potassium (128 ppm) were found in the treatment where 25% mineral fertilizer and 75% farm yard manure were applied to the field of the Early Grand.

Improving off-season vegetables production under high tunnels through integrated nutrients and water management

Urbanization as a consequence of population increase leads to increased demand of natural resources (cultivated land and fresh water) for industry, agriculture and municipal uses that leads to decline in already scarce resources. Modern agricultural technologies can contribute in overcoming food security challenges in Pakistan. With the increasing world population and declined cultivable land coined the idea of vertical farming in tunnels and this farming system is getting increased popularity among the farmers of Pakistan.

In Khyber Pakhtunkhwa province the temperature during the months of December and January is very low leading to the problem of frost that makes it impossible to grow early summer vegetables during these months. Therefore, to avoid frost and low temperature deteriorations, tunnel farming is the most viable option for higher production and early availability of summer vegetables than normal crops. This not only results in the availability of vegetable for longer duration but also a significant source of employment and income increase for farmers.

Tomato and cucumber are important vegetable crops in Pakistan. The production of off-season tomatoes and cucumbers under high tunnels has assumed great significance in the irrigated areas of KP. Tunnel farming is suitable for tomato and cucumber that can be grown 4-6 weeks earlier and is economically viable in terms of fertilizer and water use. This early cultivation results in the increase in vegetable yields with more marketing opportunities and cash flow. These issues were addressed through applied research and the high tunnel farming for growing off-seasons vegetables was popularized among the farming community.

A trial under tunnels was conducted to study the effect of integrated NPK and FYM

treatments on the yield of hybrid tomatoes and cucumbers. The properly decomposed FYM @ 100 kg/Marla was applied before transplanting nursery while NPK doses were applied after establishment of crop (30 days after transplanting). The significantly ($P \leq 0.05$) highest marketable tomato yield (1.67 t / 250 m^2) and N, P & K uptake (5.19, 2.49 & 7.31 kg / 250 m^2) were recorded where NPK was applied @ 75-75-90 kg ha^{-1} at 30 days intervals. Similarly in another study, cucumber was grown in high tunnel at different intervals. The yield data indicated that significant differences ($P \leq 0.05$) were recorded for cucumber yield and NPK uptake among the treatments. Maximum cucumber yield (2.9 t / 250 m^2) and uptake (8.68, 4.34 & 8.83 kg / 250 m^2) were found under 10-10-15 kg ha^{-1} at 7 days intervals. Foliar application of Zinc & Boron @ 0.75% & 0.5%, respectively further increased cucumber yield by 20%.

Briefing the farmers about tunnel faming

Monitoring the long term impact of conversion to organic farming systems

Green revolution introduced fertilizer responsive wheat varieties that enabled the farmers to achieve higher yield at the expense of deterioration of soil health, loss of biodiversity and increased cost of production. Under the current onslaught of climate change and rising costs of chemical fertilizers, sustainability of wheat farming particularly by small farmers is at high risk. Situation demands to identify farming approaches having potential to achieve higher returns from farming without compromising soil health. Organic farming offers the opportunity but systematic long term research is needed to generate data driven evidence in the support of this sustainable approach of farming.

To address the above stated issues, a long term field trial has been established at the experimental farm of the institute since 2018-2019 and trial is in progress during 2022-2023. Wheat and potato were sown under each of the chemical and organic farming system during winter season. During summer season, maize and sesbania were planted under chemical and organic farming systems, respectively.

Results from trials on wheat revealed significant differences (P≤0.05) between farming systems for grain yield, water use efficiency, protein contents, nitrogen and phosphorus uptake. Grain yield of 8.9 and 7.0 t ha^{-1} was recorded under chemical and organic farming systems, respectively. Water use efficiency was higher under chemical (23 kg ha^{-1} mm^{-1}) than under organic farming systems (18 kg ha^{-1} mm^{-1}). Protein contents were found higher under chemical (10%) than under organic farming (9%). Uptake of nitrogen by wheat plants was higher under chemical (191 mg $plant^{-1}$) than under organic farming systems (167 mg $plant^{-1}$). Phosphorus uptake exhibited a similar trend showing higher uptake under chemical (47 mg $plant^{-1}$) than under organic farming systems (43 mg $plant^{-1}$). Significant differences (P≤0.05) were observed between farming systems for yield of potato as higher tuber yield was recorded under chemical (10.8 t ha^{-1}) than under organic farming systems (9.4 t ha^{-1}).

Preliminary findings from the ongoing long term trial depicted the soil fertility can be maintained under organic farming systems without compromising yields to a greater extent. The project is anticipated to develop a production technology package for organic wheat and potato.

Screening of wheat genotypes for water use efficiency

Water is becoming a limiting factor for crop production. Climate change induced water scarcity is anticipated to exacerbate particularly for rain-fed areas of the country. Situation demands to identify wheat genotypes that can produce higher grain yield with minimal input of water. Water consumption of existing genotypes needs to be studied experimentally using nuclear techniques to identify the water use efficient genotypes. This information on water use efficiency of existing genotypes helps in devising recommendations of genotypes and varieties for water scarce areas besides its further exploitation in the varietal development program.

A field experiment was conducted at the experimental farm of the institute to compare water use efficiency of three wheat varieties in a two factor factorial experiment. The varieties were assigned to sub-plots whereas irrigation and no supplemental irrigation (rain-fed) was assigned to main plots. Neutron scattering moisture probe was used to assess water consumption and water balance approach was used to determine water use efficiency of varieties.

Findings of the study revealed that significant difference (P≤0.05) were observed between irrigated and rain-fed conditions for water use efficiency and uptake of nitrogen, phosphorus and potassium. Varieties also differed significantly (P≤0.05) for the uptake of nitrogen, phosphorus and potassium. Data depicted that that varieties had higher water use efficiency and uptake of nutrients under irrigated conditions than under rain-fed conditions. Lalma was found the most water use efficient variety followed by Aman and Awaz under irrigated conditions. Under the rain-fed conditions, Awaz was found the most water use efficient variety followed by Aman and Lalma.

Enrichment of agro-waste compost for nitrogen and phosphorus contents

Intensive use of chemical fertilizers to improve crop yield would be unsustainable owing to ever rising prices of chemical fertilizer products and environmental concerns. Sustainable crop production demands to partly shift towards organic production that is constrained by non-availability of good quality organic fertilizer products. Agro-wastes can be converted into compost (slow release organic fertilizer) for the improvement of soil fertility. Compost has the potential to be used as fertilizer and may serve as partial substitute for intensively used chemical fertilizers in crop production. Compost products available in local market are mostly developed from urban/ municipal wastes and may contain toxic elements (heavy metals) and have low contents of essential plant nutrients (Nitrogen-2%, Phosphorus-0.3%). Demand for organic production is on continuous rise and necessitates to develop and deploy nutrient enriched compost product by exploiting naturally available sources of plant nutrition.

The current study aims to develop nutrients enriched compost product, particularly to be used by nursery and vegetable growers. For this purpose, various organic/ inorganic sources of plant nutrition like rock phosphate (RP), poultry manure (PM), filter cake (FC), animal manure (AM), blood meal (BM), mushroom spent (MS), etc. were analyzed for their nitrogen (N) and phosphorus (P) contents. Results revealed that fish bone meal had the maximum nitrogen (4.95%) and phosphorus (1.2%) contents.

A composting trial was established at the existing composting facility of the institute. For this trail N and P rich materials were mixed with agro-wastes i.e. green plant material (GPM) and dry plant material (DPM) in various formulations for the preparation of enriched compost. Analysis of

mature composts revealed that, maximum N (1.74%) was recorded when agro-wastes (GPM+DPM) were enriched with animal manure, rock phosphate & mushroom spent, while maximum P (2.09%) was found when agro-wastes were enriched with animal manure, rock phosphate, filter cake, poultry manure & green soil (a microbial product).

Enrichment of compost tea for its nutritive value

Compost tea (liquid extract of compost) has the potential to be used as fertilizer and may serve as partial substitute for intensively used chemical fertilizers particularly for small scale production of horticultural crops. It has the potential of plant production improvement by enhancing plant nutrient status, decreasing disease incidence and generally promoting plant growth. Its use as a liquid fertilizer may reduce burden on farmers pocket as it is economical source of plant nutrition, eco-friendly and easy to formulate. Use of compost tea in Pakistan is not quite common on account of its low nutritive value, lack of indigenous research and limited awareness amongst farmers. The current study addresses these issues through applied research on enrichment of nutrient content of compost tea for use by farming community.

A number of organic sources of plant nutrition to be used for compost tea enrichment were analyzed for their nutrient contents. Analytical findings depicted that sheesham leaves and saw dust had the maximum N (3.08%) and P (1%) contents, respectively. The selected materials were then utilized in different combinations for the enrichment of compost tea.

Findings from another study on the tea enrichment revealed that highest value of nitrogen was recorded in compost tea enriched by using vermi-compost (252 ppm), followed by blood meal (232 ppm)

PLANT PROTECTION DIVISION

Biological Control

Bio-control technology represents an environmentally friendly approach to managing various economically significant insect pests. *Trichogramma*, a widely distributed bio-control agent, plays a crucial role in controlling L epidopterous pests such as tomato fruit worm, cutworms, armyworms, sugarcane borers etc. These minuscule egg parasitoids are effectively mass-reared and released to efficiently manage insect pests in major crops. Notably, fruit worms such as *Helicoverpa armigera* and wheat aphids like *Schizaphis graminum* pose serious threats to tomato and wheat crops, respectively, resulting in substantial losses. To combat these challenges, extensive research and development (R&D) efforts are being undertaken to devise and implement eco-friendly techniques such as bio-control, entomo-pathogenic fungi, pheromone trapping, and host plant resistance. These strategies aim to minimize pesticide usage, mitigate environmental impact, and bolster crop productivity.

Assessment of parasitizing potential of *Trichogramma* under different storage conditions

The assessment of the parasitizing potential of Trichogramma under different storage conditions is a crucial aspect of biological control strategies. Proper storage conditions are essential to maintain the quality and effectiveness of Trichogramma before they are released into the field. The parasitic efficacy of *T. chilonis* was evaluated across different storage conditions. Findings revealed that the highest parasitism rate (57%) was achieved at a temperature of 25±1ºC and relative humidity (R.H.) of 65±5% within plastic jars. Additionally, the longest longevity, spanning 9 days, and the shortest developmental time of 22 days were observed at 18±1 ºC and 75±5% R.H within the same plastic jar environment.

Evaluation of various wheat varieties on the biological parameters of *Sitotroga cerealella*

The results demonstrated notable findings in terms of progeny development, fertility rate, developmental time and fecundity. Specifically, under in vitro conditions, the highest progeny development, totaling 192 adults, and the highest fertility rate of 84% were observed in NIFA Insaf. Additionally, NIFA Insaf exhibited the minimum

developmental time of 22 days. On the other hand, Fakhr e-Sarhad showcased the highest fecundity, with a recorded count of 139 eggs per female under the same in vitro conditions.

Screening of different plant extracts against stored grain pests under laboratory conditions

Different plant extracts were evaluated for their efficacy against stored grain pests. The findings revealed that clove and garlic oil exhibited the most promising results in laboratory conditions. Specifically, these extracts demonstrated the lowest adult emergence, with only 9 and 21 adults. Moreover, they exhibited the longest developmental time, ranging from 32 to 33 days, and the lowest fecundity rates of 47 and 30 eggs per female. Additionally, the longevity of the pests was significantly ($P \leq 0.05$) reduced to just 7 days when exposed to these plant extracts.

Monitoring of moth population of Fruit worm, *Helicoverpa armigera* (Hub.) through pheromone baited traps in high tunnel tomato vs. field chickpea

The highest number of fruit worm moths was captured in pheromone baited traps, notably 15 per trap in April, within the chickpea field. This was followed by March (12), May (9), and June (6). Conversely, in the high tunnel tomato field, the peak capture of moths occurred in April, registering 9 moths per trap. Subsequently, the moth captures during March to May remained consistent at 6 per trap, followed by a decrease in June to 3 moths per trap. During January to February, no moths were captured in either of the crops. Overall, the period of March to May exhibited the highest activity of fruit worm moths in both crops.

Isolation and evaluation of Entomo-pathogenic fungal strains against tomato fruit worm, *Helicoverpa armigera* (Hub.) in vitro condition

A comprehensive field survey was undertaken, involving the collection of 180 soil samples from various crops and localities. Using the Galleria bait technique (GBT), a total of 97 fungal isolates were successfully obtained. These isolates were further identified through morphological characterization using taxonomic keys under a microscope. In subsequent laboratory trials, the effectiveness of these fungal strains against the tomato fruit worm was evaluated. Notably, petri dishes treated with fungal strain-1 exhibited the highest mortality rate at 82%, followed by fungal strain-2 at 67%, and fungal strain-3 at 63%. Mortality rates were observed to be directly proportional to the concentration of spores. For instance, a concentration of $1x10^8$ spores/ml resulted in

a mean mortality rate of 85.2%, followed by 70% and 56% mortality in concentrations of $1x10^7$ and $1x10^6$ spores/ml, respectively. Among the fungal strains tested, fungal strain-1 proved to be exceptionally effective in controlling the tomato fruit worm, showcasing its potential for pest management applications.

Isolation of Entomo-pathogenic fungi from soils of field crops through galleria bait technique

Assessment of irradiation doses for male sterility of tomato fruit worm, *H. armigera* and subsequent mating compatibility with wild females in Lab. and high tunnel tomato

The study's findings revealed that irradiation doses at 150 and 200 Gy effectively induced sterility in male adult moths of *H. armigera*.

Male pupae of tomato fruit worm, Helicoverpa armigera ready for irradiation doses

Upon mating with these irradiated sterile males, wild females laid 3 unviable eggs in field conditions and 10.7 unviable eggs in laboratory conditions. Interestingly, no egg hatching was observed in either of the treatments involving wild females mated with males treated at 150 Gy or 200 Gy. In contrast, in the control treatment where wild females were mated with untreated (wild) males, a substantial number of viable eggs were laid. Specifically, the maximum viable eggs counted were 149 in the field and 163 in the laboratory. The hatchability of these eggs was 90.4% in the field and 74.6% in the laboratory, highlighting the efficacy of irradiation in inducing sterility and reducing egg hatchability in *H. armigera*.

Releases of irradiated tomato fruit worm males in caged tomato plants for SIT control

Effect of natural and artificial diets on fruit worm, *Helicoverpa armigera* biology

The study results highlight the remarkable differences observed in the development and performance of *H armigera* larvae under various artificial diets. The shortest larval

period, measuring 12.7 days, was recorded in the chickpea flour-based artificial diet. This was followed by the soybean artificial diet (14.5 days), common bean artificial diet (15.0 days), mungbean artificial diet (15.5 days), and natural okra diet (16.5 days). Conversely, the longest larval period, at 17.5 days, was observed in the maize flour-based artificial diet. Additionally, the chickpea flour-based artificial diet exhibited the lowest mortality rate at 4.0%, the shortest pupal period at 10.5 days, highest adult emergence at 83%, greatest fecundity at 598.2 eggs per female, and the highest male-to-female sex ratio at 42:64. In terms of female longevity, the soybean flour-based diet recorded the highest at 13.3 days, followed by common bean, chickpea, natural okra, and mungbean flour-based diets at 12.1, 11.4, 11.2, and 11.0 days, respectively. Conversely, the maize flour-based diet recorded the lowest female longevity at 10.2 days. In conclusion, the findings emphasize the remarkable effectiveness of the chickpea flour-based artificial diet, exhibiting the shortest larval and pupal periods, low mortality rate, high adult emergence, and fecundity compared to the other diets tested.

Host plant resistance studies in different wheat genotypes against aphid

In a comprehensive assessment of 1117 wheat genotypes, varying levels of resistance to wheat aphids were identified. Among the genotypes analyzed, 44 were categorized as resistant, 264 exhibited moderate resistance, and 328 were classified as having low resistance. Additionally, 217 genotypes were found to have low susceptibility, while 122 were moderately susceptible. Finally, 142 genotypes were identified as highly susceptible to wheat aphids.

Termites

Addressing the challenge posed by subterranean termites, which are elusive and difficult to control, is a pressing concern. The conventional methods predominantly reliant on repellent synthetic insecticides are not only expensive but also environmentally detrimental. The Termite group is dedicated to demonstrating the potential effectiveness of utilizing plant extracts as sustainable and environmentally friendly alternatives for subterranean termite control. This initiative has the power to transform termite management by introducing organic, safe, and cost-effective solutions, thereby mitigating the environmental risks linked with traditional approaches. Additionally, our research explores the innovative realm of bait technology, a rapidly advancing trend in global termite management. This approach is gaining traction due to its sustainability, eco-

friendliness, and ease of use, making it an attractive strategy for termite management.

Exploitation of insecticidal characteristics of local plants for management of subterranean termites

Tests were conducted to evaluate the toxicity, deterrence, feeding behavior and residual effects of both water and alcohol-based clove bud extracts against subterranean termites. The results were clear, indicating significant toxicity and strong deterrence even at a minimal concentration of 1%. Upon performing a biochemical analysis using GCMS on the ethanolic extract of clove buds, 19 chemical compounds were identified. The primary compound, "Eugenol" scientifically known as Phenol, 2-methyl-3-(2-propenyl)-, constituted the highest proportion at 63.25%. Another significant compound was "Eugenyl acetate," or Phenol, 2-methoxy-4-(2-propenyl)-, acetate, comprising 23.05%. Eugenyl acetate is a derivative of Eugenol and is essential for the termiticidal properties found in clove extract.

The general composition of the clove bud extract included primarily Tannins, followed by Terpenoids, Flavonoids, Phenols, and trace amounts of Alkaloids, Steroids, Carbohydrates (sugars), Proteins/Amino Acids, and Saponins. In addition to clove, the anti-termite properties of Tobacco, Marigold, and Parthenium extracts were also evaluated. Among them, Tobacco exhibited moderate toxicity but lacked deterrence. On the other hand, Marigold and Parthenium extracts demonstrated limited effectiveness against subterranean termites.

Development of local attractive bait matrix and toxin delivery foraging stations for control of subterranean termite species

The experiments included testing three concentrations of methyl cellulose (25%, 50%, and 100%) to enhance the efficacy of newly developed bait matrix. In aggregation trials, the 50% methyl cellulosic baits exhibited the highest termite aggregations at 40% after 8 days, alongside the highest weight consumption at 18% after 16 days ($P \leq 0.05$). A total of 8 active foraging points were established, with 5 located within NIFA and 3 outside NIFA. Laboratory trials revealed a significant proportion of 34% of the tested termites aggregating towards the developed solid bait matrix compared to the other three cellulosic materials. Additionally, the developed bait matrix demonstrated the highest consumption rate at 22% ($P \leq 0.05$) compared to the other cellulosic materials.

In semi-field condition trials, the developed solid bait matrix consistently outperformed the other tested materials, achieving a maximum aggregation of termites at 44%.

Similarly, the developed bait matrix displayed a consumption rate of 20% ($P \leq 0.05$). These findings underscore the effectiveness of the 50% methyl cellulosic bait and the developed solid bait matrix in termite aggregation and consumption, both in laboratory and semi-field conditions.

Fruit Flies

Fruit flies (Diptera: Tephritidae) stand as formidable pests of horticultural crops worldwide, inflicting significant damage to a diverse array of fruits and vegetables, causing substantial losses to farmers and affecting traders, retailers, and exporters. The prevalent control approaches often involve extensive pesticide use, posing potential health risks and resulting in detrimental consequences such as the destruction of beneficial insect fauna, environmental pollution, and the development of insect pest resistance. Given the pressing need for more sustainable and environmentally friendly pest control methods, ongoing research in the domain of fruit flies is directed towards the development and application of alternative control strategies. These strategies are intended to be integrated into an overarching Integrated Pest Management (IPM) system, aiming to combat these quarantine pests effectively while minimizing the adverse impacts on human health and the environment.

Maintenance of fruit fly culture in laboratory

Infested fruits, including guava, peach, banana, and mango, were collected from a local fruit market and set aside for pupal recovery, initiating the establishment of a fruit fly colony. Specifically, colonies of the peach fruit fly, *Bactrocera zonata*, and the oriental fruit fly, *Bactrocera dorsalis*, were cultivated and carefully maintained in the laboratory. These colonies were nurtured on their respective natural host fruits, ensuring their viability and health for use in a range of experimental studies.

Natural hosts exposed to Fruit fly (*Bactrocera zonata*) for oviposition in cages

Feasibility of using Methyl Eugenol in combination with various food baits and ammonium acetate for the attraction of fruit fly *Bactrocera* spp. in guava orchard

Field studies were conducted to assess the attractiveness of various food baits, including protein hydrolysate, torula yeast, casein, yeast instant and sugar molasses in combination with ammonium acetate and

methyl eugenol for *Bactrocera* species in a pear orchard. The specified concentrations of these food baits were prepared by mixing them with 200 ml of water and were then placed in locally designed traps made from 1.5-liter cold drink plastic bottles. These traps were strategically positioned at a height of approximately 2 m on trees within the orchard and were spaced at suitable intervals from each other. No toxicants were introduced into the food baits. Data was systematically recorded at weekly intervals, encompassing the total number of *B. zonata* or *B. dorsalis* captured, their sex ratio, and the combined population of both species. The findings indicated a notable 70% increase in the attractiveness of food baits towards male flies of *B. zonata* and *B. dorsalis* with the addition of methyl eugenol. However, this addition resulted in 80% reduction in the attraction of female flies, rendering the bait blends less ideal for further studies.

Locally designed traps with food baits for mass trapping of fruit flies in guava orchard

Comparative screening of fruit juices and selected baits blended with ammonium acetate for mass trapping of fruit fly, *Bactrocera* species

Field trials were conducted to evaluate the field efficacy of selected food baits, including protein hydrolysate, yeast instant, and sugar molasses, in combination with ammonium acetate at a concentration of 3%. These were compared to guava and banana juices, both individually and in combination with ammonium acetate. The various concentrations of these food baits were meticulously prepared using 200 ml of water and then transferred to traps designed with entrance holes for the flies. These traps were strategically positioned within the fruit orchard, hanging on trees at an approximate height of 2 m and spaced at suitable intervals. Guava juice, both alone and in conjunction with ammonium acetate, demonstrated significant results by attracting a notably higher population of *B. zonata* and *B. dorsalis*, approximately 30-40% more. Consequently, this significantly impacted the combined population of both species compared to the other tested blends of food baits. Conversely, the population of flies captured in traps utilizing the other three baits (protein hydrolysate, yeast instant, and sugar molasses, each in combination with

ammonium acetate) did not show any significant differences.

Diversity and incidence of fruit fly species in various fruits of Peshawar region

A detailed investigation was conducted to analyze the diversity and incidence of fruit fly species in various fruits obtained from diverse localities within the Peshawar region. The study involved the collection of infested fallen fruits from orchards, which were then transported to the laboratory and carefully preserved for pupal recovery. A designated pupal chamber, filled with sawdust, was utilized for this purpose. Pupae were subsequently extracted by sieving the sawdust and then transferred to adult cages for further observation. Detailed data was meticulously recorded, encompassing pupal recovery rates, adult emergence, longevity, sex ratio, and precise species identification. The findings of the study unveiled those two prominent fruit fly species, namely *B. zonata* and *B. dorsalis*, were highly prevalent in the Peshawar region. The highest infestation and pupal recovery rates were observed in peach, followed by guava. Conversely, the lowest infestation and pupal recovery rates were recorded in loquat, followed by apricot. On a broader scale, the prevalence of *B. zonata* was found to be three times higher compared to that of *B. dorsalis* within the Peshawar region, shedding light on the relative abundance of these species in the area.

Assessment of various artificial adult diets for economized rearing of fruit flies

The study aimed to investigate the impact of different protein-based adult diets on the growth and development of *B. zonata* under optimal laboratory conditions. Various treatments were employed, utilizing yeast, casein, and protein hydrolysate, each at three different concentrations (1:3, 2:3, 1:1) and in two different forms (solid and liquid).

The results revealed that *B. zonata* fed with yeast (2:3) in solid form exhibited the shortest pupal duration (5.88 days), the longest adult life (66.16 days), and the highest male and female adult life spans (66.60 and 65.80 days, respectively). Furthermore, adult flies fed with yeast (1:1) in solid form displayed the maximum adult male and female weights (6.66; 8.29 mg), while the casein liquid diet (1:1) provided the highest pupal weight (14.54 mg). The highest number of *B. zonata* pupae (781.67) was recorded for yeast (1:3) in liquid form, and the maximum percentage of female adult emergence (58.66%) was noted for adults fed with protein hydrolysate (1:1) in solid form. The study's conclusion highlighted those diets in solid form had a more pronounced

impact on the growth and development of *B. zonata*. Additionally, the research demonstrated that *B. zonata* could be effectively reared using an artificial adult diet comprising inexpensive, locally available ingredients such as yeast. Based on the study's findings, it is recommended to utilize yeast (2:3) in solid form for efficient laboratory rearing of *B. zonata*, aiming to save both time and resources.

Effect of gamma irradiation in the production of pest free commodities

Insect pests pose a considerable threat to fruits and vegetables, easily transported to new regions through trade. Their infestations wreak havoc on food production and present alarming health hazards. In response to this pressing concern, dedicated research has honed in on radiation as a phytosanitary treatment to rid agricultural commodities of quarantine pests, thereby promoting safer trade. These pivotal studies were initiated under the aegis of an IAEA-funded project titled “Investigating the Effect of Gamma Irradiation in the Production of Pest-Free Commodities for Trade Promotion in Pakistan and Elsewhere (IAEA RC-24975)”. The project endeavors to harness the potential of gamma irradiation to guarantee pest-free commodities, bolstering the safety and efficiency of agricultural trade, not only within Pakistan but also on an international scale. Result of studies specifically conducted on mealybug during the period under report are presented.

Host preference and life cycle study

A mealybug colony was established using specimens collected from infested crops in the field. Subsequently, comprehensive host preference studies were conducted, involving free choice and no-choice tests for mealybugs. The results demonstrated a higher attraction of crawlers to okra, followed by pumpkin, potato, and apple gourd in both types of tests. Further observations conducted in controlled laboratory conditions revealed notable variations in the life cycle duration for the cotton mealybug on different host plants. Specifically, the life cycle was completed within approximately 33.37 days on okra, 30.4 days on pumpkin, 32.26 days on potato, and 27.31 days on apple gourd, highlighting the influence of host plant on the mealybug's development and life cycle.

Radiation study

Experiments were conducted involving batches of neonates and nymphs at different developmental stages, exposing them to varying doses of gamma irradiation, namely

50, 100, 150, and 200 Gy. The results indicated a dose-dependent effect on the survival of mealy bugs, with the mortality rate escalating as the radiation dose increased. Remarkably, the 3rd instar nymphs irradiated at 50 Gy demonstrated the highest neonate production, yielding an average of 112 neonates ± 7. The trend continued with the 100 Gy dose, showing a substantial number of neonates as well. However, nymphs at the 3rd stage and adult mealy bugs exposed to 150 Gy and higher doses exhibited a notable inability to produce any neonates or progress further in their development. This underlines the significant impact of gamma irradiation on the reproductive capabilities and survivability of mealy bugs.

Plant Pathology

Crop diseases impose a significant and extensive impact, easily spreading within a season and persisting from one season to the next. These diseases incur costs through direct yield losses, expenses related to chemical control, and the upkeep of disease resistance. Preemptive control programs are essential to mitigate the risk posed by new pathotypes and virulence. Below, we present the research and development outcomes conducted under the plant pathology program during the period under report:

Status and seasonal progress of airborne and vector borne diseases

A diverse collection of 208 wheat genotypes was cultivated in stationary sentinel plots at the NIFA farm, specifically curated for comprehensive epidemiological investigations concerning yellow rust, leaf rust, powdery mildew, and barley yellow dwarf. Over the course of the study, six distinct temporal disease assessments were meticulously documented. Yellow rust manifested initially as sporadic flickering in early March, and following its latent period, it markedly intensified in the latter part of the month, exhibiting a disease severity range of <1 to 24%. Notably, an escalation in yellow rust severity was observed as time progressed, with its mean value peaking at 50% during the initial week of April. Conversely, leaf rust and powdery mildew did not manifest throughout the season at the NIFA farm. The aphid-borne barley yellow dwarf disease, affecting wheat, was prevalent in only 10 genotypes (5%), showcasing varying severity levels between 30-80%. Encouragingly, disease symptoms subsided towards the end of March. This meticulous plays a pivotal role in enhancing our understanding of various wheat pathogens, aiding in the development of disease-resistant

wheat varieties, ultimately contributing to sustainable food security.

Pathogen intelligence and efficacy of all stage resistance genes

Understanding *Puccinia striiformis* f. sp. *tritici* (*Pst*) virulence, detection of durable resistance sources, and the cultivation significance of all-stage *Pst* resistance genes are essential for effective rust management and promoting host resistance development and use. We conducted a comprehensive investigation into the temporal variability of natural *Pst* virulence and races throughout the growing season at the NIFA Farm. Throughout the season at the NIFA farm, we identified and characterized five distinct Pst races: 18E136, 26E170, 26E234, 90E234, and 127E255, each presenting a range of 5-33 virulence factors. Notably, race 127E255 exhibited the broadest virulence spectrum, with the potential to target up to 33 yellow rust resistance host genes. Encouragingly, critical yellow rust resistance genes, such as *Yr1*, *Yr8*, *Yr9*, *Yr10*, *Yr15*, *Yr24*, *Yr26*, *Yr32*, *Yr41* and *YrSp*, were found to be unaffected at the NIFA Farm, suggesting their effectiveness in countering the prevailing *Pst* races. Understanding the temporal dynamics of *Pst* virulence and its interactions with host genes is pivotal for developing effective strategies to manage wheat yellow rust, ensuring sustainable wheat cultivation.

Host resistance for *Pst* management

Durable resistance

In order to mitigate the impact of yellow rust across 70% of the wheat landscape in the low altitude districts of the KP Province, it is imperative to minimize the initial inoculum of *Pst* originating from both the source area (i.e., mid and high-altitude districts) and exotic territories. To attain this objective, a thorough examination of 206 registered and approved wheat cultivars was conducted, subjecting them to an artificially induced *Pst* epidemic. The aim was to identify genotypes capable of reducing allo and auto infections, as determined by analysing disease progression data recorded over time, subsequently transformed into the Area Under the Disease Progress Curve (AUDPC) values. The AUDPC values, ranging from 0 to 1820, were crucial indicators. Notably, 24 genotypes exhibited AUDPC values falling between 201-400, signifying a state of moderate resistance and a potential for durability in combating rust progression. These genotypes are strongly recommended for strategic deployment in the source area to effectively manage *Pst* and limit its spread,

ultimately safeguarding wheat cultivation in the region.

Resistance role in disease and yield protection

The study investigated the influence of various levels of resistance in wheat cultivar groups on the development of yellow rust, as assessed by the Area Under Disease Progress Curve (AUDPC), plot yield (g), and thousand kernel weight (g). The cultivar groups were categorized into highly resistant cultivars (Fatehjang-16, Wardan-17, and Pasina17), moderately resistant cultivars (Pakistan-2013, Boroloug-16, Anaj-17), moderately susceptible cultivars (Shafaq-2006, Galaxy-2013, Land race), and a susceptible check (Morocco). Remarkable variability was observed in the measured parameters across these distinct resistance groups. Notably, the highly resistant cultivar group demonstrated a substantial impact, reducing the AUDPC compared to the susceptible check by an impressive range of 95-22%. Additionally, this group displayed a significant increase in yield per plot (g) ranging from 74 to 10%, and a noteworthy improvement in thousand kernel weight (g) varying between 21-10%. These findings underscore the critical role of highly resistant cultivars in effectively managing yellow rust and enhancing both yield and kernel weight, emphasizing the potential for utilizing such cultivars to bolster wheat productivity and resilience against this detrimental disease.

Chemicals testing for *Pst* management and yield protection

Comparative assessment of fungicides

A comparative evaluation was conducted to assess the effectiveness of five fungicides (namely, Tilt, Success, Redomil, Topsin-M, and Cymoxanil plus Mancozeb) using the yellow rust susceptible variety "Morocco" Six replications of the Morocco variety, each comprising 4-rows, were meticulously arranged in a randomized complete block design for the five fungicide treatments, adhering to the recommended doses, in addition to an untreated control. The findings revealed that the untreated control exhibited the highest statistically significant AUDPC values for yellow rust at 1520. Following this, Cymoxanil plus Mancozeb (1062), Success (898), Topsin-M (829), and Redomil (702) also displayed varying degrees of efficacy, with Tilt (104) demonstrating the least disease impact. Interestingly, the parameters of yield/per plot (g) and thousand kernel weight (g) exhibited no significant variability among the treatments, indicating a need for further in-depth analysis to comprehensively understand their impact in this context.

Tilt dose rate testing

The study delved into the impact of varying Tilt doses (ranging from 2% to 6%) on the yellow rust susceptible "Morocco" variety. The experiment encompassed six replications of the Morocco variety, each with 4-rows, meticulously arranged in a randomized complete block design, incorporating the five different Tilt dose-treatments and an untreated control. Remarkably, the 3% Tilt dose exhibited exceptional efficacy, resulting in a substantial 94% reduction in AUDPC, alongside a noteworthy enhancement of 22% in yield per plot (g) and a 5% increase in thousand kernel weight (g). These findings underscore the potential of Tilt at specific doses to significantly curb yellow rust infestation while simultaneously augmenting yield and kernel weight, demonstrating a promising avenue for optimizing disease management strategies and ultimately elevating wheat productivity.

Development of disease resistant wheat germplasm and varieties

NIFA is actively promoting the cultivation of disease-resistant elite wheat germplasm and varieties through a comprehensive national-level initiative that engages 32 key national institutions and private companies. This multifaceted program comprises the cultivation and evaluation of three distinct sets of wheat germplasm: the National Wheat Disease Screening Nursery (NWDSN), a set of candidate future varieties (National Uniform Wheat Yield Trial-Nursery), and a collection of released varieties. This encompassing effort involved the cultivation of 1123 diverse genotypes at the NIFA farm, subjecting them to disease conditions for accurate evaluation. Throughout the growing season, meticulous disease data for each entry in these sets was recorded under local conditions. These invaluable insights will be collated and presented in the final country report by the Pakistan Agricultural Research Council (PARC) in Islamabad. This report will serve as a critical resource for national breeding programs, provincial and federal seed councils, guiding the strategic release and recommendation of cultivars. This strategic approach is instrumental in averting potential epidemics of *Puccinia striiformis* f. sp. tritici (Pst) and ensuring the optimal cultivation of released cultivars, ultimately fortifying the wheat farming landscape.

Wheat seed health risk analyses

Laboratory testing was conducted on seeds from one hundred and ninety-five wheat varieties grown at NIFA Farm to assess incidences of black point and karnal bunt. Each variety underwent meticulous scrutiny, with a thousand seeds per variety being

manually examined for occurrences of black point and karnal bunt using a magnifying lens equipped with a built-in light source. The results indicated that the incidence of black point reached up to 15%, while karnal bunt incidence was observed at 7%. These incidence rates surpass the permissible thresholds, emphasizing the critical need for seed treatment employing appropriate fungicides. Ensuring such treatments is paramount to preventing and effectively managing these diseases, ultimately safeguarding the quality and yield of the wheat crop.

Medical Entomology

Dengue, a vector-borne human disease, has established endemicity within Pakistan. Since a globally effective vaccine remains elusive, the primary approach to mitigate its impact revolves around controlling the responsible vector mosquitoes. Over-reliance on insecticides for vector control has led to health hazards, entomological challenges, and environmental limitations. Consequently, research endeavors are now focused on devising environmentally friendly interventions and fostering the development of an Integrated Vector Management (IVM) strategy against dengue mosquitoes. This approach entails integrating both conventional and novel techniques to effectively combat the spread of dengue.

NIFA Dengue Guard Commercialization

Dengue Guard, developed by medical entomology group, has entered the phase of commercialization in collaboration with the industry. The imminent agreement with Evyol Group of Industries, as part of this initiative, is currently in the MoU preparation stage. Notably, the product patenting application is formally submitted to IPO Pakistan for ensuring protection of its intellectual property. In a proactive step toward public health, 1160 bottles of NIFA Dengue Guard have been distributed to security personnel across multiple PAEC centers. This highlights the commitment to enhance community well-being by providing an effective defense against the dengue virus, particularly in regions where it poses a significant health threat.

Experiments on IGRs and synthetic chemicals in Ovitraps

An infusion made from fish meal at a concentration of 0.5%, containing animal protein, was identified as a potent sensory attractant for mosquitoes within black-colored, cost-effective ovitraps. This infusion significantly impacted oviposition, with a reduction to (≤70 eggs/trap/week) compared

to the control group (≥90 eggs/trap/week). Interestingly, the use of synthetic pesticides within the traps, aimed at larval mosquito control, exhibited some deterrence effects. However, insect growth regulators (IGRs) did not display repellent properties against mosquitoes in the ovitraps.

Hunt for naturally existing tsl mutation in *Aedes aegypti* and *Ae. albopictus* for construction of more robust Genetic Sex Strain (GSS) for SIT

Within the framework of IAEA-CRP (44003) RC-No. 24085, eggs and larvae from both Aedes species were meticulously collected across diverse climatic and topographic regions of Pakistan. To explore the natural occurrence of temperature-sensitive lethal (tsl) mutations for the development of genetic sexing strains, various developmental stages were targeted. These stages included first instar and fourth instar larvae, as well as pupae.

In the pursuit of identifying promising colonies with tsl mutations, heat exposure was applied to these developmental stages. Specifically, two colonies of *Aedes aegypti* and one colony of *Ae. albopictus* were singled out due to their potential resistance. Subsequently, these colonies underwent extensive thermal screening to validate the presence of tsl mutations. The thermal screening involved subjecting first and fourth instar larvae, extracted from mass populations, to thermal exposure at temperatures of 40°C and 41°C for duration of 3 hours. This rigorous screening process was designed to uncover any indications of potential resistance or sensitivity to heat, crucial for the advancement of genetic sexing strains.

SOCIO-ECONOMIC IMPACT

PLANT BREEDING AND GENETICS DIVISION

Plant Breeding & Genetics Division is continuously undertaking efforts to develop high yielding varieties of wheat for both rainfed and irrigated areas of the KP, pulses (mungbean and common bean) and oilseed Brassica. These varieties have a 5-10% edge in terms of yield over already existing varieties being cultivated in the province. These varieties are playing a pivotal role in contributions towards national food security and uplifting living standards of subsistence farmers of the KP. In the year 2022-23, 19200 kg pre-basic seed of NIFA's wheat varieties i.e., Fakhre NIFA 2023, NIFA Awaz 2019 and NIFA Lalma 2013 to cover an area of 384 acres. 455 kg pre-basic seed was produced at NIFA from of NIFA green and black-seeded mungbean varieties i.e. Ramzan, NIFA Mung-17, NIFA Mung-2019, NIFA Mung Spinghar-21 and NIFA Mung Sikaram-21, 110 kg pre-basic seed of NIFA kidney bean varieties "NIFA Lobia Red-22 and NIFA Lobia Yellow-22" produced at NIFA and 70 kg pre-basic seed was distributed to progressive farmer under PSDP Pulses Project for further multiplication on their respective seed multiplication farms in the Kurram.

FOOD AND NUTRITION DIVISION

The Food and Nutrition Division of NIFA is playing an important role in mitigation of malnutrition and thus improve the health and productivity of the Pakistani Population. Spot tests kits developed by NIFA are used by Nutrition International, Iodine Global Network (IGN) private mills, regulatory bodies and nutrition programs, Vitamin A, iodine and Iron spot kits worth Rs. 5.22 million were supplied to various organization for quality control and quality assurance purposes. Development of technologies for Preservation/Value addition of fruit and vegetables to mitigate postharvest losses through conventional and nuclear techniques is major focus of R&D activities of Food and Nutrition Division (FND). Trainings were conducted to transfer technologies to farmers/entrepreneurs to improve their socioeconomic stability. Limited scale production of fruit products for R&D purpose within the institute earned total receipts of around Rs. 0.58389 million during the 2022-2023. Irradiation services were provided to gemstone traders for value addition of gemstones (Topaz, Kunzite, Tourmaline and Quartz etc.). NIFA earned nearly Rs. 1.53 million

from gemstone irradiation services. However, the gemstone traders are the actual beneficiaries as the value of the gemstones is enhanced 3 to 4 times by irradiation. Radiation services were also provided to R&D and academic organizations that earns a good name for NIFA. Food and Environmental safety group continued to provide comprehensive analytical services for food and water testing, generating a total revenue of Rs 536,100/- during 2023. These tests encompassed a wide range of analyses, including chemical, biochemical, and microbial assessments, such as proximate analysis, milk compositional and adulteration testing, and complete water microbial/chemical analyses. A total of Rs. 0.142 was earned from sale of mushroom and mushroom spawn during the year 2022-2023 as part of the mushroom popularization program at NIFA. Moreover, five radio talks were delivered on the subject for a Pushto program "Karkeela" by radio Pakistan Peshawar.

SOIL AND ENVIRONMENTAL SCIENCES DIVISION

Soil and Environmental Sciences Division has devised cost-effective and climate smart agriculture technology packages for key crops of the province. These technology packages are in the process of rapid absorption within farming communities. Through the adoption of packages developed by S&ESD, there had been a remarkable increase in the efficiency of water and nutrients at farm level. This increased input efficiency is being transformed into the improvement in farm productivity and net profit from farming business consequently leading towards uplift of socio-economic conditions. Marginalized communities are the key beneficiaries of S&ESD technology packages as through the use of nutrient efficient wheat genotypes, it is very likely that grain yield may increase by up to 30% besides increase in quality that may help to overcome the mineral malnutrition. Vegetable growers are obtaining up to 10 times more net returns than conventional vegetable farming by practicing NIFA developed tunnel farming technology.

PLANT PROTECTION DIVISION

The economic production of crops faces direct impediments due to the yield losses inflicted by insect pests and diseases. These ailments are suspected to have caused substantial yield reductions ranging from 15-30% in different agro-ecological zones across the country. Emphasizing the economic importance of disease management in crop production, the national wheat improvement sub-program at NIFA, specifically focused on rust resistance, annually contributes a substantial sum of 12.3 million $A towards the economic value of disease control. Other tireless efforts at the

Plant Protection Division (PPD) are channeled into the development of innovative technologies and products aimed at crop protection and disease management. The outcomes of these endeavors are shared with academia, researchers, agriculture extension specialists, and farmers, the ultimate end-users of these advancements. This dissemination of knowledge and technology generates widespread economic benefits, exemplified by products like Dengue Guard, a mosquito repellent, fruit fly traps for effective fly control, tricho-cards for biological control of lepidopteron pests and NIFA Termap for exhaustive trapping of termites, all of which carry substantial economic impact. The availability of these products at approved official rates not only contributes to generating income for the institute but also establishes a sustainable economic model. This model has a positive cascading effect on the environment and ensures economic returns for farmers. The far-reaching impact of these initiatives extends beyond individual farms to enhance agricultural productivity, improve environmental sustainability, and ultimately boost economic prosperity within the region.

PUBLICATIONS

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2. Khalil, S.A., Y. Ali and R. Zamir. 2023. Effect of two different peach cultivars and budding dates on swat local Peach rootstock. Journal Plantarum, 5(1): 49-58.

3. Khattak GSS., I. Saeed, S. Ahmad, A. Wahid, A. Jehan. 2023. Characterization of newly developed high yielding common bean (Phaseolus vulgaris L.) varieties 'NIFA Lobia Red-22 and NIFA Lobia Yellow-22'. Intl. J. Appl. Exp. Biol. 2(2), 133-139.

4. Salim, M., M. Kamran, I. Khan, A. U. R. Saljoqi, S. Ahmad, M. H. Almutairi, A. A. Sayed, L. Aleya, M. M. Abdel-Daim, and M. Shah. 2023. Effect of larval diets on the life table parameters of dengue mosquito, Aedes aegypti (L.) (Diptera: Culicidae) using age-stage two sex life table theory. Sci. Rep. 13: 11969.

5. Salim M., A. Tausef, M. Kamran, A.B. Mubarak A.R. Saljuki, and I. Khan. 2023. Effect of Irradiation on Growth and Development of Pulse Beetle, Callosobruchus maculatus (F.) (Coleoptera: Bruchidae). Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/Journal Xi'an Shiyou Univ. 19: 1139–1158.

6. Khan A., M.Ullah, G.Z.Khan, et al. 2023. Assessment of various colors combined with insecticides in devising ovitraps as attracting and killing tools for mosquitoes. Insects 14 (25). https://doi.org/10.3390/insects14010025.

7. Ahmad, A., G. Z. Khan, M. Ullah et al. 2023. Evaluation of different high doses aqueous plant extracts for the sustainable control of Aedes aegypti mosquitoes under laboratory conditions. Journal of King Saud University – Science 35. https://doi.org/10.1016/j.jksus.2023.10299.

8. Shah S.A., S.A. Ali and P. Khan. 2023. Periodic Variation in Nitrogen Content of Plum Leaves. Acad. Res. J. Agri. Sci. Res., 11(1): 20-26.

9. Raza A., Z. Ali and S. A. Ali. 2023. Standardization of protocol for the formulation of compost tea and its efficacy study on potato. Pure and Applied Biology, 12(2): 1044-1055.

10. N. Akhtar, S.A. Khan, M. Amin, A. A. Khan, A. Ali, S. 2023. Manzoor. Bayesian Estimation of a Geometric Distribution Using Informative Priors Based on a Type-I Censoring Scheme. Statistics in Transition 24(3): 257-63.

11. N. Akhtar, S.A. Khan, M. Amin, A.A. Khan, Z. Almaspoor, A. Ali, S. Manzoor. 2023. Bayesian estimation of a geometric life testing model under different loss functions using a doubly type-1 censoring scheme. Hindawi, Mathematical Problems in Engineering, Volume 2023: 1-14.

FUNDED RESEARCH PROJECTS

Sr. #	Project Title	Project Duration	Total Funds	Principal Investigator	Funding Agency
1.	Environment friendly management of tomato fruit worm, *Helicoverpa armigera* through bio-control, *Trichogramma chilonis* coupled with SIT in tomato/ okra in greenhouse and field conditions	2017-2023	Rs. 5.5 M	Mr. M. Zahid, DCS	IAEA-CRP
2.	Breeding heat tolerant and high yielding chickpea (*Cicer arietinum* L.) genotypes	2020-2023	Rs. 2.147 M	Dr. Iqbal Saeed, PS	PSF
3.	Promoting research for productivity enhancement in pulses	2019-2024	Rs. 24.446 M	Dr. Gul Sanat Shah, CS	PARC-PSDP
4.	Hunt for naturally existing tsl mutation in *Aedes aegypti* and *Ae. albopictus* for construction of more robust Genetic Sex Strain (GSS) for SIT	2020-2025	Rs. 2.298 M	Dr. Misbah ul Haq, PS	IAEA-CRP
5.	Cooperative agreement for mutual trial planting of wheat varieties between CIB, CAS, China and NIFA, Pakistan	2021-2025	Rs. 0.55 M	Dr. Syed Tariq Shah, PS	CIB, CAS, China
6.	Adaptation of Low Energy Machine Generated Radiation Sources for Surface Decontamination and Disinfestation of Food in Pakistan	2021-2026	Rs. 9.17 M	Mr. Alamgeer Khan, PS	IAEA-CRP
7.	Sustainable approaches for effective control of peach stone replant disorders	2022-2025	Rs. 2.8 M	Mr. Shahid Akbar Khalil, PS	PSF
8.	Development of hybrid indirect type solar dryer for drying of fruits and vegetables	2022-2025	Rs. 3.261 M	Dr. Maazullah Khan, DCE	ALP
9.	Strengthening and Enhancing National Capabilities for the Development of Climate Smart Crops, Improvement in Animal Productivity and Management of Soil, Water and Nutrient Resources Using Nuclear and Related Techniques	2022-2025	Rs. 89 M	Dr. M. Imtiaz, DCS	IAEA-TC
10.	Promoting Sustainable Agricultural and Food Productivity in the Association of Southeast Asian Nations Region	2022-2025	-	Mr. M. Zubair Shah, PE	IAEA-RAS

Sr. #	Project Title	Project Duration	Total Funds	Principal Investigator	Funding Agency
11.	Improving the Quality Management Practices in Radiation Processing Facilities for Better Performance and Applications	2022-2026	-	Mr. Alamgeer Khan, PS	IAEA-RAS
12.	Investigating the effect of gamma irradiation in the production of pest free commodities for trade promotion in Pakistan and elsewhere	2022-2028	Rs. 12.52 M	Dr. Inamullah Khan, DCS	IAEA-CRP
13.	Enhancing the Capacity and the Utilization of the Sterile Insect Technique for Aedes Mosquito Control	2022-2026	-	Dr. Gul Zamin Khan, DCS	IAEA-RAS
14.	Breeding Okra Genotypes for Higher Yield	2023-2026	Rs. 2.00 M	Dr. Syed Tariq Shah, PS	ALP
15.	Development of High Yielding Rapeseed Mutants Adaptable to Rain-fed Areas in KP through Nuclear Interventions	2023-2026	Rs. 3.169 M	Hafiz Munir Ahmad, PS	ALP
16.	Production of Black Soldier Fly as sustainable proteinaceous food for poultry industry in Pakistan	2023-2026	Rs. 2.257 M	Dr. Noor Fatima, JS	PSF
17.	Evaluation and deployment of multiple stress tolerant bio fortified wheat germplasm in Khyber Pakhtunkhwa	2022-2024	Rs. 1.5 M	Dr. Farooq i Azam, PS	CYMMIT NARC

EVENTS / TRAININGS ORGANIZED

Sr.	Title	Date	Name of organizers
1.	One-day Refresher Training on "Iodine Analysis for Lab Technicians" Department of Health, KP	07-02-2023	Dr. Zahid Mehmood, PS Mr. Tauqeer Ahmad, JS
2.	10th Training Course for PAF Officials on "Modern Food Handling Techniques"	13-02-2023 to 17-02-2023	Dr. Zahid Mehmood, PS Mr. Tauqeer Ahmad, JS
3.	Use of Electron Beam & X-rays Technology in Industry and Qualitative Analysis of Added Micronutrients in Foods	23-02-2023	Dr. Zahid Mehmood, PS Mr. Alamgeer Khan, PS
4.	NIFA Farmers/Seed Day	15-03-2023	Dr. Farooq- i-Azam, PS Dr. Roshan Zamir, DCS
5.	One-day awareness seminar on Drying of Fruits and Vertical Farming of Vegetables	30-05-2023	Dr. Maazullah Khan DCE Mr. Parvez Khan, PS Dr. Amir Raza, PS Mr. M. Asim Irshad, JS
6.	Popularization and commercialization of insect pests control technologies	25-07-2023	Mr. Muhammad Zahid, DCS Dr. M. Misbah ul Haq, PS Dr. M. Hamayoon Khan, SS
7.	One day workshop on management strategies for insect pests of medical importance.	20-09-2023	Dr. Inamullah Khan, DCS Dr. Gul Zamin Khan, PS
8.	38th Postgraduate training course on "The use of nuclear and other techniques in Food and Agriculture Research".	16-10-2023 to 20-10-2023	Mr. Muhammad Zahid, DCS Mr. Shahid Akbar Khalil, PS
9.	Mushroom Farming Popularization as Cottage Industry	21-12-2023	Dr. Muhammad Ibrahim, PS Mr. Aurang Zeb Khan, PSA

EVENTS / TRAININGS ATTENDED

Sr.	Title	Date	Name	Location
1.	IAEA Regional Meeting on Food Safety	16-10-2023 to 20-10-2023	Mr. Tauqeer Ahmad, JS	NIAB, Faisalabad
2.	Technical Formatting and Filling of Patents/Trade Marks	25-01-2023	Dr. Muhammad Amin, PS Dr. Muhammad Ibrahim, PS	NCP, Islamabad
3.	One-Month Fellowship on ISO/IEC 17043 accreditation requirements as proficiency provider	19-06-2023 to 14-07-2023	Dr. Talat Mahmood, SS	Brin, Bogor, Indonesia
4.	One-Month Fellowship on Advanced Nuclear and Molecular Techniques for Foodborne Pathogen Detection	19-06-2023 to 14-07-2023	Mr. M. Asim Irshad, JS	Brin, Bogor, Indonesia
5.	Travelling Wheat Seminar (TWS-23)	28-02-2023 to 11-03-2023	Dr. Syed Tariq Shah, PS	Different wheat stations and fields
6.	Brain Storming Session on National Wheat Breeding Strategy and line of action for Indigenous Germplasm Development in Country	09-05-2023 to 10-05-2023	Dr. Syed Tariq Shah, PS Dr. Farooq-i-Azam, PS	NARC, Islamabad
7.	Bridging gap between potential and national average wheat yield in Pakistan	20-09-2023	Dr. Roshan Zamir, DCS	AARI Faisalabad
8.	Next Generation Wheat Workshop	26-01-2023 to 27-01-2023	Dr. Farooq-i-Azam, PS	NARC, Islamabad
9.	Patent and Plant Breeder Rights Application Drafting	31-05-2023 to 01-06-2023	Dr. Salman Ahmad, SS	NARC, Islamabad
10.	High-Throughput Phenotyping and Genotyping Tools to Accelerate the wheat breeding for Young-generation Wheat Scientists	17-07-2023 to 18-07-2023	Dr. Akhtar Ali, SS	AARI, Faisalabad

Sr.	Title	Date	Name	Location
11.	Social Research Methodology and Techniques	16-05-2023 to 16-05-2023	Mr. M. Zahid, DCS	PARD, Peshawar
12.	Office Procedure and Management in Public Sector.	04-07-2023 to 07-07-2023	Mr. M. Zahid, DCS Dr. Gul Zamin Khan, PS	PARD, Peshawar
13.	An orientation to E-Government	23-05-2023 to 25-05-2023	Dr. Gul Zamin Khan, PS Dr. M. Hamayoon Khan, SS	PARD, Peshawar
14.	Senior Officer Management Course (SOMC#37)	18-09-2023 to 08-11-2023	Dr. Gul Zamin Khan, PS	PIEAS, Islamabad
15.	IPM, efficient use of pesticides and safety measures	22-11-2023	Dr. M. Hamayoon Khan, SS	Tobacco Research Station Mardan
16.	Filing of Income Tax Return	10-07-2023 to 12-07-2023	Dr. M. Hamayoon Khan, SS	PARD, Peshawar
17.	Planning & Management of Developmental Projects in newly merged Districts	18-07-2023 to 20-07-2023	Mr. M. Salman, SS Mr. Usman Khalique, JS	PARD, Peshawar
18.	Management of Local Government System	14-03-2023 to 16-03-2023	Mr. M. Irfan, JS Mr. Usman Khalique, JS	PARD, Peshawar
19.	Sustainable and Integrated Management of Insect pests and Diseases of Crops	01-11-2023 to 02-11-2023	Dr. Noor Fatima, JS	NIAB, Faisalabad
20.	Sharing of Experience in Nuclear Science and Technology	30-08-2023	Dr. Noor Fatima, JS	PAEC Rest House, Islamabad
21.	One Day Seminar on Bio Safety	22-02-2023	Dr. Muhammad Imtiaz, DCS	Chemical Safety Board, SPD-North, Rawalpindi

Sr.	Title	Date	Name	Location
22.	Regional Training Course on Climate Smart Agriculture to Improve Soil Fertility and Water Use Efficiencies, Combat Salinity, Enhance Nutrients and Increase Productivity of Major Crops in Asia and the Pacific	06-03-2023 to 17-03-2023	Dr. Amir Raza, PS Mr. Parvez Khan, PS Dr. Salman Ahmad, PS	NIAB, Faisalabad
23.	Basic Management Course	17-07-2023 to 11-08-2023	Mr. Shahzada Asif Ali, SS	SES, Islamabad
24.	Hands-on Training on "Soil, Water and Plant Analyses"	29-08-2023 to 31-08-2023	Dr. Haroon Shahzad, JS	NIAB, Faisalabad

NIFA OFFICERS LIST

Name		Designation
DIRECTOR OFFICE		
1-1	Dr. Gul Sanat Shah, Ph.D. Botany (Plant Breeding)	Director / CS
2-2	Dr. Muhammad Amin, Ph.D. Statistics	Manager ORIC / PS
PLANT BREEDNG & GENETICS DIVISION		
3-1	Dr. Roshan Zamir, Ph.D. Horticulture	Head / DCS
4-2	Hafiz Munir Ahmad, M.Sc. (Hons.) Plant Breeding & Genetics	PS
5-3	Dr. Muhammad Irfaq Khan, Ph.D. Biology	PS
6-4	Mr. Shahid Akbar Khalil, M.Sc. (Hons.) Horticulture	PS
7-5	Dr. Farooq-i-Azam, Ph.D. Crop Genetics & Breeding	PS
8-6	Dr. Syed Tariq Shah, Ph.D. Crop Genetics & Breeding	PS
9-7	Dr. Iqbal Saeed, Ph.D. Crop Genetics & Breeding	PS
10-8	Dr. Salman Ahmad, Ph.D. Crop Genetics & Breeding	PS
11-9	Dr. Akhtar Ali, Ph.D. Crop Genetics & Breeding	SS
12-10	Mr. Shahzad Ahmad, M.Sc. (Hons.) Plant Breeding & Genetics	JS
FOOD & NUTRITION DIVISION		
13-1	Dr. Maazullah Khan, Ph.D. Agricultural Food Engineering	Head / DCE
14-2	Dr. Muhammad Ibrahim, Ph.D. Plant Pathology	PS
15-3	Dr. Zahid Mehmood, Ph.D. Food Science and Technology	PS
16-4	Mr. Alamgeer Khan, M.S. Medical Physics	PS
17-5	Mr. Khurshid Ahmad, M.Phil. Chemistry	SS
18-6	Mr. Tauqeer Ahmad, M.Sc. (Hons.) Food Science and Technology	JS

Name		Designation
19-7	Mr. M. Asim Irshad, M.Sc. (Hons.) Food Science and Technology	JS
20.8	Mr. Muhammad Nisar, M.Phil Chemistry	ARO
21.9	Mr. Aurangzeb Khan, M.Sc Chemistry	ARO
22.10	Mr. Arshid Ali, M.Sc Chemistry	ARO
SOIL AND ENVIRONMENTAL SCIENCES DIVISION		
23-1	Dr. Muhammad Imtiaz, Ph.D. Soil Science	Head / DCS
24-2	Dr. Syed Azam Shah, Ph.D. Agronomy	DCS
25-3	Mr. Mukhtiar Ali, M.Sc. (Hons.) Soil Science	PS
26-4	Dr. Amir Raza, Ph.D. Natural Resources & Life Sciences	PS
27-5	Mr. Parvez Khan, M.Sc. (Hons.) Soil Science	PS
28-6	Mr. Zahid Ali, M.Sc. (Hons.) Soil Science	PS
29-7	Mr. Shahzada Asif Ali, M.Sc. (Hons.) Agronomy	SS
30-8	Dr. Haroon Shahzad, Ph.D. Soil Science	JS
PLANT PROTECTION DIVISION		
31-1	Dr. Syed Jawad Ahmad Shah, Ph.D. Plant Pathology	Head / DCS
32-2	Mr. Muhammad Zahid, M.Sc. (Hons.) Entomology	DCS
33-3	Dr. Inamullah Khan, Ph.D. Entomology	DCS
34-4	Dr. Gul Zamin Khan, Ph.D. Entomology	DCS
35-5	Dr. M. Misbah ul Haq, Ph.D. Entomology	PS
36-6	Dr. Muhammad Hamayoon Khan, Ph.D. Entomology	PS
37-7	Mr. Muhammad Salman, M.Sc. (Hons.) Plant Protection	SS
38-8	Mr. Muhammad Arfan, M.Sc. (Hons.) Entomology	SS
39-9	Mr. Usman Khaliq, M.Sc. (Hons.) Entomology	JS

Name		Designation
40-10	Mrs. Noor Fatima, M.Sc. (Hons.) Entomology	JS
TECHNICAL SERVICE DIVISION		
41-1	Mr. Muhammad Zubair Shah, M.S. Chemical Engineering	Head / PE
42-2	Mr. Abdul Khaliq, M.Sc. Computer Science	PS
43-3	Mr. Asif Murad, B.Sc. Electronics Engineering	PE
44-4	Mr. Jahangir Khan, M.S. Nuclear Engineering	SE
ADMINISTRATION & ACCOUNTS		
45-1	Mr. Sardar Khalid Khan, MBA	Sr. Admin Officer
46-2	Mr. Muhammad Jamil, MBA (Finance) and M.Sc., Economics	Sr. Account Officer
47-3	Mr. Raufullah, M.L.I.Sc.	Pr. Librarian

OFFICIALS PROMOTIONS

S. No.	Name	From	To	On
1.	Dr. Gul Sanat Shah	Dy. Chief Scientist	Chief Scientist	01.12.2023
2.	Dr. Gul Zamin Khan	Pr. Scientist	Dy. Chief Scientist	-do-
3.	Dr. Syed Azam Shah	Pr. Scientist	Dy. Chief Scientist	-do-
4.	Dr. Salman Ahmad	Sr. Scientist	Pr. Scientist	-do-
5.	Dr. M. H. Khan	Sr. Scientist	Pr. Scientist	-do-
6.	Mr. Muhammad Jamil	Sr. Accounts officer	Pr. Accounts Officer	-do-
7.	Mr. Shahzada Asif Ali	Jr. Scientist	Sr. Scientist	-do-
8.	Mr. Arshad Ali	Pr. Scientific Assistant	Asstt Research Officer	28.05.2023
9.	Mr. Aurangzeb Khan	Pr. Scientific Assistant	Asstt Research Officer	-do-
10.	Mr. Abdullah Khan	Jr. Executive-II (A/Cs)	Jr. Executive-I (A/Cs)	-do-
11.	Mr. Zahidullah Khan	Sr. Assistant (Admin)	Superintendent	-do-
12.	Mr. Midrarullah	Sr. Scientific Assistant	Pr. Scientific Assistant	-do-
13.	Syed M. Kamran	Sr. Technician	Pr. Technician	-do-
14.	Mr. Mujahid Hamid	Scientific Assistant-I	Sr. Scientific Assistant	-do-
15.	Mr. Luqman Shah	Technician-III	Technician-II	-do-
16.	Mr. Asghar Ali	Jr. Assistant-I (Admin)	Assistant (Admin)	-do-
17.	Mr. Bashir Ahmed	Driver-II	Driver-I	-do-
18.	Mr. Robin Rauf	Sanitary Attendant-I	Sr. Sanitary Attendant	-do-
19.	Mr. Fazal Dad	Chowkidar	Chowkidar-I	-do-
20.	Mr. Iftikhar Ahmed	Chowkidar	Chowkidar-I	-do-
21.	Mr. Malik Parvez	Chowkidar	Chowkidar-I	-do-
22.	Mr. Mir Muhammad	Chowkidar	Chowkidar-I	-do-
23.	Mr. Sanhar Ali	Chowkidar	Chowkidar-I	-do-
24.	Mr. M. Younas	Chowkidar	Chowkidar-I	-do-
25.	Mr. Muhammad Boota	Chowkidar	Chowkidar-I	-do-
26.	Mr. Bakhur Zaman	Chowkidar	Chowkidar-I	-do-
27.	Mr. Saeedullah	General Attendant-II	General Attendant-I	-do-
28.	Mian Sajid Shah	Cook-III Helper	Cook-II	-do-

PICTORIAL VIEW OF SCIENTIFIC EVENTS / TRAININGS

One-day Refresher Training on "Iodine Analysis for Lab Technicians"
Department of Health, KP on 07 Feb. 2023

10th Training Course for PAF Officials on "Modern Food Handling Techniques"
Feb. 13-17, 2023

Electron Beam & X-rays Technology in Industry and Qualitative Analysis of Added Micronutrients in Foods, Feb. 23, 2023

NIFA Farmer's Day (Mar. 15, 2023)

Drying of Fruits & Vertical Farming of Vegetables on May 30, 2023

Workshop on "Population and Commercialization of Insect pests Control Technologies'' held on July 25,2023

Training Course on "Seed Health Testing and Seed Pathology Protocols" from August 15-21, 2023

Workshop on "Management Strategies for Insect Pests of Medical Importance" held on September 20, 2023

38th Postgraduate Training Course on the "Use of Nuclear and other Techniques in Food & Agricultural Research on October 16-20, 2023

Workshop on Mushroom Farming Popularization as Cottage Industry December 21, 2023

Director NIFA presenting vote of thanks during QMS ISO 9001:2015 1st Surveillance Certification audit of NIFA November 20-21, 2023

28th MAY 2023 CELEBRATIONS

Dr. Misbah ul Haq, PS

Mr. Masood Khattak, Foreman

Mr. Arshad Hamid Awan, Accountant

DEVELOPED FACILITIES & RECEIVED EQUIPMENT/IMPLEMENTS

Threshing floor and security check post constructed under PARC- Pulses Project (PSDP # 635) entitled "Promoting Research for Productivity Enhancement in Pulses"

Boom Sprayer received under PARC- Pulses Project (PSDP # 635)

Mechanical weeder received under PARC- Pulses Project (PSDP # 635)

RO water purification plant installed under IAEA project RC-24975 on Nov. 22, 2023

Hybrid Solar Dryer (Under construction) under ALP project # 001

Atomic Absorption Mass Spectrometer installed under IAEA TC project Pak5053

OFFICIAL VISITS

Mr. Sadiq Hussain, Provincial Manager (Salt Iodization Program), Nutritional International Representative in Peshawar visited on January 03, 2023

Mr. Attiq Ahmed Chaudhry, MD ATCOP visited on January 10, 2023

Deputy Director Bureau of Agriculture, Peshawar visited on February 03, 2023

Director NIFA Visited Jamra Mardan for OFDTS on February 16, 2023

Member Science (PAEC) Visited on June 02, 2023

Member Science (PAEC) Visited on June 02, 2023


Officials of Kharif Pulses Traveling Seminar visited on August 24, 2023


Visit of Dr. Imtiaz Hussain, PARC Member (Science) & Muhammad Arshad Farooq, DG (P&DD) / Executive Director (ALP) on August 26, 2023


Mr. Obaid-Ur-Rehman, Director (IS), DOS PAEC, Visited on October 10, 2023

EDUCATIONAL TRIPS TO NIFA


Shaheed Banazir Bhutto Women University, Peshawar on January 12, 2023

Women University, Mardan on October 12, 2023

University of Haripur, Haripur on December 14, 2023

FRESH APPOINTMENTS

Dr. Haroon Shahzad, JS
Appointment on 13-02-2023

Zeeshan Sakhi, SA-IV
Appointment on 27-03-2023

Muhammad Daud, SA-IV
Appointment on 28-03-2023

Tauqeer Ahmed, SA-IV
Appointment on 28-03-2023

Waqas Khan, SA-IV
Appointment on 28-03-2023

Amir Mansoor, SA-IV
Appointment on 28-03-2023

Hazrat Zubair, SA-IV
Appointment on 10-04-2023

Asif Jan, SA-IV
Appointment on 10-04-2023

Rashid Ali, SA-IV
Appointment on 17-04-2023

Muhammad Rahman, SA-IV
Appointment on 17-04-2023

M. Khuram Shahzad, SA-IV
Appointment on 10-04-2023

TRANSFERS / POSTINGS

Transfer IN : **WELCOME**

M. Jamil, PAO
From PAEC HQ Islamabad
01-03-2023

Muhammad Ali, Asstt (Admin)
From BINO, Bahawalpur
02-03-2023

Anwar Din, Chowkidar
From NIA, Tandojam
20-03-2023

Abdur Rehman, Pr. Tech
From MDP, Sectt, Islamabad
13-06-2023

Fayaz Ahmad, Driver-II
From REO, Peshawar
05-07-2023

Abdul Khaliq, Pr. Scientist
From ICCC, Islamabad
08-09-2023

Zeenat Aman, Jr. Assistant
From MPB-2, Karak
09-10-2023

Muhammad Asif, Tech-I
From CPC, D.G. Khan
16-10-2023

Transfer OUT : **ALLAH HAFIZ**

Ali Raza, Js
To NIAB Faisalabad
31-01-2023

M. Islam, Acct. Officer
To IRNUM, Peshawar
21-02-2023

Yasir Muhib, Sr, Acct Officer
To IRNUM, Peshawar
03-03-2023

Jamshaid Akhtar, Tech-II
To KNC, Mianwali
06-06-2023

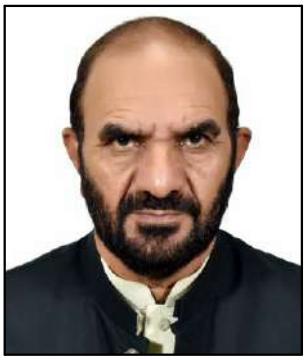
Atta ur Rehman, Driver-II
To REO, Peshawar
21-07-2023

Bashir Ahmed, Driver-I
To KNC, Mianwali
04-08-2023

RETIREMENTS / RELIEVING

Muhammad Shakeel Khan
Pr. Admin Officer
Retired on 12.01.2023

Mr. Malang Khan,
Scientific Assistant-II
Retired on12.04.2023



Mr. Muhammad Tariq,
Research Associate
Retired on 15.11.20

Dr. Talat Mehmood,
Senior Scientist
Joined Kohsar University
Murree as Associate Professor
on 22.08.2023

Mr. M. Zeeshan Khan,
Assistant A/Cs
Joined Election Commission of
Pakistan as Dy. Assistant
Director on 21.09.2023

FAREWELL ON RETIREMENT


Mr. Muhammad Shakeel Khan, Pr. A. Officer, Retirement on January 11, 2023

Mr. Malang Khan, Sr- Scientific Assistant,
Retirement on April 11, 2023

الله حافظ


Mr. Muhammad Tariq, Research Associate, Retirement on October 15, 2023

EXCURSION TRIPS

Farm Management Murree & Galiyat, Sep. 1-3, 2023

FND Swat & Kalam, on Sep. 15-17, 2023

PBGD Gilyat & Muree, on Sep. 15-16, 2023

ORIC, Soil Science & Admin, Hunza & Gilgit on Sep. 27, October 01, 2023

OFFICIALS PROMOTION PARTIES


Promotion Party on Feb. 09, 2023 (Officials promoted in the year 2022)




Promotion Party on Dec. 20, 2023 (Officials promoted in the year 2023)

CHRISTMAS CELEBRATIONS

Christmas Celebration with Christian Community

SAD DEMISE OF NIFA EMPLOYEE

Mr. Doran Shah passed away on October 12, 2023

إِنَّا لِلَّهِ وَإِنَّا إِلَيْهِ رَاجِعُونَ

SCIENTIFIC EVENTS CALENDAR 2024

NUCLEAR INSTITUTE FOR FOOD AND AGRICULTURE PESHAWAR

ISO 9001 : 2015 Certified

Scientific Events Calendar 2024

FEBRUARY 28, 2024

Workshop on "Use of Electron Beam and X-rays Technology and Qualitative Analysis of Added Micronutrients in Foods"

Organizers

Dr. Zahid Mehmood, PS 0333-5033898
zahidnifa@gmail.com
Mr. Alamgeer Khan, PS 0346-9322294

MARCH 6, 2024

NIFA Farmer's Day

Organizers

Dr. Roshan Zamir, DCS 0301-8580109
Dr. Syed Tariq Shah, PS 0333-9169298
stariq81@yahoo.com
Dr. Salman Ahmad, PS 0333-1612221

APRIL 25, 2024

Workshop on "Integrated Nutrient and Water Management for Off-Season Fruits & Vegetables Production"

Organizers

Dr. Amir Raza, PS 0304-0501455
amir.boku@gmail.com
Mr. Parvez Khan, PS 0333-9386824

MAY 9, 2024

Workshop on "Popularization of Eco-friendly Insect Pest Control Technologies"

Organizers

Dr. M. Misbah ul Haq, PS 0300-5511402
misbah_nifa@yahoo.com
Dr. M. Hamayoon Khan, PS 0333-9227687

JUNE 4, 2024

Workshop on "Solar Drying of Fruits & Vegetables"

Organizers

Dr. Maazullah Khan, DCE 0300-5834039

Mr. M. Asim Irshad, JS 0334-7053090
aaxim.ch@gmail.com

SEPTEMBER 24, 2024

Workshop on "Management Strategies for Insect Pests of Medical Importance"

Organizers

Dr. Gul Zamin Khan, DCS 0331-3811979
gulzaminkhan@yahoo.com
Dr. Inamullah Khan, DCS 0334-9059180

OCTOBER 14-18, 2024

39th Postgraduate Training Course on "The Use of Nuclear and other Techniques in Food & Agricultural Research"

Organizers

Dr. Muhammad Amin, PS 0333-9156518
aminkanju@gmail.com
Dr. Haroon Shahzad, JS 0323-6038220
Dr. Noor Fatima, JS 0333-4478208

DECEMBER 19, 2024

Workshop on "Mushroom Farming Popularization as Cottage Industry"

Organizers

Dr. Muhammad Ibrahim, PS 0334-9180642
ibra786pk@yahoo.co.uk
Mr. Khurshid Ahmad, SS 0315-5440068

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ANNUAL REPORT 2023

NIFA NIJAT-23

Fakhre NIFA-2023

ISO/IEC 17025:2017
Food Testing Lab Accreditation

NIFA Sarson-T23

ISO 9001 : 2015 Certified

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